



2017

INFRASTRUCTURE REPORT CARD

**A COMPREHENSIVE ASSESSMENT
OF AMERICA'S INFRASTRUCTURE**



2017 INFRASTRUCTURE REPORT CARD

For nearly 20 years, the American Society of Civil Engineers has been releasing its quadrennial Infrastructure Report Card. Its message is starting to take hold: public opinion surveys regularly show that Americans recognize the need to repair our nation's aging and deteriorating infrastructure.

Yet we still are not investing in infrastructure to the level it requires and warrants as the backbone of our economy. Notably, public officials are talking about the need to improve our infrastructure more regularly, even making campaign promises. But they have yet to follow through in a grade-changing way. Failing to act to rebuild America's infrastructure costs every American family \$3,400 a year, and the costs and consequences to our economy are significant.

ASCE represents more than 150,000 civil engineers worldwide who are the stewards of infrastructure. We design, build, and maintain it. We are also natural problem solvers. That is why the Report Card not only defines the problems facing our nation's infrastructure; it also offers solutions.

Quite a few of ASCE's past recommendations have come to fruition, such as creating a National Dam Rehabilitation Program and state gas tax increases to raise investment in surface transportation. Yet, the overarching solutions remain the same because the underlying challenges have yet to be effectively addressed. That's why, in 2017, we're leading with investment. Without real funding, every other solution can be implemented but the \$2 trillion question will still be looming. In infrastructure, you get what you pay for and for decades we haven't been paying nearly enough. It shows in the grades.

It's time to change that, not in one-time, short-term patches and small-scale investment increases, but through bold leadership, thoughtful planning, and—most importantly—sustained, strategic investment. Through such transformative action, our infrastructure will be improved and built for the future.

All Americans share a role in renewing the nation's infrastructure and solving our problems will take collective action and tough choices. Government and the private sector must partner to pay down our infrastructure debt, and commit to a future in which we preserve infrastructure and value it as our economic backbone. Join the American Society of Civil Engineers and others in advocating for infrastructure investment and restoration by sharing this Infrastructure Report Card and contacting your elected officials. Every day we continue to delay investing in our nation's infrastructure, we escalate our shared costs, jeopardize our health, and risk our security – an option our country, economy, and communities can no longer afford.

Norma Jean Mattei, Ph.D., P.E.
American Society of Civil Engineers President 2017



WE MUST COMMIT TODAY TO REALIZE AN AMERICAN INFRASTRUCTURE SYSTEM THAT SECURES OUR NATION'S SHARED PROSPERITY.

Our nation is at a crossroads. Deteriorating infrastructure is impeding our ability to compete in the thriving global economy, and improvements are necessary to ensure our country is built for the

future. While we have made some progress, reversing the trajectory after decades of underinvestment in our infrastructure requires transformative action from Congress, states, infrastructure owners, and the American people.

Our nation's infrastructure challenges are significant but solvable. Through strategic, sustained investment, bold leadership, comprehensive planning, and careful preparation for the needs of the future, America's infrastructure will be improved and restored.

For the U.S. economy to be the most competitive in the world, we need a first-class infrastructure system — transport systems that move people and goods efficiently and at reasonable cost by land, water, and air; power transmission systems that deliver reliable, low-cost power from a sustainable range of energy sources; and water systems that protect public health. To achieve this, leaders on both sides of the political aisle need to make good on promises they have made to improve our nation's infrastructure and ensure these pledges don't fall by the wayside after each election cycle. Infrastructure is the foundation that connects the nation's businesses, communities, and people, driving our economy, improving our quality of life, and ensuring our public health and safety. Now is the time to renew, modernize, and invest in our infrastructure to maintain our international competitiveness. The longer we wait, the more it will cost.



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AMERICA'S CUMULATIVE
INFRASTRUCTURE GPA



THE 2017 INFRASTRUCTURE REPORT CARD

The 2017 *Infrastructure Report Card* reveals that we have made some incremental progress toward restoring our nation's infrastructure. But it has not been enough. **As in 2013, America's cumulative GPA is once again a D+.**






























The 2017 grades range from a B for Rail to a D- for Transit, illustrating the clear impact of investment — or lack thereof — on the grades. Three categories — Parks, Solid Waste, and Transit — received a decline in grade this year, while seven — Hazardous Waste, Inland Waterways, Levees, Ports, Rail, Schools, and Wastewater — saw slight improvements. Six categories' grades remain unchanged from 2013 — Aviation, Bridges, Dams, Drinking Water, Energy, and Roads. The areas of infrastructure that improved benefited from vocal leadership, thoughtful policymaking, and investments that garnered results. These improvements demonstrate what can be accomplished when solutions that move projects forward are approved and implemented.



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Over the last four years, several infrastructure categories showed progress, resulting in grade increases. However, the 2017 Report Card's cumulative GPA of D+ reflects the significant backlog of needs facing our nation's infrastructure writ large. Underperforming, aging infrastructure remains a drag on the national economy, and costs every American family \$3,400 a year.

 AVIATION 	 PARKS & RECREATION 
 BRIDGES 	 PORTS 
 DAMS 	 RAIL 
 DRINKING WATER 	 ROADS 
 ENERGY 	 SCHOOLS 
 HAZARDOUS WASTE 	 SOLID WASTE 
 INLAND WATERWAYS 	 TRANSIT 
 LEVEES 	 WASTEWATER 



INFRASTRUCTURE INVESTMENT NEEDS

Infrastructure is the backbone of the U.S. economy and a necessary input to every economic output. It is critical to the nation's prosperity and the public's health and welfare. Infrastructure's condition has a cascading impact on our nation's economy, impacting business productivity, gross domestic product (GDP), employment, personal income, and international competitiveness.

America's infrastructure bill is long overdue. Every four years, ASCE estimates the investment needed in each infrastructure category to maintain a state of good repair and earn a grade of B. The most recent analysis reveals the U.S. has only been paying half of its infrastructure bill for some time and failing to close that gap risks rising costs, falling business productivity, plummeting GDP, lost jobs, and ultimately, reduced disposable income for every American family.

Even though the U.S. Congress and some states have recently made efforts to invest more in infrastructure, these efforts do not come close to the \$2.0 trillion in needs. The good news is that closing America's infrastructure gap is possible if Congress, states, infrastructure owners, and voters commit to increasing our investment. To raise the overall infrastructure grade and maintain our global competitiveness, Congress and the states must invest an additional \$206 billion each year.

As ASCE discovered in its 2016 economic study, *Failure to Act: Closing the Infrastructure Investment Gap for America's Economic Future*, failing to close this infrastructure investment gap brings serious economic consequences:

- ▶▶ **\$3.9 trillion in losses to the U.S. GDP by 2025;**
- ▶▶ **\$7 trillion in lost business sales by 2025; and**
- ▶▶ **2.5 million lost American jobs in 2025.**

On top of those costs, hardworking American families will lose upwards of \$3,400 in disposable income each year — about \$9 each day.

The time to invest in our nation's infrastructure is now. The longer we wait, the more it costs. Investing now will save our country more in the long run while also creating economic opportunity, enhancing quality of life, and ensuring public health and safety.



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Cumulative Infrastructure Needs by System Based on Current Trends, Extended to 2025

ALL VALUES IN BILLIONS OF CONSTANT 2015 DOLLARS

2016–2025 (10 YEARS)

Infrastructure Systems	Total Needs	Estimated Funding	Funding Gap
Surface Transportation ¹	\$2,042	\$941	\$1,101
Water/Wastewater Infrastructure ¹	\$150	\$45	\$105
Electricity ¹	\$934	\$757	\$177
Airports ¹	\$157	\$115	\$42
Inland Waterways & Marine Ports ¹	\$37	\$22	\$15
Dams ²	\$45	\$5.6	\$39.4
Hazardous & Solid Waste ³	\$7	\$4	\$3
Levees ⁴	\$80	\$10	\$70
Public Parks & Recreation ⁵	\$114.4	\$12.1	\$102.3
Rail ⁶	\$154.1	\$124.7	\$29.4
Schools ⁷	\$870	\$490	\$380
TOTALS	\$4,590	\$2,526	\$2,064

¹ Data taken from ASCE's *Failure to Act: Closing the Infrastructure Investment Gap for America's Economic Future* (2016).

² Total needs are federal and non-federal high-hazard dams.

³ Funding only includes publicly funded remediation, not funds from private sector.

⁴ Total needs number based on discussions with the National Committee on Levee Safety

⁵ Does not include backlog and estimated spending for U.S. Army Corps of Engineers and city parks.

⁶ Needs and funding estimates based on market projections and current investment trends.

⁷ Data from *State of Our Schools: America's K-12 Facilities* (2016). 21st Century School Fund, Inc., U.S. Green Building Council, Inc., and the National Council on Schools Facilities.

*numbers may not add up due to rounding



SOLUTIONS TO RAISE THE GRADES

To raise the national infrastructure grade over the next four years, ASCE urges the following starting points, so that every American family, community, and business can thrive. Through strategic, sustained investment, bold leadership, thoughtful planning, and careful preparation for the needs of the future, America's infrastructure will be improved and restored.

INVESTMENT

If the United States is serious about achieving an infrastructure system fit for the 21st century, some specific steps must be taken, beginning with **increased, long-term, consistent investment**. To continue to delay such investment only escalates the costs and risks of an aging infrastructure system — an option the country, the economy, and families can no longer afford. To close the \$2.0 trillion 10-year investment gap, meet future need, and restore our global competitive advantage, we must **increase investment from all levels of government and the private sector from 2.5 percent to 3.5 percent of U.S. Gross Domestic Product (GDP) by 2025**. This investment must be consistently and wisely allocated, and must begin with the following steps:

1. Put the “trust” back into “trust funds.” Dedicated public funding sources on the local, state, and federal levels need to be consistently and sufficiently funded from user-generated fees, with infrastructure trust funds never used to pay for or offset other parts of a budget.
2. Fix the Highway Trust Fund by raising the federal motor fuels tax. To ensure longterm, sustainable funding for the federal surface transportation program the current user fee must be raised and tied to inflation to restore its purchasing power, fill the funding deficit, and ensure reliable funding for the future.
3. Authorize and fund programs to improve specific categories of deficient infrastructure and support that commitment by fully funding them in an expedient, prioritized manner.
4. Infrastructure owners and operators must charge, and Americans must be willing to pay, rates and fees that reflect the true cost of using, maintaining, and improving infrastructure.

LEADERSHIP & PLANNING

Smart investment will only be possible with leadership, planning, and a clear vision for our nation's infrastructure. **Leaders from all levels of government, business, labor, and nonprofit organizations must come together to ensure all investments are spent**



wisely, prioritizing projects with critical benefits to the economy, public safety, and quality of life, while also planning for the costs of building, operating, and maintaining the infrastructure for its entire lifespan. To do so, we must:

1. Require all projects greater than \$5 million that receive federal funding use **life cycle cost analysis** and develop a plan for funding the project, including its maintenance and operation, until the end of its service life.
2. **Create incentives** for state and local governments and the private sector to invest in maintenance.
3. Develop tools to ensure that projects most in need of investment and maintenance are prioritized, to **leverage limited funding wisely**.
4. **Streamline the project permitting process** across infrastructure sectors, with safeguards to protect the natural environment, to provide greater clarity to regulatory requirements, bring priority projects to reality more quickly, and secure cost savings.
5. Identify a pipeline of infrastructure projects attractive to **private sector investment and public-private partnerships**. ASCE recognizes civil engineers' unique leadership role in addressing our infrastructure challenges. ASCE issued its "Grand Challenge," a call to action for the entire civil engineering profession to increase the value and capacity of infrastructure and increase and optimize infrastructure investments by transforming the way we plan, deliver, operate, and maintain our nation's infrastructure.

PREPARING FOR THE FUTURE

We must utilize new approaches, materials, and technologies to ensure our infrastructure is more **resilient** — to more quickly recover from significant weather and other hazard events — and **sustainable** — improving the "triple bottom line" with clear economic, social, and environmental benefits.

1. **Develop active community resilience programs for severe weather and seismic events to establish communications systems and recovery plans to reduce impacts on the local economy, quality of life, and environment.**



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2. **Consider emerging technologies and shifting social and economic trends** — such as autonomous vehicles, distributed power generation and storage, and larger ships — when building new infrastructure, to assure long-term utility.
3. **Improve land use planning** at the local level to consider the function of existing and new infrastructure, the balance between the built and natural environments, and population trends in communities of all sizes, now and into the future.
4. **Support research and development** into innovative new materials, technologies, and processes to modernize and extend the life of infrastructure, expedite repairs or replacement, and promote cost savings.



GRADING METHODOLOGY

Every four years, America's civil engineers provide a comprehensive assessment of the nation's 16 major infrastructure categories in ASCE's *Infrastructure Report Card*. Using a simple A to F school report card format, the Report Card examines current infrastructure conditions and needs, assigning grades and making recommendations to raise them.

The ASCE Committee on America's Infrastructure, made up of 28 dedicated civil engineers from across the country with decades of expertise in all categories, volunteers their time to work with ASCE Infrastructure Initiatives staff to prepare the *Report Card*. The Committee assesses all relevant data and reports, consults with technical and industry experts, and assigns grades using the following criteria:

- *Capacity*: Does the infrastructure's capacity meet current and future demands?
- *Condition*: What is the infrastructure's existing and near-future physical condition?
- *Funding*: What is the current level of funding from all levels of government for the infrastructure category as compared to the estimated funding need?
- *Future Need*: What is the cost to improve the infrastructure? Will future funding prospects address the need?
- *Operation and Maintenance*: What is the owners' ability to operate and maintain the infrastructure properly? Is the infrastructure in compliance with government regulations?
- *Public Safety*: To what extent is the public's safety jeopardized by the condition of the infrastructure and what could be the consequences of failure?
- *Resilience*: What is the infrastructure system's capability to prevent or protect against significant multi-hazard threats and incidents? How able is it to quickly recover and reconstitute critical services with minimum consequences for public safety and health, the economy, and national security?
- *Innovation*: What new and innovative techniques, materials, technologies, and delivery methods are being implemented to improve the infrastructure?

GRADING SCALE

A: EXCEPTIONAL, FIT FOR THE FUTURE

The infrastructure in the system or network is generally in excellent condition, typically new or recently rehabilitated, and meets capacity needs for the future. A few elements show signs of general deterioration that require attention. Facilities meet modern standards for functionality and are resilient to withstand most disasters and severe weather events.

B: GOOD, ADEQUATE FOR NOW



The infrastructure in the system or network is in good to excellent condition; some elements show signs of general deterioration that require attention. A few elements exhibit significant deficiencies. Safe and reliable, with minimal capacity issues and minimal risk.

C: MEDIOCRE, REQUIRES ATTENTION

The infrastructure in the system or network is in fair to good condition; it shows general signs of deterioration and requires attention. Some elements exhibit significant deficiencies in conditions and functionality, with increasing vulnerability to risk.

D: POOR, AT RISK

The infrastructure is in poor to fair condition and mostly below standard, with many elements approaching the end of their service life. A large portion of the system exhibits significant deterioration. Condition and capacity are of serious concern with strong risk of failure.

F: FAILING/CRITICAL, UNFIT FOR PURPOSE

The infrastructure in the system is in unacceptable condition with widespread advanced signs of deterioration. Many of the components of the system exhibit signs of imminent failure.



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AVIATION



U.S. airports serve more than two million passengers every day. The aviation industry is marked by technologically advanced and economically efficient aircraft, however, the associated infrastructure of airports and air traffic control systems is not keeping up. Congestion at airports is growing; it is expected that 24 of the top 30 major airports may soon experience “Thanksgiving-peak traffic volume” at least one day every week. With a federally mandated cap on how much airports can charge passengers for facility expansion and renovation, airports struggle to keep up with investment needs, creating a \$42 billion funding gap between 2016 and 2025.

BRIDGES



The U.S. has 614,387 bridges, almost four in 10 of which are 50 years or older. 56,007 — 9.1% — of the nation’s bridges were structurally deficient in 2016, and on average there were 188 million trips across a structurally deficient bridge each day. While the number of bridges that are in such poor condition as to be considered structurally deficient is decreasing, the average age of America’s bridges keeps going up and many of the nation’s bridges are approaching the end of their design life. The most recent estimate puts the nation’s backlog of bridge rehabilitation needs at \$123 billion.



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DAMS



Dams provide vital service and protection to our communities and economy. The average age of the 90,580 dams in the country is 56 years. As our population grows and development continues, the overall number of high-hazard potential dams is increasing, with the number climbing to nearly 15,500 in 2016. Due to the lack of investment, the number of deficient high-hazard potential dams has also climbed to an estimated 2,170 or more. It is estimated that it will require an investment of nearly \$45 billion to repair aging, yet critical, high-hazard potential dams.

DRINKING WATER



Drinking water is delivered via one million miles of pipes across the country. Many of those pipes were laid in the early to mid-20th century with a lifespan of 75 to 100 years. The quality of drinking water in the United States remains high, but legacy and emerging contaminants continue to require close attention. While water consumption is down, there are still an estimated 240,000 water main breaks per year in the United States, wasting over two trillion gallons of treated drinking water. According to the American Water Works Association, an estimated \$1 trillion is necessary to maintain and expand service to meet demands over the next 25 years.



ENERGY



Much of the U.S. energy system predates the turn of the 20th century. Most electric transmission and distribution lines were constructed in the 1950s and 1960s with a 50-year life expectancy, and the more than 640,000 miles of high-voltage transmission lines in the lower 48 states' power grids are at full capacity. Energy infrastructure is undergoing increased investment to ensure long-term capacity and sustainability; in 2015, 40% of additional power generation came from natural gas and renewable systems. Without greater attention to aging equipment, capacity bottlenecks, and increased demand, as well as increasing storm and climate impacts, Americans will likely experience longer and more frequent power interruptions.

HAZARDOUS WASTE



Over 18,000 sites and an associated 22 million acres of land are related to the primary hazardous waste programs that comprise much of the nation's hazardous waste infrastructure, and more than half of the U.S. population lives within three miles of a hazardous waste site. The current capacity of the nation's hazardous waste infrastructure is generally adequate, owing in no small measure to significant improvements in managing materials through recycling and reuse, rather than disposal. There have also been significant improvements in remediation technologies, resulting in faster and less resource-intensive cleanup approaches.



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INLAND WATERWAYS



The United States' 25,000 miles of inland waterways and 239 locks form the freight network's "water highway." This intricate system, operated and maintained by the U.S. Army Corps of Engineers, supports more than half a million jobs and delivers more than 600 million tons of cargo each year, about 14% of all domestic freight. Most locks and dams on the system are well beyond their 50-year design life, and nearly half of vessels experience delays. Investment in the waterways system has increased in recent years, but upgrades on the system still take decades to complete.

LEVEES



A nationwide network of 30,000 documented miles of levees protects communities, critical infrastructure, and valuable property, with levees in the U.S. Army Corps of Engineers Levee Safety Program protecting over 300 colleges and universities, 30 professional sports venues, 100 breweries, and an estimated \$1.3 trillion in property. As development continues to encroach in floodplains along rivers and coastal areas, an estimated \$80 billion is needed in the next 10 years to maintain and improve the nation's system of levees. In 2014 Congress passed the Water Resources Reform and Development Act, which expanded the levee safety program nationwide, but the program has not yet received any funding.



PARKS & RECREATION



A vast network of infrastructure goes into supporting more than seven billion outdoor recreational outings. Americans enjoy park and recreation facilities maintained by entities at all levels of government. At the federal level, the National Park Service, U.S. Forest Service, and U.S. Army Corps of Engineers are the main providers of park facilities. States and localities provide the bulk of park and recreational facilities that seven in 10 Americans use on a regular basis. National forests and grasslands capture and filter drinking water for 180 million people. America's parks and public lands also support industries such as lodging, restaurants and bars, grocery and convenience stores, and gas stations.

PORTS



The United States' 926 ports are essential to the nation's competitiveness, serving as the gateway through which 99% of overseas trade passes. Ports are responsible for \$4.6 trillion in economic activity – roughly 26% of the U.S. economy. As ships get bigger, congestion at landside connections to other components of the freight network increasingly hinders ports' productivity. Similarly, on the water side, larger ships require deeper navigation channels, which only a few U.S. ports currently have. To remain competitive globally and with one another, ports have been investing in expansion, modernization, and repair.



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RAIL



B

For more than 150 years the rail network has been a critical component of the U.S. transportation system and economy. Today it carries approximately one-third of U.S. exports and delivers five million tons of freight and approximately 85,000 passengers each day. The private freight rail industry owns the vast majority of the nation's rail infrastructure, and continues to make significant capital investment — \$27.1 billion in 2015 — to ensure the network's good condition. U.S. rail still faces clear challenges, most notably in passenger rail, which faces the dual problems of aging infrastructure and insufficient funding.

ROADS



D

America's roads are often crowded, frequently in poor condition, chronically underfunded, and are becoming more dangerous. More than two out of every five miles of America's urban interstates are congested and traffic delays cost the country \$160 billion in wasted time and fuel in 2014. One out of every five miles of highway pavement is in poor condition and our roads have a significant and increasing backlog of rehabilitation needs. After years of decline, traffic fatalities increased by 7% from 2014 to 2015, with 35,092 people dying on America's roads.



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SCHOOLS



Every school day, nearly 50 million K-12 students and six million adults occupy close to 100,000 public school buildings on an estimated two million acres of land. The nation continues to underinvest in school facilities, leaving an estimated \$38 billion annual gap. As a result, 24% of public school buildings were rated as being in fair or poor condition. While there have been a number of insightful reports in recent years, state and local governments are plagued by a lack of comprehensive data on public school infrastructure as they seek to fund, plan, construct, and maintain quality school facilities.

SOLID WASTE



Overall management of municipal solid waste (MSW) across America is currently in fair condition. In many cases, the transport and disposal of MSW is self-funded and managed by the private sector, and therefore is sufficiently funded. Americans generate about 258 million tons of MSW annually, of which approximately 53% is deposited in landfills — a share that has plateaued in recent years. Currently, 34.6% of MSW is recycled and 12.8% is combusted for energy production. There is a need to change the way we think of how solid waste is generated, managed, and potentially used as a resource. Americans need to recognize that what is routinely discarded may in fact be a reusable resource.



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TRANSIT



Transit in America continues to grow, carrying 10.5 billion trips in 2015, and adding new lines and systems every year. Yet the symptoms of overdue maintenance and underinvestment have never been clearer. Despite increasing demand, the nation's transit systems have been chronically underfunded, resulting in aging infrastructure and a \$90 billion rehabilitation backlog. While some communities are experiencing a transit boom, many Americans still have inadequate access to public transit.

WASTEWATER



The nation's 14,748 wastewater treatment plants protect public health and the environment. Years of treatment plant upgrades and more stringent federal and state regulations have significantly reduced untreated releases and improved water quality nationwide. It is expected that more than 56 million new users will be connected to centralized treatment systems over the next two decades, and an estimated \$271 billion is needed to meet current and future demands. Through new methods and technologies that turn waste into energy, the nation's 1,269 biogas plants help communities better manage waste through reuse.



OVERVIEW

U.S. airports serve more than two million passengers every day. The aviation industry is marked by technologically advanced and economically efficient aircraft, however, the associated infrastructure of airports and air traffic control systems is not keeping up. Congestion at airports is growing; it is expected that 24 of the top 30 major airports may soon experience “Thanksgiving-peak traffic volume” at least one day every week. With a federally mandated cap on how much airports can charge passengers for facility expansion and renovation, airports struggle to keep up with investment needs, creating a \$42 billion funding gap between 2016 and 2025.

CAPACITY & CONDITION

New, technologically advanced and fuel efficient aircraft are being deployed regularly, however, that tells only half the story of the aviation industry. In the other half, progress at the nation’s airports and in the air traffic control system is slow, as investment has been consistently lagging in the past 18 years, unable to keep up with demands of increased traffic and new technologies.

In 2015 there were in the United States:

- 8,727,691 commercial flights for the year;
- Approximately 7,000 aircraft in the air at any given time; and
- 2.25 million passengers every day.

The U.S. aviation network includes 3,345 airports as part of the National Plan of Integrated Airport Systems (NPIAS) with 3,331 existing and 14 proposed. Of these, 514 airports offer commercial service. There were a total of 786 million enplanements in the nation’s airports in 2015, up from 728 million in



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By 2020, the FAA estimates that NextGen improvements, if implemented, could result in a cumulative reduction in fuel consumption of 1.46 billion gallons and a projected 41% reduction in aircraft delays. This would generate \$38 billion in savings through 2020 for aircraft operators, the traveling public, and FAA.

FUNDING & FUTURE NEED

Generally, there are four sources of funding used to finance airport development: airport cash flow; revenue and general obligation bonds; federal/state/local grants, including the Airport Improvement Program (AIP); and Passenger Facilities Charges (PFCs). Under the 2012 FAA reauthorization, AIP received \$13.4 billion over four years or approximately \$3.35 billion annually funded primarily through airline ticket taxes. The PFC Program allows the collection of PFC fees – federally capped at no more than \$4.50 – for every enplaned passenger at commercial airports.

One interesting note is that as airlines have implemented a la carte pricing, ticket price revenue has suffered because the airline ticket taxes are not applied to baggage fees, food sales, or other discretionary passenger purchases. Allowing for a modest increase of approximately \$1 per ticket in the airline tax would cover much of the investment gap in airport infrastructure funding.

Funding issues have been compounded by the failure of Congress to regularly reauthorize FAA programs. Between 2007 and 2012 and again since 2015, the FAA operated under a series of short-term authorizations, leading to delays in investment decisions of FAA-funded airport projects. The current authorization will lapse on September 30, 2017. Furthermore, lapses in FAA authorization led to the stoppage of work on more than \$10 billion in national aerospace and support projects and \$2.5 billion in grants to new airport projects were withheld.

ASCE's *Failure to Act* economic study released in 2016 projects that the average annual investment gap for airports through 2025 is expected to decrease from \$4.6 billion to \$4.2 billion. However, by 2040, the cumulative gap is expected to slightly increase from a per year average of \$3.3 billion to \$3.5 billion in 2015 dollars – leaving a total investment gap of \$88 billion. By 2025 these projected infrastructure investment short falls may cause the loss of nearly 257,000 jobs and \$337 billion in lost GDP.

PUBLIC SAFETY & RESILIENCE

Airport security and the safety of the traveling public is an ongoing challenge for the nation's aviation enterprise. The needs of additional security to address the threats posed to airports and aircraft have had an impact on the operation of the nation's aviation system. The Transportation Security Agency (TSA) spent \$5.6 billion on aviation security in 2015; this does not include the financial burden on airports to accommodate security requirements.

The cost of additional security is measured not just in terms of the direct cost of security personnel, but also in terms of the needed footprint and additional infrastructure needed. Security measures also include hidden costs, such as the additional time spent by passengers undergoing security procedures, up to and including missed flights.



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Bridges



9.1% of bridges rated structurally deficient



SUMMARY

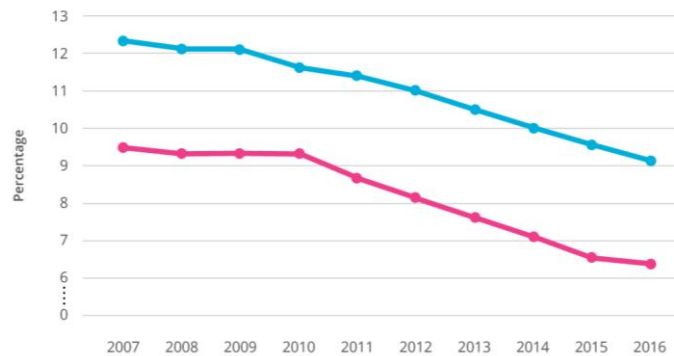
The U.S. has 614,387 bridges, almost four in 10 of which are 50 years or older. 56,007 — 9.1% — of the nation’s bridges were structurally deficient in 2016, and on average there were 188 million trips across a structurally deficient bridge each day. While the number of bridges that are in such poor condition as to be considered structurally deficient is decreasing, the average age of America’s bridges keeps going up and many of the nation’s bridges are approaching the end of their design life. The most recent estimate puts the nation’s backlog of bridge rehabilitation needs at \$123 billion.

CONDITION & CAPACITY

Over the past decade, there has been increased awareness of the significance of bridges to our nation’s economy and the safety of the traveling public. At all levels of government, a concerted effort has been made to reduce the number of structurally deficient bridges in the U.S.—bridges that require significant maintenance, rehabilitation, or replacement. Structurally deficient bridges are not unsafe, but could become so and need to be closed without substantial improvements.

As of 2016, one in 11 (9.1%) of bridges were designated structurally deficient, which

Structurally Deficient Bridges



Structurally Deficient
Bridges by Number



Structurally Deficient
Bridges by Area

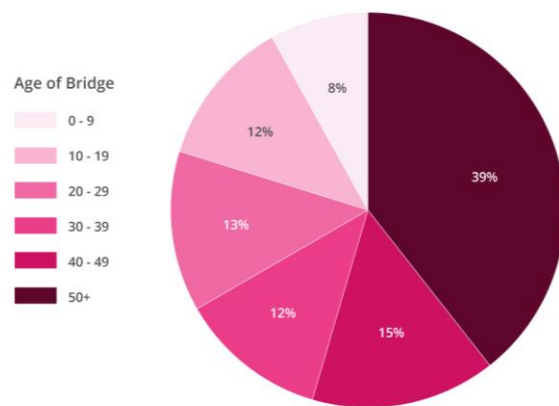


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represents an improvement from a decade ago when 12.3% of bridges were structurally deficient. As bridges greatly vary in size, the percentage of deck area that belongs to structurally deficient bridges is another useful indicator. 6.3% of total bridge area belonged to structurally deficient bridges in 2016, an improvement from 9.5% in 2007. Encouragingly, higher traffic volume bridges are less likely to be structurally deficient. Yet, on average, there were 188 million trips across a structurally deficient bridge each day in 2016. Some states are doing better than others at maintaining, repairing, or replacing their bridges. The percentage of bridges that are structurally deficient ranged from 1.6% in Nevada to 24.9% in Rhode Island in 2016.

Of the 614,387 bridges in the National Bridge Inventory, almost four in 10 (39%) are over 50 years or older, and an additional 15% are between the ages of 40 and 49. The average bridge in the U.S. is 43 years old. Most of the country's bridges were designed for a lifespan of 50 years, so an increasing number of bridges will soon need major rehabilitation or retirement.

America's Bridges by Age



As part of a bridge's regular inspection, it may be determined that the bridge can only carry traffic up to a certain weight or speed, requiring posting of a load restriction. One in 10 (10.1%) bridges had such restrictions in 2016. Posted bridges can dramatically increase driving time for larger vehicles such as school buses, ambulances, and delivery trucks. Bridges that do not serve current traffic demand or meet current standards, whether due to too few lanes or too narrow lanes or shoulders, are considered functionally obsolete. More than one in eight (13.6%) bridges in the U.S. were functionally obsolete in 2016 (if a bridge is both functionally obsolete and structurally deficient, it is only counted as structurally deficient). These bridges frequently act as choke points and can increase congestion.

FUNDING & FUTURE NEED

In recent years, investment at all levels of government has prioritized fixing bridges. The federal government estimates that \$17.5 billion was spent on bridge capital projects in 2012, with \$6 billion from the federal government and \$11.5 billion from state and local sources. This is a substantial increase from the \$11.5 billion that was spent on bridges in 2006. Investments in bridges were bolstered in 2009 and 2010 with the influx of additional funding from the American Recovery and Reinvestment Act and peaked in 2010 with \$18 billion spent. Despite the recent increases in spending, investments in the country's bridges are insufficient. The most recent federal estimate puts the backlog of rehabilitation projects for the nation's bridges at \$123 billion. *See the Roads chapter for more information on public spending on highways, including bridges.*

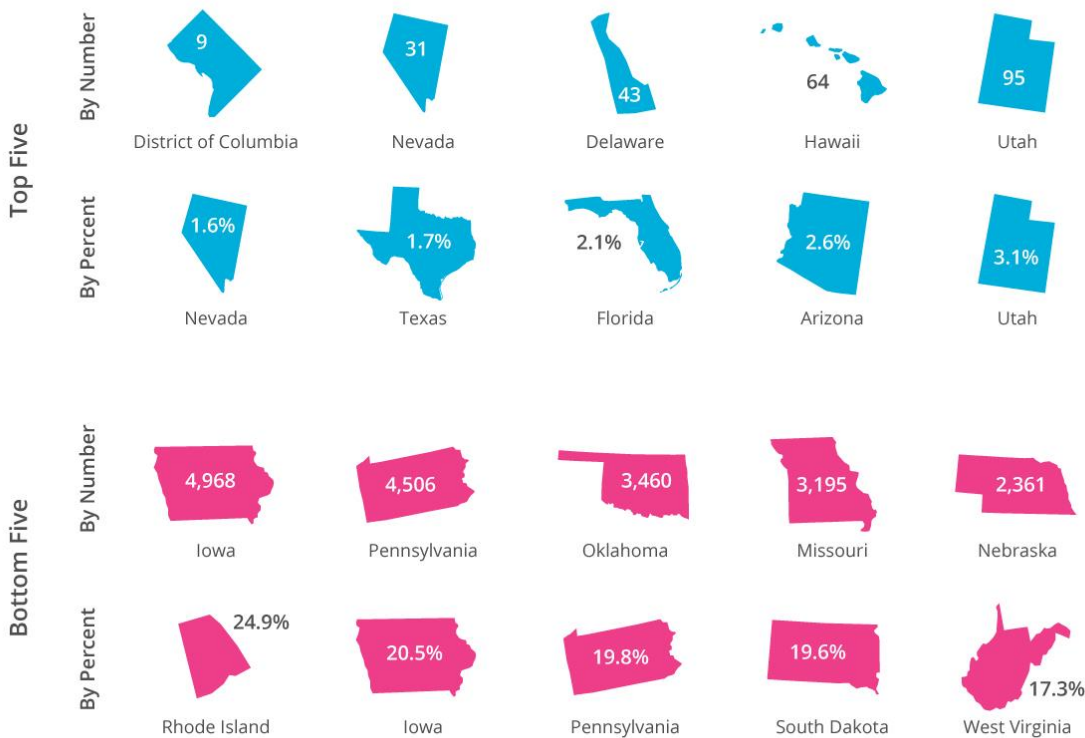
The past decade has also been marked with uncertainty for the federal surface transportation program, making it a challenge for state transportation agencies to make long-term plans. In December 2015, Congress passed the Fixing America's Surface Transportation (FAST) Act, a five-year surface



transportation bill, which should secure federal funding through 2020, however implementation of the increased funding levels included in the FAST Act has been delayed due to Congress’ inability to pass a new spending bill.

Federal investment in bridges has historically been paid for from the Highway Trust Fund, however, the fund has been teetering on the brink of insolvency for nine years due to the limitations of its primary funding source, the federal motor fuels tax. The state of the Highway Trust Fund is explored in greater depth in the *Roads* chapter.

Structurally Deficient Bridges: Top and Bottom Five States by Number and Percent



INNOVATION

New technologies and materials are helping engineers build bridges better and faster while also improving maintenance for longer bridge life. Sensors are being embedded into both new and existing bridges to provide continuous feedback on structural conditions. These data help engineers identify and address problems earlier and improve public safety. New materials such as ultra-high performance concrete, high performance steel, and composites are being used to add durability, higher strengths, resilience, and longer life to bridges. Prefabricated bridge elements—structural components that are built off-site—are being used to reduce the amount of time traffic needs to be disrupted while a bridge is repaired or constructed.



RECOMMENDATIONS TO RAISE THE GRADE

1. Increase funding from all levels of government to continue reducing the number of structurally deficient bridges, decrease the maintenance backlog, and address the large number of bridges that have passed or are approaching the end of their design life.
2. Bridge owners should consider the costs across a bridge's entire lifecycle to make smart design decisions and prioritize maintenance and rehabilitation.
3. Fix the federal Highway Trust Fund by raising the federal motor fuels tax. To ensure long-term, sustainable funding for the federal surface transportation program, the current user fee of 18.4 cents per gallon on gasoline and 24.4 cents per gallon on diesel should be raised and tied to inflation to restore its purchasing power, fill the funding deficit, and ensure reliable funding for the future.
4. States should ensure their funding mechanisms (motor fuels taxes or other) are sufficient to fund needed investment in bridges.
5. States and the federal government should consider long-term funding solutions for transportation infrastructure and potential alternatives to the motor fuel taxes, including further study and piloting of mileage-based user fees.

DEFINITIONS

Structurally deficient – Bridges that require significant maintenance, rehabilitation, or replacement. These bridges must be inspected at least every year since critical load-carrying elements were found to be in poor condition due to deterioration or damage.

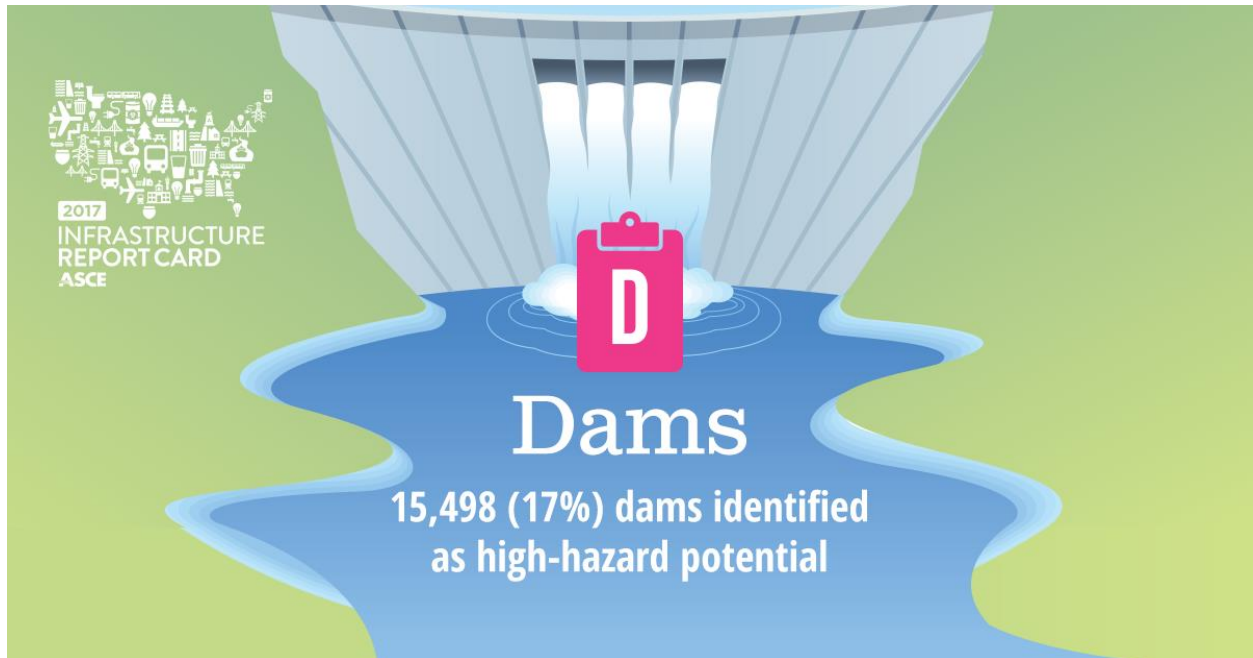
Functionally obsolete – Bridges that do not meet current engineering standards, such as narrow lanes or low load-carrying capacity. A bridge that is both structurally deficient and functionally obsolete is only counted as structurally deficient.

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SUMMARY

Dams provide vital service and protection to our communities and economy. The average age of the 90,580 dams in the country is 56 years. As our population grows and development continues, the overall number of high-hazard potential dams is increasing, with the number climbing to nearly 15,500 in 2016. Due to the lack of investment, the number of deficient high-hazard potential dams has also climbed to an estimated 2,170 or more. It is estimated that it will require an investment of nearly \$45 billion to repair aging, yet critical, high-hazard potential dams.

CONDITIONS & CAPACITY

Dams come in a variety of sizes and serve a number of purposes. Our nation's dams provide essential benefits such as drinking water, irrigation, hydropower, flood control, and recreation. The public most commonly thinks of engineering marvels like the Hoover Dam in Nevada rather than the smaller structure that created the lake at the center of a planned community. No matter how large or small, dams have a powerful presence that frequently is overlooked until failure has occurred.

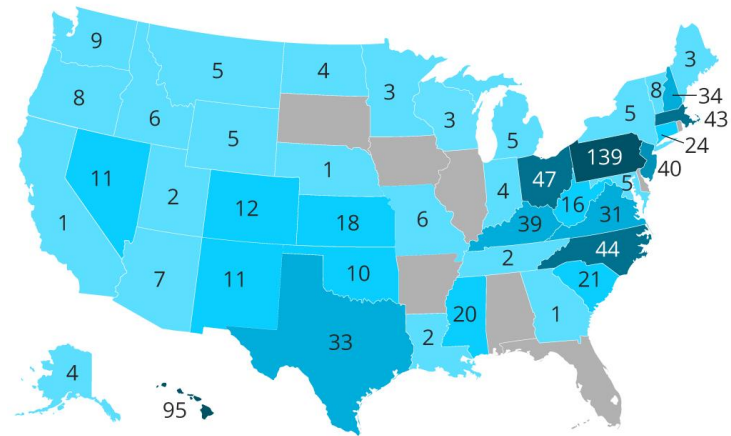
The safe operation and proper maintenance of dams is critical to sustaining the benefits, while mitigating the risk of a dam failure. Yet despite their importance, thousands of dams remain in need of rehabilitation to meet current design and safety standards. These structures are not only aging, but are subject to stricter criteria because of increased downstream development and advancing scientific knowledge predicting flooding, earthquakes, and dam failures.

Dams are classified based on their hazard potential, or anticipated consequences in the case of failure. The failure of a dam that is classified as high-hazard potential is anticipated to cause a loss of life. The



number of high-hazard potential dams is growing rapidly; as of 2015, there are approximately 15,500 dams in the United States that are classified as high-hazard potential. This number has climbed from 10,213 high-hazard potential dams in 2005 and is anticipated to continue to climb as areas below dams continue to be developed. With population growth expected to slow, the U.S. has an opportunity to more methodically develop currently unpopulated areas to avoid placing homes and other structures below dams, thereby reducing the number of structures classified as “high-hazard potential.” Another 11,882 dams are currently labeled as significant hazard potential, meaning a failure would not necessarily cause a loss of life, but could result in significant economic losses. While these figures climb, the increase has slowed because more dams are inspected on a more regular basis, allowing for the identification of deficiencies before they lead to a failure.

Dams that May Qualify for National Rehabilitation Funds



The average age of our nation’s dams is 56 years. By 2025, seven out of 10 dams in the United States will be over 50 years old. Fifty years ago dams were built with the best engineering and construction standards of the time. However, as the scientific and engineering data have improved, many dams are not expected to safely withstand current predictions regarding large floods and earthquakes. In addition, many of these dams were initially constructed using less-stringent design criteria for low-hazard potential dams due to the lack of development.

FUNDING & FUTURE NEED

Investment is needed to rehabilitate deficient dams and to improve the efficacy of policies and regulatory programs that oversee dam safety programs. Upgrade or rehabilitation is necessary due to deterioration, changing technical standards, and improved techniques, as well as better understanding of the area's precipitation conditions, increases in downstream populations, and changing land use. When a dam's hazard classification is changed to reflect an increased hazard potential, the dam may need to be upgraded to meet an increased need for safety. Many dam owners, especially private dam owners, find it difficult to finance rehabilitation projects.

The Association of State Dam Safety Officials estimates that the combined total cost to rehabilitate the nation’s non-federal and federal dams exceeds \$64 billion. To rehabilitate just those dams categorized as most critical, or high-hazard, would cost the nation nearly \$22 billion, a cost that continues to rise as maintenance, repair, and rehabilitation are delayed.

The U.S. Army Corps of Engineers estimates that more than \$25 billion will be required to address dam deficiencies for Corps-owned dams. At current investment rates, these repairs would take over 50 years



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to complete. The Bureau of Reclamation has identified approximately 20 of its high- and significant-hazard potential dams as in need of repair or upgrade. The cost of those actions is estimated at \$2 billion over the next 15 years.

The Water Infrastructure Improvements for the Nation (WIIN) Act signed into law in 2016 authorized a national dam rehabilitation and repair program, which would help fund the repair, removal, or rehabilitation of the nation's non-federal, high-hazard potential dams. When fully appropriated the provision has the potential to help to repair some of the highest priority dam safety rehabilitation projects in the country. Until this program is funded a lack of financial resources will continue to be a reason dam owners are unable to implement needed repairs and upgrades.

Nearly half of all states have a grant or low-interest revolving loan program to assist dam owners with repairs. This local commitment of funds can help to make the potential federal grants go even further. Overall, state dam safety program staffing has increased over the past several years. In 2015 state programs spent over \$49 million¹ on their regulatory programs, a 10% increase from just four years ago. The federal National Dam Safety Program was reauthorized by the Water Resources Reform and Development Act (WRRDA) in 2014 but has not seen a full appropriation at authorized levels.

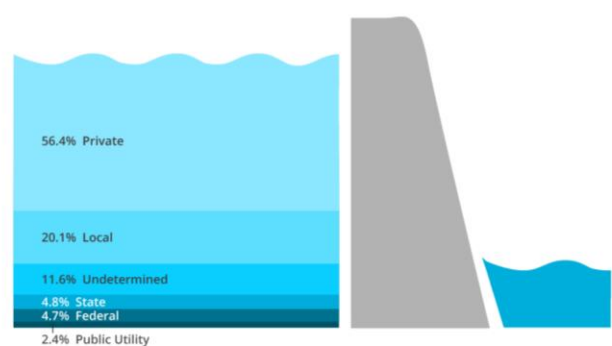
PUBLIC SAFETY & RESILIENCE

In order to improve public safety and resilience, the risk and consequences of dam failure must be lowered. Progress requires better planning for mitigating the effects of failures; increased regulatory oversight of the safety of dams; improving coordination and communication across governing agencies; and the development of tools, training, and technology.

Dam failures not only risk public safety, they also can cost our economy millions of dollars in damages. Failure is not just limited to damage to the dam itself. It can result in the impairment of many other infrastructure systems, such as roads, bridges, and water systems. When a dam fails, resources must be devoted to the prevention and treatment of public health risks as well as the resulting structural consequences. For this reason, emergency action plans (EAPs) for use in the event of an impending dam failure or other uncontrolled release of water are vital. The number of high-hazard potential dams with an EAP has increased in recent years; as of 2015 77% of dams have EAPs – up from 66% in the 2013 Report Card and marked progress toward the national goal of 100%.

Our nation's dams are owned and operated by many different entities including all levels of government. However more than half are owned by a private entity. The federal government owns 3,381 dams, or approximately 4% of the nation's

Dams Ownership in the United States





dams. The U.S. Army Corps of Engineers owns only 709 dams, more than half of which are 50 years old. With the majority of dams privately held, these structures likely rely on state dam safety programs for inspection. State dam safety programs have primary responsibility and permitting, inspection, and enforcement authority for more than three-quarters of the nation's dams. Therefore, state dam safety programs bear a large responsibility for public safety, but unfortunately, many lack sufficient resources, and in some cases, enough regulatory authority, to be effective. The national number of dams per state safety program employee totals 205. For perspective, some of the top state dam safety programs such as California, Colorado, New Jersey, and Pennsylvania have less than 135 dams per staff member (the California Division of Safety of Dams, a robust state dam safety program with regulatory oversight over many of the nation's most consequential dams, has only 20 dams per staff member). Despite continued efforts by public safety and engineering advocacy groups, Alabama continues to remain the only state without a dam safety regulatory program.

EAPs play the biggest role in keeping people and property safe in the event of a dam breach or failure. As of 2013, just five states had 100% of high-hazard potential dams with EAPs. Several states are making notable progress on increasing the percentage of dams with EAPs, including Hawaii, which went from having 2 dams with EAPs in 1999 to 120 in 2015.

Innovative approaches in risk management have the potential for seeing the costs of rehabilitation go down. The dam safety engineering practice is moving towards a risk-based decision-making process for the design, rehabilitation, and operation of dams. Risk-based decisions enable the dam owner to better utilize limited funding and prioritize projects by focusing on repairs and operational changes that reduce risk to acceptable levels, thus improving community resilience. Engineers, dam owners, regulators, and emergency management professionals should be engaging communities potentially affected by a dam failure in order to provide a fair portrayal of risk. Through broader community collaboration, stakeholders will be better able to support land use decisions, emergency action planning, and maintenance and rehabilitation funding, which will reduce community risk in the long term.

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RAISING THE GRADES—SOLUTIONS THAT WORK NOW

- Fund the national dam rehabilitation and repair funding program to cost-share repairs to non-federal, high-hazard potential dams.
- Develop emergency action plans for every high-hazard potential dam by 2021.
- Implement a national public awareness campaign to educate individuals on the location and condition of dams in their area and become more “dam aware.”
- Implement better public education about high-hazard potential dams, specifically ensuring the public has a better understanding of the dam rating system and how we determine condition.
- Encourage incentives to governors and state legislatures to provide sufficient resources and regulatory authorities to their dam safety programs.
- Require federal agencies that own, operate, or regulate dams to meet the standards of Federal Guidelines for Dam Safety.
- Encourage improved land use planning at the local level so that communication about how dams affect local areas is more accurately known and considered in future planning.



DEFINITIONS

Emergency Action Plan - A formal document that identifies potential emergency conditions at a dam and specifies preplanned actions to be followed to minimize property damage and loss of life should those conditions occur. The EAP contains procedures and information to assist the dam owner in issuing early warning and notification messages to responsible downstream emergency management authorities. It also should include inundation maps to show the emergency management authorities the critical areas for action in case of an emergency.

Dam Owner – Party or parties responsible for the safety and liability of the dam and for financing its upkeep, upgrade, and repair.

Dam Regulator – Party or parties responsible for dam safety enforcement including the safety evaluations of existing dams, review of plans and specifications for dam construction and major repair work, periodic inspections of construction work on new and existing dams, and review and approval of emergency action plans.

High-Hazard Potential Dam – A dam in which failure or mis-operation is expected to result in loss of life and may also cause significant economic losses, including damages to downstream property or critical infrastructure, environmental damage, or disruption of lifeline facilities.

Significant-Hazard Potential Dam – A dam in which the failure or mis-operation is not expected to cause loss of life, but results in significant economic losses, including damages to downstream property, critical infrastructure, environmental damage, or disruption of lifeline facilities.

Low-Hazard Potential Dam – A dam located in a rural or agricultural area where failure would not only cause the loss of the dam itself but may cause minor damage to nonresidential and normally unoccupied buildings, or rural or agricultural land.

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OVERVIEW

Drinking water is delivered via one million miles of pipes across the country. Many of those pipes were laid in the early to mid-20th century with a lifespan of 75 to 100 years. The quality of drinking water in the United States remains high, but legacy and emerging contaminants continue to require close attention. While water consumption is down, there are still an estimated 240,000 water main breaks per year in the United States, wasting over two trillion gallons of treated drinking water. According to the American Water Works Association, an estimated \$1 trillion is necessary to maintain and expand service to meet demands over the next 25 years.

CAPACITY AND CONDITION

The United States uses 42 billion gallons of water a day to support daily life from cooking and bathing in homes to use in factories and offices across the country. Around 80% of drinking water in the U.S. comes from surface waters such as rivers, lakes, reservoirs, and oceans, with the remaining 20% from groundwater aquifers. In total, there are approximately 155,000 active public drinking water systems across the country. Most Americans – just under 300 million people – receive their drinking water from one of the nation’s 51,356 community water systems. Of these, just 8,674 systems, or 5.5%, serve more than 92% of the total population, or approximately 272.6 million people. Small systems that serve the remaining 17.4% of the population frequently lack both economies of scale and financial, managerial, and technical capacity, which can lead to problems of meeting Safe Drinking Water Act standards. Drinking water is delivered via one million miles of pipes across the country. Many of those pipes were laid in the early to mid- 20th century with a lifespan of 75-100 years. With utilities averaging a pipe replacement rate of 0.5% per year, it will take an estimated 200 years to replace the system – nearly double the useful life of the pipes.



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Because America's drinking water infrastructure provides a critical service, significant new investment and increased efficiencies are needed as filtration plants, pipes, and pumps age past their useful life. Every day, nearly six billion gallons of treated drinking water are lost due to leaking pipes, with an estimated 240,000 water main breaks occurring each year. It is estimated that leaky, aging pipes are wasting 14 to 18% of each day's treated water; the amount of clean drinking water lost every day could support 15 million households.

To address deteriorating water infrastructure, asset management provides utility managers and decision-makers with critical information on capital infrastructure assets and timing of investments. Some key steps for asset management include making an inventory of critical assets; evaluating their condition and performance; developing plans to maintain, repair, and replace assets; and funding these activities.

FUNDING

While drinking water infrastructure is funded primarily through a rate-based system, the investment has been inadequate for decades and will continue to be underfunded without significant changes as the revenue generated will fall short as needs grow. According to the American Water Works Association, upgrading existing water systems and to meeting the drinking water infrastructure needs of a growing population will require at least \$1 trillion.

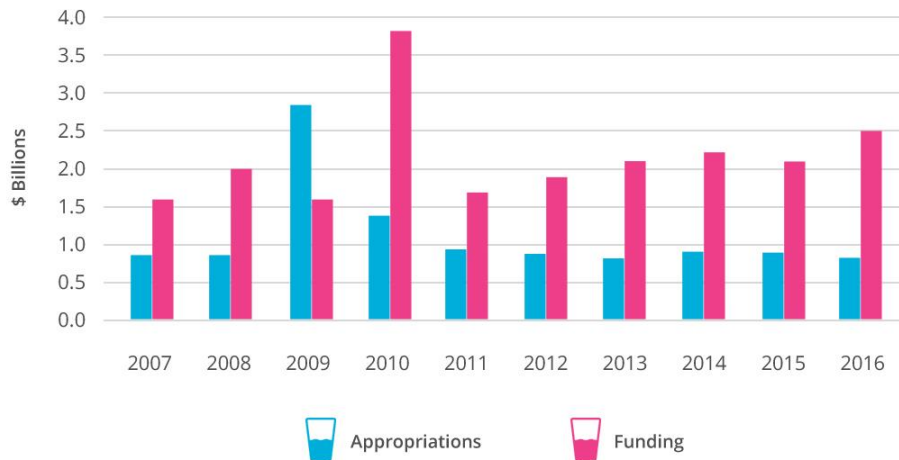
The majority of funding for drinking water infrastructure comes from revenue generated by rate payers. In the nation's largest 50 cities, the rate users pay varies greatly; the lowest average monthly water bill is \$14.74 in Memphis, while Seattle residents pay the most at \$61.43. This large gap exemplifies the varied approaches to rate structure, as well as the contrast of need and investment across the country. While higher rates that reflect the true cost of service are important, public assistance programs should be considered for low income populations. Between 2009 and 2014, state and local governments decreased capital spending for both drinking water and wastewater by 22%; at the same time, federal capital spending did not change significantly.

The federal government offers financial support to local governments and utilities in the form of loans through the Drinking Water State Revolving Fund, which provides low-interest loans to state and local water infrastructure projects. The Environmental Protection Agency (EPA) provides an allotment of funding for each state, and each state provides a 20% match. Since the program's inception, \$32.5 billion of low-interest loans have been allocated. However, with needs far surpassing the program's budget, it is unable to meet all investment needs or fund every deserving project.

In 2014, Congress authorized a new mechanism to fund primarily large water infrastructure projects over \$20 million through the Water Infrastructure Finance and Innovation Act (WIFIA). In 2016 Congress appropriated \$17 million in funds for the program. It is estimated that using WIFIA's full financial leveraging ability that a single dollar injected into the program can create \$50 dollars for project lending. Under current appropriations, EPA estimates that current budget authority may provide more than \$1 billion in credit assistance and may finance over \$2 billion in water infrastructure investment.



Drinking Water State Revolving Fund Appropriations and Funding



FUTURE NEED

Municipal drinking water consumption in the United States has declined by 5% this decade, marking the first time in nearly 40 years that water use at home has decreased. Total freshwater withdrawals this decade continue to decline in almost every sector including agriculture, industrial, domestic, and thermoelectric. This is primarily due to increased efficiencies and the reduction in withdrawals for retired coal-fired power plants.

Drinking water needed for public supply in the United States has been relatively flat since 1985 even as the population has increased by approximately 70 million people over the same period. Water conservation efforts, including through water efficient fixtures, have had a significant impact in reducing per capita water usage. Importantly, while per capita demand has fallen, population trends have significantly challenged how cities manage water. For example, the Government Accountability Office estimates that 99 of 674 mid-sized cities in the U.S. are shrinking. This poses significant challenges to utility managers; fewer rate payers and a declining tax base make it difficult to raise funds for capital infrastructure plans. To respond, utilities must raise rates, often in cities where jobs and pay have not kept pace with the economy, putting a burden on those who can least afford rate increases. Conversely, in areas of the country that are growing, such as the West and Southwest, water managers must respond to increased overall demand.

PUBLIC SAFETY

Drinking water quality in the United States remains the safest in the world. The EPA sets legal limits for over 90 contaminants in drinking water. The Safe Drinking Water Act (SDWA) allows states to set and enforce their own drinking water standards as long as the standards meet or exceed EPA's minimum



national standards. Smaller systems that serve under 10,000 people report that a lack of resources and personnel can limit the frequency of testing, monitoring, maintenance, and technical capability in their systems. With sufficient funding and proper oversight, these risks can be mitigated and water quality can remain safe.

RESILIENCE AND INNOVATION

America's drinking water infrastructure doesn't stop at pipe, reservoir, pump station, and treatment plant upgrades; many threats to drinking water infrastructure can be attributed to the sources of drinking water, such as polluted water bodies, depleted aquifers, and inadequate storage. As watersheds continue to be impacted by shifting migration patterns, land use changes, consumption trends, and extreme weather, water infrastructure upgrades will be required to meet new demands. With proper planning, education, and conservation utilities are making strides to ensure demand is met for decades to come. Water conservation and improvements in water-use efficiency appear to have gained a general acceptance among water utilities as a sensible practice of water management.

According to the American Water Works Association, a majority of utilities –74%– have a formal conservation program, and 86% consider conserved water as one of their water supply alternatives. Additionally, many communities that have separate drinking water and wastewater departments are beginning to work together or even consolidate, creating “one water” utilities that manage water more holistically.

RECOMMENDATIONS TO RAISE THE GRADE

- Reinvigorate the State Revolving Loan Fund (SRF) program under the Safe Drinking Water Act through permanent reauthorization and tripling the amount of annual appropriations.
- Fully fund the Water Infrastructure Finance and Innovation Act (WIFIA) at its authorized level.
- Preserve tax exempt municipal bond financing. Low-cost access to capital helps keep lending for drinking water upgrades strong and accessible for communities large and small.
- Establish a federal Water Infrastructure Trust Fund to finance the national shortfall in funding of infrastructure systems under the Clean Water Act.
- Eliminate the state cap on private activity bonds for water infrastructure projects to bring an estimated \$6 to \$7 billion annually in new private financing.
- Encourage utilities to take regional approaches for water delivery to take advantage of economies of scale.
- Increase federal support and funding for green infrastructure, watershed permitting, and other programs that promote the concept of “one water” to protect source watersheds.
- Encourage utilities to conduct revenue forecasting models to determine the necessary rate revenues over a period of time and then institute rates that reflect the true cost of supplying clean, reliable drinking water.
- Encourage utilities to undertake asset management programs.
- Increase federal and local support for vocational training in the drinking water sector as engineers, operators, and maintenance staff begin to retire in large numbers.



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- Support and advance conservation ballot measures that protect source water through dedicated funding to land and water protection.
- Utility managers must remain diligent to ensure science-based decisions control operations and facility function. While lead and other contaminants post significant health concerns when ignored, with proper funding safe and clean drinking water can be ensured.

DEFINITIONS

Non-community Water System is a public water system that is not a community water system and that regularly serves at least 25 of the same people over six months/year. These may include systems that provide water to schools, day care centers, government/military installations, manufacturers, hospitals or nursing homes, office buildings, and other facilities.

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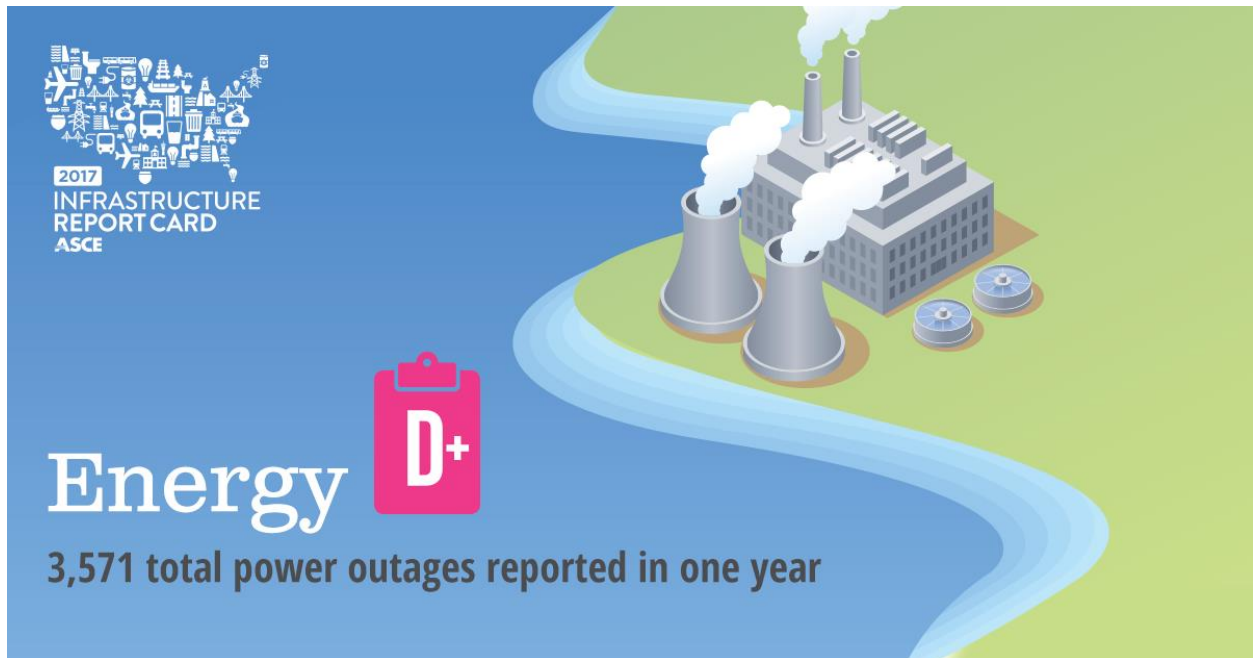
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OVERVIEW

Much of the U.S. energy system predates the turn of the 20th century. Most electric transmission and distribution lines were constructed in the 1950s and 1960s with a 50-year life expectancy, and the more than 640,000 miles of high-voltage transmission lines in the lower 48 states' power grids are at full capacity. Energy infrastructure is undergoing increased investment to ensure long-term capacity and sustainability; in 2015, 40% of additional power generation came from natural gas and renewable systems. Without greater attention to aging equipment, capacity bottlenecks, and increased demand, as well as increasing storm and climate impacts, Americans will likely experience longer and more frequent power interruptions.

CAPACITY & CONDITION

Near-term, U.S. energy systems are projected to deliver sufficient energy to meet national demands in the near term, as energy consumption fell slightly, from 98 quadrillion British thermal units (Btu) in 2014 to 97.7 quadrillion Btu in 2015, and is estimated to grow at a modest rate, averaging 0.4% per year from 2015 through 2040. In general, the capacity and condition of energy systems depend on ownership and geographic region, with privately-owned sources in the best position to invest. Reduced electric demand, changing delivery costs, and new regulations, including those focused on reducing environmental impact, have prompted transformations across the sector in recent years, with growth in natural gas, solar, and wind generation. In 2015, 40% of additional power generation came from natural gas and renewable systems, a trend that continues. However, little consideration has been given to long-term energy sustainability. Fossil fuels and uranium have limited reserves, leaving them unable to meet future power generation and delivery needs. Electricity and oil and gas delivery via well-maintained wires and pipelines remain the most efficient and safe supply chains; new distributed technologies may play an increasingly important long-term role particularly as cities grow in population.



ELECTRICITY

Electricity delivery in the U.S. depends on an aging and complex patchwork system of power generation facilities, transmission and distribution (T&D) grids, local distribution lines, and substations, owned by an array of investor- and publicly-owned utilities, independent power producers, and governmental agencies. While investor-owned utilities make up only 6% of the number of electricity providers, they serve 68% of electric customers.

Some parts of the U.S. electric grid predate the turn of the 20th century. Most T&D lines were constructed in the 1950s and 1960s with a 50-year life expectancy, and were not originally engineered to meet today's demand, nor severe weather events. With more than 640,000 miles of high-voltage transmission lines across the three interconnected electric transmission grids – the Eastern Interconnection, Western Interconnection, and Texas Interconnection – the lower 48 states' power grid is at full capacity, with many lines operating well beyond their design. The resulting congestion raises concerns with distribution, reliability, and cost of service, producing constraints for delivering power from remote generation sites, specifically from renewable sources, to consumers. Often a single line cannot be taken out of service to perform maintenance as it will overload other interconnected lines in operation. Grids operating in Alaska and Hawaii are similarly congested and physically islanded from the other states. As a result of aging infrastructure, severe weather events, and attacks and vandalism, in 2015 Americans experienced a reported 3,571 total outages, with an average duration of 49 minutes.

OIL & GAS

America's 2.6 million miles of oil and gas pipelines connect sources such as wells and import/export terminals with processing facilities and consumers. Over two-thirds of the lower 48 states depend on interstate pipelines for delivery of natural gas. Most lines are owned by private utilities or municipalities.

Consumption of natural gas has increased by over 24% between 2005 and 2015 and continues to rise. Since 2013, oil and natural gas pipeline construction has continued at a fairly brisk pace to address new sources, with 2016 to 2019 construction expected to modestly increase over the previous five-year period. Despite recent construction, a large percentage of higher-pressure natural gas transmission lines were installed before 1980. On average, oil refineries have operated around or over 90% capacity since 1985, with limited new additions; existing facility upgrades have kept up with demand for gasoline, other fuels, and raw products for manufacturing. Periodic failures in existing oil and gas pipelines and quality concerns in new construction point to the need for increased monitoring and maintenance spending. The concentration of processing plants on the shores of southern states creates significant exposure to future storm and climate change impacts.

FUNDING & FUTURE NEED

Due to private ownership, national security concerns, and costs of service, there is limited public visibility into infrastructure investment levels and need across electricity, oil and gas, and alternative energy sources. Increased investment in alternative sources of energy for power generation, heating and cooling, transportation, and process industries is needed for a sustainable future, but investment in this area lags, principally due to a lack of federal energy policy.



Permitting processes present a particular challenge to energy infrastructure, amounting to substantial expenses and causing significant delays in the construction of critical lines necessary to bring renewable energy into the grid. Operations and maintenance spending by pipeline owners will continue to expand as new regulatory guidelines aimed at increased safety are issued by states and the federal U.S. Department of Transportation's Pipeline and Hazardous Material Safety Administration (PHMSA) and as pipeline miles increase.

For electricity – including generation facilities and T&D infrastructure – the cumulative investment gap between 2016 and 2025 is estimated to be \$177 billion. Funding is generally not an issue for building new T&D lines. At the same time, utilities face considerable pressure to cover maintenance and system upgrade costs through regulator-capped rate increases, and thus struggle to justify more reliable lines or make long-term investments. Industry players including Edison Electric Institute, representing electric utilities, and market research firm SNL Energy predict a modest reduction in T&D spending in years 2017 to 2020, while spending on new generation is expected to be flat, driven by older generation replacement and expanded renewable energy.

Investment in oil and gas infrastructure is driven by changing sources, increasing demand, and commodity pricing fluctuations, as well as physical condition, failure events, and regulation. In geographic regions where demand approaches or exceeds existing supply, commodity pricing is elevated and funding is justified; when commodity pricing is low, infrastructure investment declines.

PUBLIC SAFETY, RESILIENCE, & INNOVATION

The U.S. energy sector faces significant challenges as a result of aging infrastructure, including supply, security and reliability, and resiliency issues in the face of severe weather events, all posing a threat to public safety and the national economy. Between 2003 and 2012, weather-related outages, coupled with aging infrastructure, are estimated to have cost the U.S. economy an inflation-adjusted annual average of \$18 billion to \$33 billion. Some states have enacted “storm hardening” policies to improve reliability during weather events, but these are typically influenced by local politics, rather than engineers’ recommendations. Local solutions, such as distributed generation and resilient microgrids, may offer lower-cost alternatives to major system investments particularly in areas at elevated risk from severe weather or other natural disasters.

Periodic oil and gas pipeline leaks and failures present risks to the environment and the public. Most domestic oil refineries are situated along the coasts, subjecting them to risks from receding shorelines, climate change, and storm-related impacts. Each time there is a pipeline break or refinery outage, prices spike and supply is disrupted, with even minor disruptions having immediate impact. Statistics maintained by the PHMSA indicate that the frequency of significant pipeline incidences has remained flat in recent years; however, each incident typically results in injuries and/or deaths, environmental impacts, and regional economic disruption. Meanwhile, the number of reported “spill” events has increased in the last several years, up from 573 in 2012 to 715 in 2015, and events such as multiple leaks at the Aliso Canyon gas storage field in California and Colonial gasoline pipeline failures in Alabama have highlighted system fragility and prompted federal rulemaking. Various monitoring techniques including in-line nondestructive testing, leakage surveys, and remote sensing (enabled by fiber optics, LiDAR, others) have been developed to mitigate these problems and are in various stages of deployment.



Automated valve shutoff to address earthquakes and leaks has also been critical in reducing consequences of failure to the public and the environment.

Cybersecurity and physical security remain important topics with respect to energy system resiliency and infrastructure owners are seeking to address them in response to federal mandates. Select energy systems such as the transmission grid are also exposed to low-probability severe threats, such as geomagnetic pulse, which could have significant impact on public safety and the economy.

RECOMMENDATIONS TO RAISE THE GRADE

- Adopt a federal energy policy that carefully assesses needed changes, including alternative energy sources such as renewables and distributed generation, to provide clear direction for meeting current and future demands.
- Streamline permitting processes, to facilitate prompt construction of critical new transmission lines and natural gas pipelines. Process streamlining must include steps to consider alternative approaches and ensure prudent and safe routing.
- Develop a national “storm hardening” plan that considers investment in T&D, refinery, and generation systems that withstand storms or that enable rapid restoration of energy supply after storm events.
- Increase new and rebuilt distribution lines’ minimum design loads for ice, wind, and temperature to improve reliability and public safety and reduce inconveniences associated with power outages.
- Promote usage of remote sensing and inspection technologies to lower the cost of energy system monitoring; focus operation and maintenance spending on highest-risk system components.
- Implement performance-based regulations that mandate verification of pipeline integrity and increased investment in early corrective action for inadequate pipelines.
- Promote usage of accepted engineering standards for all overhead T&D lines, pipelines, and support structures to help ensure safety and reliability.

DEFINITIONS

Energy Systems – Those which: (1) generate, transmit, and distribute electric power, and (2) collect, refine, and transport fuels including solid (e.g., coal, biomass), liquid (e.g., oil, gasoline), and gaseous (e.g., natural gas) fuels, for delivery to consumers.

Renewable Energy – Biomass, hydroelectric, geothermal, wind, and solar sources (for energy generation)

British thermal unit (Btu) – A measure of power, related to the heat content of various types of fuel; the amount of heat needed to raise the temperature of one pound of liquid water by one degree Fahrenheit

Energy storage – Systems that capture energy production at one time via mechanical, electrical, and electrochemical means to enable energy dispatch at a later time when demanded



Distributed generation – Generation of energy local to its demand

Grid – The interconnected system of power lines and related equipment that delivers high-voltage electricity from power generating stations to substations, where it is transformed to a lower voltage for distribution to consumers. In the 48 lower states, the grid is comprised of three regional interconnected systems: the Eastern Interconnection, Western Interconnection, and Texas Interconnection; there is no single “national” grid. Alaska has separate Railbelt and Southeast Alaska grids, whereas Hawaii has island-based independent grids.

High-voltage transmission lines – Lines that carry electricity from power generation facilities to concentrated locations where bulk electricity is needed (typically at 138 kV and higher) and distributed at lower voltages

Congestion – Flows of electricity across the system that are restricted or constrained below desired levels, either by the physical/electrical capacity or operational policies designed to protect security and reliability

In-line nondestructive testing – Testing and analysis techniques to evaluate pipeline conditions without causing damage

Leakage surveys – Inspection of a pipeline system to find leakage of carried media

Remote sensing – Using satellites or high-flying aircraft, UAVs, and related technology to evaluate and/or monitor pipeline conditions

LiDAR – Light Detection And Ranging; a remote sensing method that uses a pulsed laser of light to measure and site energy infrastructure

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Hazardous Waste

53% of Americans lives within 3 miles of a hazardous waste site

OVERVIEW

Over 18,000 sites and an associated 22 million acres of land are related to the primary hazardous waste programs that comprise much of the nation's hazardous waste infrastructure, and more than half of the U.S. population lives within three miles of a hazardous waste site. The current capacity of the nation's hazardous waste infrastructure is generally adequate, owing in no small measure to significant improvements in managing materials through recycling and reuse, rather than disposal. There have also been significant improvements in remediation technologies, resulting in faster and less resource-intensive cleanup approaches.

CAPACITY & CONDITION

Three primary programs have shaped the nation's hazardous waste infrastructure: Superfund, RCRA, and Brownfields. Each of these three programs plays a distinct and important role in the overall infrastructure that manages hazardous waste. As evidence of the importance of maintaining and strengthening the nation's hazardous waste infrastructure, more than half of the U.S. population lives within three miles of a hazardous waste site. Over 18,000 sites and an associated 22 million acres of land are addressed through these three programs.

Recognizing that hazardous waste disposal without planning and management endangers the public health and environment, Congress passed the Resource Conservation and Recovery Act (RCRA) in 1976 to manage hazardous waste from generation to disposal. The RCRA Corrective Action (CA) program drives the cleanup of legacy sites while the RCRA permitting program governs the generation and proper disposal of ongoing operations that result in hazardous waste.

To clean up hazardous waste produced and improperly disposed of prior to the enactment of RCRA, Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act



construction projects started in prior fiscal years. The backlog of deferred shovel ready projects has been substantially reduced—a very positive development. What is not clear is whether this represents an actual acceleration in the pace of cleanup, or if funding constraints for hazardous waste cleanup programs—at the federal (i.e., Superfund), state, and regional levels—are resulting in fewer sites being addressed through these cleanup programs. It is reasonable to assume that both factors may be contributing to a smaller backlog of deferred projects.

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

While the RCRA waste management and cleanup program has established a solid foundation for protecting the nation’s health and the environment, its mission continues to evolve to meet waste management and cleanup challenges and leverage opportunities to integrate resource conservation into economic productivity.

The impact of the RCRA program is significant. There are about 6,600 facilities, with over 20,000 process units, in the full RCRA permitting universe, and between approximately 350,000 and 550,000 facilities that generate hazardous waste. Approximately 2.5 billion tons of solid, industrial, and hazardous waste resulting from the manufacturing and use of goods are managed through the program, of which 30 to 40 million tons are classified as hazardous waste annually.

RCRA corrective actions are addressing more than 3,700 existing contaminated facilities needing cleanup. The program also provides grant funding to help states implement authorized hazardous waste programs. RCRA has built-in incentives for regulated facilities to reduce or avoid greenhouse gas emissions through materials and land management practices.

Some of the major challenges facing the RCRA program is the need to keep supporting the development of new manufacturing technologies and waste management methods, revisit regulatory frameworks, and make modifications that allow businesses, especially those in the manufacturing sector, to operate in accordance with the protection of human health and the environment, while streamlining the permitting process. The program’s shift to an electronic permitting program is an important part of that effort. The program has been a catalyst for encouraging process substitution, materials and energy recovery, as well as properly conducted recycling, reuse, and treatment, with a meaningful evolution from a strictly “waste management” program to “sustainable materials management”.

A key measure of how the RCRA program is performing is its effectiveness in protecting populations and preventing exposure to hazardous chemicals. Recent data shows that 87% of RCRA facilities have controls in place that prevent human exposure to toxic chemicals, and 77% of RCRA facilities are effectively preventing the migration of contaminated groundwater.

BROWNFIELDS

The Brownfields Program is principally supported through a variety of grants from EPA to support local execution of environmental assessments, cleanup, and job training activities. In addition to EPA funding, other agencies across the government provide funding in support of brownfields redevelopment. While there are many publicly-supported levels of brownfields redevelopment, cleanup is typically an initiator, and therefore the assessment and cleanup investment is critical to beneficial progress.



The impacts of Brownfields redevelopment have included economic and environmental benefits. Cleanup has led to improve home values and a greater tax base, with an economic benefit ratio of 18-to-1 for every federal dollar spent, including business expansion and job growth related to infrastructure improvements and improved business performance.

FUNDING & FUTURE NEED

Approximately 70% of Superfund cleanup activities historically have been paid for by parties responsible (PRPs) for the cleanup of contamination. Until the mid-1990s, most of the funding for clean-up activities led by the government (where there was no PRP to pay for cleanup) came from a tax on the petroleum and chemical industries. Currently, virtually all funding for government-led cleanup sites under Superfund comes from general revenues or special accounts funded through settlements with PRPs. The Superfund program has experienced flat or declining budgets since 2009. Drilling down in the FY 2016 and proposed 2017 budgets, there is a modest proposed increase in the Superfund budget, with largest increase for the remedial response program, which is used to fund long-term cleanup actions. The performance of the Superfund program can be evaluated in the pace at which NPL actions are taken and the key milestones are achieved. The pace of the program has been slowed by declining budgets. The number of construction completions has generally declined, as has the number of site deletions.

Operating costs of groundwater treatment systems represents a large and growing share of Superfund expenditures, and that cost impact is felt by EPA, states (which are responsible for long-term O&M costs at non-PRP lead sites), federal Superfund sites (e.g., Department of Defense and Department OE facilities), and of course, by the private sector at PRP-led sites. All of these parties are making targeted investments in technology to optimize both the characterization and cleanup process. This focus on optimization represents an important commitment to improve the program.

Over the past several years, EPA's workforce has declined by over 2,000 employees. With that reduction in force, the ranks of EPA Superfund project managers, scientists, and engineers has significantly declined, as has the Agency's staff of procurement professionals. As a result, EPA's ability to keep pace with program needs has been substantially impacted.

For Brownfields, current funding levels are less than what is needed to optimize the benefits of this successful program. That shortfall has an impact on both pre-construction and construction activities. While some projects are deferred altogether due to lack of available funds, other projects progress in series of small phases, adding time and cost for achieving cleanup. In a 2011 study of Superfund costs conducted by the Government Accountability Office, EPA Regional officials estimated that the costs to perform timely and cost-effective remedial construction on existing projects on an annual basis was \$253 to \$414 million more than the expected budget.

Approximately 30% of grant proposals submitted to EPA for brownfields cleanup are funded. Many deserving projects that could significantly benefit communities aren't getting funded. More funding would leverage more dollars and stimulate job growth and economic benefit, while improving the condition of the nation's infrastructure. While the benefits of the brownfield program are evident in



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Inland Waterways

49% of vessels experience delays
across the inland waterways system

OVERVIEW

The United States' 25,000 miles of inland waterways and 239 locks form the freight network's "water highway." This intricate system, operated and maintained by the U.S. Army Corps of Engineers, supports more than half a million jobs and delivers more than 600 million tons of cargo each year, about 14% of all domestic freight. Most locks and dams on the system are well beyond their 50-year design life, and nearly half of vessels experience delays. Investment in the waterways system has increased in recent years, but upgrades on the system still take decades to complete.

CAPACITY & CONDITION

A unique component of the nation's freight network, inland waterways are shared by only 38 states and are operated and maintained by the U.S. Army Corps of Engineers (USACE). The system includes a vast network of 25,000 miles of waterways and 239 locks used for commerce. The Atlantic Intercoastal Waterway serves ports along the East Coast, such as the Port of Virginia. In the Pacific Northwest, the waterway system leads to the Port of Seattle and other ports in the area.

Delivering more than 575 million tons of cargo in 2015, valued at \$229 billion, these waterways connect to inland and ocean ports, providing direct access from international markets.

Barge transport provides the most fuel-efficient way to move goods on the ground; on a single gallon of fuel, a barge can move goods four times farther than trucks. Inland waterways are vital to our nation's agriculture industry, as 60% of grain exports are moved by barge. Similarly, in the energy sector, more than 22% of domestic petroleum and petroleum products and 20% of coal used to generate electricity are moved on the inland waterways. Barges carrying goods such as soybeans and iron travel major water channels including the Mississippi River and the Pacific Northwest's Columbia-Snake Rivers. The system supports more than half a million jobs.



Inland Waterways



For the industries that rely on the inland waterways to move their products, this aging and unreliable system can be costly. The majority of locks and dams on the system are well beyond their 50-year design life. A lock acts as an elevator for a cargo ship, making it easier for vessels to navigate the uneven and inconsistent water levels of U.S. rivers. When a ship reaches a lock, gates open for the ship to enter the lock chamber. Once the ship is within the lock, a valve either fills or empties the lock to bring the ship level with the water on the other side of the opposite gate. The opposite gate then opens for the ship to proceed.

Coupled with increasing traffic, vessels may be delayed for hours while aging locks are shut down for maintenance and repair. Between 2000 and 2014, the average delay per lockage nearly doubled from 64 minutes to 121 minutes. Across the system, 49% of vessels experienced delays in 2014. However, delay data is not currently standardized across the system and the reason for delay is not recorded, making it hard to accurately assess delays.

FUNDING & FUTURE NEED

Inland waterways construction and rehabilitation costs, including for locks, are shared by the federal government through general funds and by users through the Inland Waterways Trust Fund on a 50-50



basis. Operation and maintenance costs for inland waterways are covered in full by the federal government.

The Inland Waterways Trust Fund is supported by a 29 cents per gallon tax on barge fuel, and cannot exceed expenditures in a given year. In April 2015, this user tax was increased by 9 cents for the first time since 1995 upon the urging of the Inland Waterways Users Board, in order to increase investment in the system.

The USACE estimates overall investment needs of \$4.9 billion over the next 20 years.

Thanks to recent increases in investment and project prioritization, there has been some improvement in the projected completion date of many inland waterway lock and dam rehabilitation projects. For example, projects once expected to be completed in 2090 are now on track to be completed in 2038. However, for this progress to come to fruition, and the trend to improve, funding must continue at a higher and more consistent level, given the large backlog of needs. One major project, the Olmsted Lock on the Ohio River, depleted available funding for other inland waterways projects. In the Water Resources Development Act (WRDA) of 2014, additional federal funding was allocated to free up Inland Waterways Trust Fund money for other projects.

RESILIENCE & INNOVATION

The USACE has moved to a risk aversion decision making process, to better prioritize which projects are addressed first. In addition, USACE released *Technologies to Extend the Life of Existing Infrastructure*, a first-of-its-kind best practices compilation on life cycle maintenance management, innovative technologies, and emerging capabilities that are happening at USACE locks and dams.

RECOMMENDATIONS

- Give USACE contract authority for projects, to avoid the stop-and-start of construction currently happening because of the appropriations process.
- Fund waterways projects at the authorized levels and do so consistently, passing a Water Resources Development Act on a two-year cycle.
- Ensure that full use of the Inland Waterways Trust Fund continues to be appropriated, and increase the amount spent on operations and maintenance of the inland waterways each year.
- Utilize alternative financing and delivery methods, such as public-private partnerships, when appropriate.
- Develop and implement a standardized measurement for delays on the system.

DEFINITIONS

Draft – The depth of a waterway, which determines the size of barge or ship that can travel through it.

Dredge — To excavate or deepen the bed of a harbor, river, or other area of water by scooping out sediment and moving it to a different location. This technique is often used to keep waterways navigable.



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Lock chambers — An enclosure consisting of a section of canal that can be closed to control the water level. It is used to raise or lower vessels that pass through it.

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OVERVIEW

A nationwide network of 30,000 documented miles of levees protects communities, critical infrastructure, and valuable property, with levees in the U.S. Army Corps of Engineers Levee Safety Program protecting over 300 colleges and universities, 30 professional sports venues, 100 breweries, and an estimated \$1.3 trillion in property. As development continues to encroach in floodplains along rivers and coastal areas, an estimated \$80 billion is needed in the next 10 years to maintain and improve the nation's system of levees. In 2014 Congress passed the Water Resources Reform and Development Act, which expanded the levee safety program nationwide, but the program has not yet received any funding.

CAPACITY AND CONDITION

Levees are usually earthen embankments or concrete floodwalls, which have been designed and constructed to contain, control, or divert the flow of water to reduce the risk of temporary flooding. Vertical concrete floodwalls may be erected in urban areas where there is insufficient land for an earthen levee.

Most of the levees across the country were built in the middle of the last century by federal, state, and local agencies or by private property owners. The average age of levees in the U.S. is 50 years and many are showing their age. While there are newer or reconstructed levees, a large number of levees were built in response to the widespread flooding on the Mississippi River in 1927 and 1937, and in California after catastrophic flooding in 1907 and 1909.

Every state in America and the District of Columbia rely on levees for flood control to reduce risk to homes, businesses, and property. The nationwide network of levees consists of 30,000 documented miles and up to an estimated 100,000 miles of levees protects millions of people in cities large and small. Levees are critical to reducing risk to the public and property from devastating floods caused by



the rising of rivers during high rain events or from surge and waves during large coastal storm events. With more than half of the U.S. population living within 50 miles of a coast and continued development in flood plains, levees play a critical life safety role. Unfortunately, because this infrastructure often goes unnoticed, citizens are frequently unaware of the risks associated with possible failure of a levee.

According to the U.S. Army Corps of Engineers' (USACE) National Levee Database (NLD), levees are found in approximately 35% of the nation's counties, with nearly two-thirds of Americans living in a county with at least one levee. Earthen embankments make up 97% of all the levees in the USACE Levee Safety Program, while floodwalls make up the remaining 3%. The NLD contains 11,900 individual levee systems accounting for the nearly 30,000 miles of documented levees. The USACE maintains authority over 13,700 miles, while other federal, state, or local agencies are responsible for the remaining 15,400 miles in the NLD. Due to the large inventory of levees outside of USACE's authority, the condition of the nation's levees is largely unknown, but future efforts are planned to gain a better understanding of the nation's levees, as authorized in Water Resources Reform and Development Act of 2014.

The USACE has performed engineering inspections and risk assessments to understand the condition and characterize the flood risk associated with levees in their authority. Currently, USACE has completed risk assessment on over 1,200 levee systems out of the 2,500 in the USACE program. The risk assessment shows that of USACE-owned levees, 5% are high to very high risk, 15% moderate risk, and 80% low risk. The assessments are based on several criteria, including possible loading events such as floods, storms, and earthquakes; level of performance; and consequences of failure. Major deficiencies include culverts, seepage – the biggest risk driver – and vegetation. The numbers of high and moderate risk levees are expected to grow as more inspections are performed, raising awareness of their conditions. Currently, less than half of the levees in USACE's authority have risk assessment and risk characterizations.

Levees function passively or may require active mechanical operations. For example, some levees have gates and pumps, which may require personnel to operate them in times of floods. Levees require regular maintenance and periodic upgrades to retain their level of protection.

FUNDING & INVESTMENT

It is estimated that \$80 billion is needed in the next 10 years to maintain and improve the nation's levees. Federal funding is available only for USACE-owned levees. More than half of levees are owned by states and localities, which often have limited budgets for repairs and maintenance.

The 2014 Water Resources Reform and Development Act (WRRDA) created a new National Levee Safety Initiative (NLSI). This program will promote consistent safety standards, create levee safety guidelines, and provide funding assistance to states for establishing participating levee safety programs. WRRDA authorized \$395 million to support levee safety initiative. However, since the NLSI was passed, not a single dollar has been appropriated for the program, nor has the program been identified in the Presidential Budget Request as a priority. Even if funds are appropriated for this program, they are not intended to be used for levee repairs, maintenance, or rehabilitation of the infrastructure. Funding the National Levee Safety Initiative to create state programs would be a major step toward improving the



nation's levee infrastructure. Without investment in this program, levees will continue to languish and much of this critical infrastructure's condition will remain unknown.

PUBLIC SAFETY, RESILIENCE & INNOVATION

Levees play a critical role in protecting many American communities and their economies at risk of dangerous flooding. Those in the USACE Levee Safety Program protect over 300 universities, 30 professional sports venues, 100 breweries, and an estimated \$1.3 trillion in property. During floods in the summer of 2015, the U.S. Army Corps of Engineers estimated that levees in the South, Central, and Southwestern United States prevented more than \$13.1 billion in damage. Along the Mississippi River decades of levee upgrades have prevented \$306 billion in flood damage prevention, equating to a 24-to-1 return on investment of that infrastructure. The National Flood Insurance Program (NFIP), which encourages flood risk mitigation activities and requires at-risk homeowners to purchase insurance, saves the national economy \$1.7 billion in avoided losses due to flooding.

With ownership and maintenance responsibilities for U.S. levees spread across multiple jurisdictions, the Federal Emergency Management Agency (FEMA), USACE, and local partners have undertaken efforts to increase coordination across agencies for levee inventories, inspections, safety ratings, and public awareness, including development of public safety and information programs.

RECOMMENDATIONS

- Fully fund the National Levee Safety Program passed in the Water Resources Reform and Development Act of 2014.
- Complete the National Levee Inventory for both federal and nonfederal levees.
- Adopt a levee hazard potential classification system.
- Complete levee mapping as outlined in the National Flood Insurance Program reform bill and implement FEMA's new levee mapping and analysis program.
- Increase funding at all levels of government and leverage private funds to address structural and nonstructural solutions that reduce risk to people and property.
- Require insurance where appropriate, and create emergency action plans for levee-protected areas.
- Ensure that operation and maintenance plans cover all aspects of a complex levee system.
- Assess levees using updated hydrology and hydraulic analyses that incorporate the impact of urbanization and climate change, particularly for coastal levees.

GLOSSARY OF TERMS

Culvert – An opening through an embankment for the conveyance of water by mean of pipe or an enclosed channel.

Seepage – The slow movement of water through small openings and spaces in the surface of unsaturated soil into or out of a body of surface or subsurface water.

Levees – Manmade barriers (e.g., as an embankment, floodwall, or other structure) that are built to provide protection from hurricane, storm, or flood protection relating to seasonal high water, storm



surges, precipitation, or other weather events; such a barrier is normally subject to water loading for only a few days or weeks during a calendar year.

Earthen levees – constructed from compacted soil that is typically covered with various surface materials, such as grass, gravel, stone, asphalt, or concrete, to help prevent erosion.

Acceptable Levee Condition – The inspected system is in satisfactory condition, with no deficiencies, and will function as intended during the next flood event

Minimally Acceptable Levee Condition – One or more items have a minor deficiency that need to be corrected, and an engineering determination concludes that the items would not prevent the segment or system from performing as intended during the next flood event

Unacceptable Levee Condition – An unacceptable rating means that one or more items that make up the levee system would prevent the system from performing as intended. It may also mean that a serious deficiency noted in past inspections has not been corrected within the established timeframe

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OVERVIEW

A vast network of infrastructure goes into supporting more than seven billion outdoor recreational outings. Americans enjoy park and recreation facilities maintained by entities at all levels of government. At the federal level, the National Park Service, U.S. Forest Service, and U.S. Army Corps of Engineers are the main providers of park facilities. States and localities provide the bulk of park and recreational facilities that seven in 10 Americans use on a regular basis. National forests and grasslands capture and filter drinking water for 180 million people. America's parks and public lands also support industries such as lodging, restaurants and bars, grocery and convenience stores, and gas stations.

CONDITION & CAPACITY

A vast network of infrastructure goes into supporting more than seven billion outdoor recreational outings. Roads, bridges, trails, campsites, boat ramps, and other facilities help facilitate interaction with our public lands and access to the outdoors. The National Park Service (NPS) alone manages more than 75,000 constructed assets. The U.S. Army Corps of Engineers (USACE) ranks among the top federal providers of outdoor recreation, hosting approximately 370 million visitors annually at 403 lake and river projects in 43 states. NPS welcomed 307.2 million visitors in 2015 and national forests and grasslands hosted 161 million visits in 2012. Our national wildlife refuges accommodated nearly 47 million visitors in 2014. All of these parks require roads, trails, parking areas, and other facilities to make them accessible. Maintenance and investment keep the infrastructure safe and capable of meeting the demand of a growing population.

America's parks and public lands also support numerous industries within our economy – lodging, restaurants and bars, grocery and convenience stores, gas stations, and other retailers. In 2015 NPS visitors spent \$16.9 billion in communities within 60 miles of a park. Their spending supported 295,000 jobs that produced a payroll of \$11.1 billion. U.S. Forest Service lands support more than 205,000 jobs



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associated with recreation and wildlife visitor use. Their visitors contribute \$11 billion to the economies of mostly rural, gateway communities each year.

Capital spending by local and regional public park agencies in the U.S. generated nearly \$59.7 billion in economic activity and supported 340,000 jobs in 2013. The more than 6,600 state park sites constitute less than a quarter of national acreage, but see two and a half times as many visitors on an annual basis—nearly 759 million visits in 2015. The average local park and recreation agency provides 9.5 acres of park land for every 1,000 residents. 29% of American households reported using their local park frequently in 2015 and 47% reported frequenting occasionally.

These lands, historical parks and cultural sites, monuments, battlefields, and recreational areas play other critical roles in American life. National forests and grasslands capture and filter drinking water for 180 million people in over 68,000 communities. It's estimated that the value of water flowing from U.S. Forest Service lands is \$7.2 billion annually. Major U.S. cities like Los Angeles, Portland, Denver, and Atlanta receive a significant portion of their water supply from national forests.

INVESTMENT AND FUNDING

The 2016 centennial of the National Park Service helped shine a light on the infrastructure needs and crowded facilities in our national parks. In 2015 NPS reached a record-high of \$11.9 billion in deferred maintenance, which NPS defines as “maintenance that was not performed at the required intervals to ensure an acceptable facility condition to support the expected life cycle of an asset.” \$5.97 billion of the deferred maintenance is for paved roads and structures including bridges, tunnels, and paved parking areas. The remaining \$5.95 billion in deferred maintenance includes unpaved parking areas, unpaved roadways, utility systems, dams, constructed waterways, marinas, aviation systems, railroads, ships, monuments, fortifications, towers, interpretive media, and amphitheatres.

NPS classifies \$2.38 billion of these other facilities as highest priority non-transportation facilities. This is a total increase of \$434.2 million in total deferred maintenance over the year before and an increase of over a billion dollars in deferred maintenance in paved roads and structures since 2013.

At other federally owned and operated parks, the situation is similar. The USACE manages 12 million acres of lands and waters that are available for a wide variety of recreational activities. Visitation has steadily increased in recent years, and this upward trend is likely to continue; 90% of USACE lakes and rivers with recreation areas are located within 50 miles of a metropolitan area. Visitors to USACE facilities spend \$13 billion annually and support 187,000 jobs. The majority of USACE recreation facilities are over 50 years old and require upkeep to meet visitor health and safety standards. The USACE continually evaluates recreation area operations to maintain or improve cost efficiency in operations.

At the Forest Service, budgets are being squeezed by the need to focus more financial resources on wildfire suppression. At the close of FY2015, the Forest Service reported a \$5.1 billion maintenance backlog, including deferred maintenance for roads, trails, buildings, water systems, and fences, among other categories. Since then, deferred maintenance totals have likely grown, because for the first time in the agency's history, more than half of its budget is being consumed by spending related to wildfires.



Investment in outdoor recreation facilities will continue to be impacted as more and more development encroaches into areas at risk from wildfire.

It's not just national parks that face significant budget shortfalls; Since the 1990s, general fund support for state parks has steadily declined. States have undertaken various strategies to fill the gap, including increasing user fees for park entrance, camping and lodging, and recreational activities, as well as privatizing certain park operations. However, these financing strategies are insufficient to address the significant backlog of critical infrastructure projects. Conservative estimations indicate deferred maintenance in state parks totals more than \$95.3 billion.

There has been some progress in addressing the chronic underfunding of our park and recreation infrastructure over the past few years. Congressional appropriations to NPS increased 7.5% over the last 10 years, after adjusting for inflation. For state parks, total operational capital expenditures grew 25.3%, or \$159 million, in 2016. These gains were often a result of increased general fund allocations or dedicated bonds, both made possible by a recovering economy.

The federal transportation bill, Moving Ahead for Progress in the 21st Century Act (MAP 21) established the Federal Lands Transportation Program (FLTP) to supplement the deferred maintenance budget typically provided through discretionary appropriations. It provided \$240 million to NPS and \$30 million to be allocated competitively to the Forest Service, Corps, and Bureau of Land Management. FLTP was reauthorized under the most recent federal transportation bill, the Fixing America's Surface Transportation (FAST) Act, in December of 2015. The NPS receives an annual sum each year through the FAST Act and is expected to receive a total of \$1.4 billion between FY16-FY2020. The U.S. Forest Service will also receive an annual sum for a total investment of \$85 million. The Corps will compete with the Bureau of Land Management, Bureau of Reclamation, and other independent federal agencies with natural resource and land management responsibilities for an additional \$120 million available through FLTP.

In December of 2016, Congress passed the National Park Service Centennial Act (H.R. 4680). This legislation establishes the National Park Centennial Challenge Fund (NPCCF) that requires a one-to-one match of federal and private funds, directs the National Parks Foundation to create A Second Century endowment, and focuses NPCCF investment on an identified list of signature projects and programs eligible for funding, while prioritizing deferred maintenance, physical improvements to visitor services facilities, and trail maintenance.

There are also lessons to be learned from our state parks. Utah and South Carolina are adding new recreational infrastructure to spur increased revenue. Michigan and Idaho have increased revenues by offering year-round passes at their Department of Motor Vehicles. By increasing their access to potential customers, Michigan has seen a 30% increase in year-round pass revenue despite decreasing the cost of the pass from \$24 to \$10 for a license plate access sticker.

SOLUTIONS TO RAISE THE GRADES

- Charge appropriate user fees at the local, state, and federal levels and allowing those agencies to use all collected user fees to support maintenance, operations and enhancements to their park systems.



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- Encourage communities who benefit economically from parks and public lands investment to also invest in their maintenance.
- Reauthorize and fully fund the Land and Water Conservation Fund to support acquisition of land and easements on land at the federal, state, and local levels.
- Increase appropriations for the National Park Service, the U.S. Army Corps of Engineers, the U.S. Forest Service, and other federal providers of recreational facilities to address maintenance backlogs.
- Leverage partnerships between the National Park Service and other recreation facilities operators and private groups to better utilize facilities and compensate for usage.
- Enact legislation to permit the U.S. Army Corps of Engineers to retain all collected recreation fees for use at its facilities.
- Renegotiate franchise fees with concessionaires of park and recreation facilities to increase return to support operation and maintenance of facilities.
- Conservation and recreation advocates should collaborate and cooperate to benefit public interest in both conservation and recreation.

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Ports

99% of America's overseas trade passes through ports

OVERVIEW

The United States' 926 ports are essential to the nation's competitiveness, serving as the gateway through which 99% of overseas trade passes. Ports are responsible for \$4.6 trillion in economic activity — roughly 26% of the U.S. economy. As ships get bigger, congestion at landside connections to other components of the freight network increasingly hinders ports' productivity. Similarly, on the water side, larger ships require deeper navigation channels, which only a few U.S. ports currently have. To remain competitive globally and with one another, ports have been investing in expansion, modernization, and repair.

CAPACITY & CONDITION

The first recorded international commerce in the New World was in 1565 when English soldiers traded guns and ammunition to the French for food in what we now know as Jacksonville, Florida. From this auspicious beginning, America's coastal settlements grew and with them, its ports. Today, the United States has more than 926 coastal, Great Lakes, and inland harbors. U.S. ports and terminals handled more than 82,000 vessels in 2015. Ports serve as the gateway through which 99% of America's overseas trade passes through and were responsible for \$4.6 trillion in economic activity in 2014—roughly 26% of the nation's economy—making them essential to U.S. competitiveness. Nearly \$1.75 trillion worth of cargo moved through seaports in 2013. The top 10 U.S. ports accounted for 78% of U.S. foreign waterborne trade in 2015. The movement of goods through ports supports 23.1 million jobs, and provides \$321.1 billion in tax revenue to federal, state, and local governments.

Inside a port's gates, cranes load containers on and off ships, cooled warehouses store perishable items, and an operations center ensures efficient transport. By maintaining a port's facilities, its lifespan can be greatly extended. There are ports, such as the Ports of Virginia, with facilities built during World War I



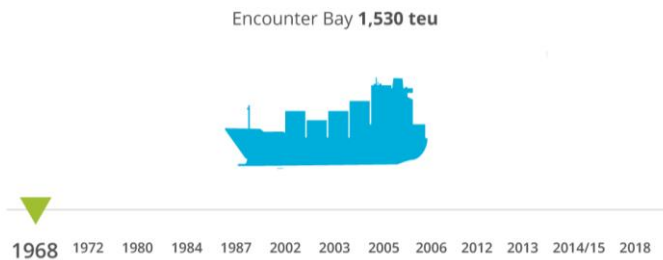
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that are still in use after extensive modernization. Operating equipment must be frequently upgraded due to usage and technical advancement, but most other aspects of ports have long service lives. However, major U.S. ports are experiencing greater change due to larger vessels, requiring the ports to adjust equipment, berth depths, terminal layout, and cargo handling operations on a more frequent basis than in the past.

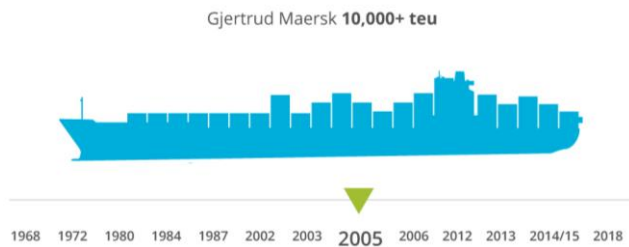
Ports are part of the greater freight network, with roadways and rail lines playing an important role in ports' success. The freight network is only as strong as its weakest link and congestion on these landside connections hinders productivity for ports. In a survey of ports, a third indicated that this congestion over the past 10 years caused port productivity to decrease by 25% or more. To improve freight movement, the federal Fixing America's Surface Transportation (FAST) Act requires states to have state freight plans.

Meanwhile, on the water side, larger ships need deeper navigation channels—typically 45 feet deep or more—to be able to access a port. The Panama Canal Expansion allows ships that can carry 13,000 TEU (twenty foot equivalent units) to reach East Coast ports, however only a few of the nation's existing ports are currently able to accommodate ships this large. As ships continue to grow, the majority of existing port infrastructure will not be able to accommodate these larger vessels. Ports need to add cranes to ensure they can reach the cargo on wider ships, increase the size of the container yard to hold cargo, and supply sufficient power to pull ships into port.

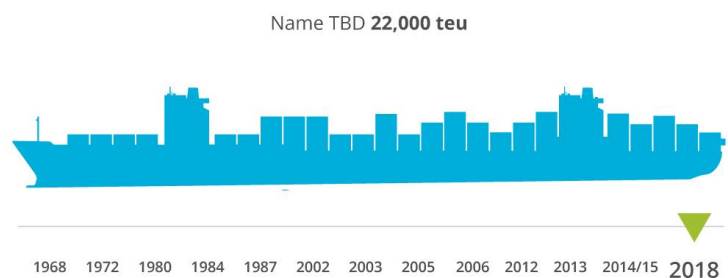
Container Ship Size Through the Years



Container Ship Size Through the Years



Container Ship Size Through the Years



FUNDING & FUTURE NEED

Despite the national significance of ports, most port-related investments are limited to state or local appropriations. If there are multiple ports within a state, they often compete for the same funding resources if any funding programs exist at all. For example, Florida, Louisiana, and Texas are home to many local ports competing for a limited amount of available state project funding.



Grants, specifically the Transportation Investment Generating Economic Recovery (TIGER) competitive grant program, represent the primary source of federal port investment. Since the program's inception in 2009, 11% of the program's funding has been awarded to 48 port projects. The Fixing America's Surface Transportation (FAST) Act of 2015 created a national freight program with a new \$4.5 billion competitive grant program, which will fund eligible port-related projects. The Water Resources Reform and Development Act (WRRDA) of 2014 also authorized port-related projects, however only two of the 34 authorized projects were appropriated in the last federal appropriations cycle.

The federal Harbor Maintenance Trust Fund (HMTF), designed to pay for dredging in harbors, has a balance of \$8.41 billion. The fund collects its revenue through a 0.125% user fee on the value of the cargo in imported containers. Typically, that comes to about \$15 per container box. Despite the significant dredging needs at the majority of U.S. ports, the fund's balance has often been used for other purposes including federal deficit offsets and as a result has not been appropriated for its designated purpose. WRRDA included provisions designed to encourage the use of the funds for their designated purpose. To restore full channel depths and widths, it is estimated it will take at least five years of the U.S. Army Corps (USASCE) of Engineers receiving full HMTF revenues.

To remain competitive globally and with one another, ports have been investing in their facilities, and plan to spend \$154.8 billion from 2016 to 2020 on expansion, modernization, and repair. However, connections to these ports are in need of modernization, including roads, rail, and inland waterways on the landside, and navigation channels on the water side. Landside connections are scheduled to receive only \$11 billion in new federal funding for freight improvements through 2020, yet baseline projected needs total \$29 billion.

PUBLIC SAFETY AND RESILIENCE

Natural disasters, terrorist attacks, and other crises at seaports result in billions of dollars in damage and the loss of long-term economic activity. As a result, ports face a balancing act of efficiently moving goods while also maintaining secure facilities. Many different agencies and groups, including the U.S.

Department of Homeland Security (DHS), U.S. Coast Guard, and Transportation Security Administration (TSA), are responsible for keeping ports secure. As an entry point for goods from other countries, especially foodstuffs, containers are screened by the TSA upon arrival to a port. A division within DHS is developing the Port Security Risk and Resource Management System (PortSec) to assess and reduce risks to ports.

DHS and other federal agency programs support port resiliency against such events through information sharing and grants for projects to enhance resiliency. These programs help ports create effective disaster implementation plans and exercises for restoring normal operations.

RECOMMENDATIONS

- Increase overall investment into the freight program, to ensure ports can effectively distribute and receive goods as ships continue to grow in size.



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- Appropriate funds to the congressionally-authorized projects to ensure that projects crucial to freight movement are completed in a timely manner.
- Ensure that ports have a seat at the table as states create and execute freight plans.
- Adopt new technologies to reduce wait times at docks, boost efficiency, and increase security.
- Improve freight and landside connections to strengthen the entire freight system and reduce congestion that is costly to the economy when moving goods.

DEFINITIONS

TEU – (Twenty Foot Equivalent Unit) is the unit of the capacity of a container ship, which is approximately half a semi-truck’s load.

Dredging — To excavate or deepen the bed of a harbor, river, or other area of water by scooping out sediment and moving it to a different location. This technique is often used to keep waterways navigable.

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In the 2013 report card, this chapter included commuter rail, which is included in the 'Transit' chapter in this report card.

OVERVIEW

For more than 150 years the rail network has been a critical component of the U.S. transportation system and economy. Today it carries approximately one-third of U.S. exports and delivers five million tons of freight and approximately 85,000 passengers each day. The private freight rail industry owns the vast majority of the nation's rail infrastructure, and continues to make significant capital investment — \$27.1 billion in 2015 — to ensure the network's good condition. U.S. rail still faces clear challenges, most notably in passenger rail, which faces the dual problems of aging infrastructure and insufficient funding.

CAPACITY & CONDITION

The U.S. rail network is comprised of nearly 140,000 miles of track and over 100,000 bridges. The system can be divided into two categories: private freight railroads and intercity passenger rail, operated almost exclusively by Amtrak.

FREIGHT RAIL

U.S. freight railroads are categorized into three classes based on the distance served and earnings: seven large Class I railroads, 21 regional/Class II railroads, and 547 short line/Class III railroads. In 2015, U.S. freight railroad volume was nearly twice what it was in 1980, even though the network's overall reach has declined. Class I railroads shed nearly 30% of their rail miles between 1990 and 2013, with many portions becoming short lines or abandoned. As of 2013, Class I railroads operated approximately 95,000 rail miles, regional railroads operated approximately 10,000 miles, and short line railroads operated approximately 33,000 miles. Capacity across the Class I network today is generally sufficient to meet current needs, but demand for rail is expected to grow as road congestion and demand for goods continue to increase. Recently, the Class I railroads have increased carrying capacity through the operation of double stack containers and heavier carloads.



Freight railroads, as owners of the infrastructure, are responsible for the condition of the majority of the nation's track, bridges, and connections at ports and intermodal facilities, and proactively maintain, replace, and upgrade systems through maintenance and capital programs. Changes in freight cargo trends in recent years have necessitated changes in the network. Coal, the most commonly transported bulk product by rail, has experienced a decline, while intermodal traffic has experienced substantial growth, requiring investment in connections to ports and truck transfer facilities. Freight railroads continue to upgrade their networks to support additional demand with greater capacity, added efficiency, and improved safety. This has required the rebuilding of bridges, tunnels, track, and signal systems.

Federal forecasts predict an approximately 40% increase in U.S. freight shipments, including by rail, by 2040. To prepare for the future, the U.S. Department of Transportation worked with the transportation industry to draft the first *National Freight Strategic Plan*, to address impediments to the efficient flow of goods in support of the nation's economy. The Fixing America's Surface Transportation (FAST) Act requires the strategic plan be completed by 2017 and be updated every five years.

PASSENGER RAIL

Amtrak operates a 21,356-mile network in over 500 communities, which served 31.3 million passengers in 2016. The system can be divided into two categories: the Northeast Corridor (NEC), running from Boston to Washington, D.C., and the "national network" of 15 interstate routes. Amtrak owns and operates the majority of the NEC's track—363 out of 457 miles—as well as 260 miles of track outside the NEC, including 18 tunnels and 1,414 bridges. Eight commuter railroads and four freight railroads operate on the NEC. (*For more information on commuter rail, see the Transit chapter.*) More than 90% of Amtrak's network, and almost all of the "national network," runs on tracks owned by freight railroads and, to a lesser extent, commuter railroads, and Amtrak pays the infrastructure owner for its use. As a result, Amtrak relies on freight railroad maintenance and system support to deliver quality, timely service.

Including the commuter railroads that operate on the NEC, there are approximately 750,000 passenger trips on the NEC each day and the corridor accounts for over half of Amtrak's daily ridership. The NEC is the busiest railroad in North America with approximately 2,200 trains operating over some portion of its network every day. It is highly capacity-constrained, creating service challenges for both Amtrak as well as commuter and freight railroads that operate on the corridor. Capacity is generally sufficient in other parts of Amtrak's network, with states supporting service expansions particularly on the West Coast and the connections to the NEC. Recently there has been a renewed national interest in expanding passenger rail service. High-speed passenger rail project planning is underway in several areas, including California, Florida, the Chicago area, and Texas.

While safe to operate, much of the NEC's infrastructure is beyond its useful life, increasing maintenance costs and reducing system reliability. The average age of major NEC backlog projects is 111 years old, including 10 moveable bridges, three sets of tunnels, and one viaduct. Upgrades and repairs to basic infrastructure items like signals, power systems, and tracks, as well as service improvement projects to add capacity, are needed to meet growth in the northeastern economy and related travel demand. The



condition of the NEC continues to deteriorate while projects are on hold pending funding. Amtrak has been left with little choice but to be reactive to maintenance issues due to inadequate funding.

FUNDING & FUTURE NEED

FREIGHT RAIL

The freight rail industry's private investment in their infrastructure has been growing over the last five years. The railroads used the slower traffic period during the recession to make improvements and redesign the freight network to meet future need. In 2015, the Class I freight railroads spent \$27.1 billion maintaining, modernizing, and expanding their systems with major track and bridge replacement projects, capacity upgrades, and the deployment of the federally-mandated signaling system, positive train control.

Short lines and regional railroads provide a connection to Class I railroads for lower density traffic and are therefore important to help farmers and businesses move goods. Their investment needs are more difficult to fund from freight receipts and they often rely on state and local funding, as well as tax credits, to provide this important freight service. Currently significant investments need to be made to upgrade track to handle 286,000 pound rail cars, as well as repair and replace aging bridges. In 2013 the Federal Railroad Administration estimated that Class II and III railroads would only be able to invest \$1.6 billion out of a needed \$6.9 billion over the following five years to maintain, modernize, and expand capacity. Federally, the Railroad Track Maintenance Tax Credit—also known as the 45G Tax Credit—helps short line railroads make capital investments by providing a credit equal to 50% of the cost of qualifying infrastructure projects. The tax credit was authorized in 2004 for five years and has been extended repeatedly.

Through the FAST Act, Congress created a new federally-funded, freight-focused competitive grant program. Fostering Advancements in Shipping And Transportation For The Long-Term Achievement of National Efficiencies (FASTLANE) grants will provide \$4.5 billion through 2020 to freight and highway projects of national or regional significance.

PASSENGER RAIL

The U.S. invests a much smaller amount in passenger rail, relative to the size of our population and landmass, than many countries in Europe and Asia. Amtrak covered 94% of its operating costs in 2016 with ticket sales and other revenue, but relies heavily on government funding for capital investment. This is not unusual—no country operates a passenger rail system without some form of public funding.

Despite Amtrak's growing ridership, with 2016 the sixth straight year in which ridership exceeded 30 million, financial support for capital investments in infrastructure has been insufficient. The NEC, which accounts for the majority of infrastructure Amtrak owns and the majority of its ridership, has a state-of-good-repair backlog of \$28 billion. \$11 billion is needed to fund basic infrastructure projects while \$17 billion is needed for major backlog projects.

Amtrak received a \$2.45 billion loan from the U.S. Department of Transportation in fall 2016, primarily for the purchase of 28 new high-speed train sets, but also to make track and station upgrades along the



NEC. This loan will allow Amtrak to add capacity and improve service along the NEC, but will not solve the large and growing backlog of capital needs.

PUBLIC SAFETY, RESILIENCE & INNOVATION

Rail accidents and derailments are down nearly 50% over the last decade. Railroads have been reconfiguring highway-rail crossings to separate the two and improve safety. While fewer people are being killed or sustaining injuries in highway-rail crossing incidents, 237 people were killed and 991 people were injured in 2015. To further improve safety and reduce accidents associated with operator error, like the 2015 Amtrak derailment in Philadelphia which cost eight lives, the federal government has required the installation of positive train control (PTC) by 2018. PTC is a signal technology designed to prevent collisions and ensure safe operating speeds and will be required for all lines carrying passengers.

Rail resilience is often tested by extreme weather events, which degrade infrastructure and lead to delays as well as concerns about continuing availability of service. Super Storm Sandy demonstrated the need to address resiliency, as key tunnels under the East River and Hudson River were severely damaged.

Railroads have adapted new technologies to monitor the health of the rails and target problem areas for maintenance. Innovations include infrastructure condition data collection and processing tools, such as track geometry cars that travel over the rails looking for defects. Technology includes onboard tools that check the alignment of the track and acoustic and heat sensors that monitor passing trains for potential issues. These technologies help detect problems early and prevent derailments, and early results suggest such monitoring prevented more than 1,000 service interruptions in 2015.

RECOMMENDATIONS TO RAISE THE GRADE

- At the state and regional level, rail should be a part of multimodal strategic plans and capital investment programs that supports a role for both freight and passenger rail.
- Support a regulatory and financial environment that encourages continued private investment in the nation's freight railroad system.
- Use innovative financing methods like revenue bonds and tax exempt financing at the state and local levels, public-private partnerships, and state infrastructure banks to increase funding for freight and passenger rail.
- Develop state-level short line assistance programs with low-interest loans and grants to modernize these rail lines to permit 286,000 pound loads and increase allowable speeds, continue the federal Railroad Track Maintenance Tax Credit.
- Establish a federal rail trust fund to fund rail improvements, including matching provisions to encourage participation by states as well as private companies.
- Improve passenger rail in dense corridor markets in a balanced investment program with air, bus, and automobile travel.

DEFINITIONS

Intermodal – The transfer of products involving multiple modes of transportation—truck, railroad, barge, or ship.



Double stack – The stacking of a shipping container on top of another container. To allow of double stack containers on a route, railroads frequently need to raise bridge and tunnel clearances.

Positive Train Control – A signaling system designed to determine a train's location, direction and speed and use that data to prevent: train-to-train collisions; derailments caused by excessive speed; unauthorized incursions by trains onto sections of track where maintenance activities are taking place; and movement of a train through a track switch left in the wrong positions.

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2017 INFRASTRUCTURE REPORT CARD



OVERVIEW

America's roads are often crowded, frequently in poor condition, chronically underfunded, and are becoming more dangerous. More than two out of every five miles of America's urban interstates are congested and traffic delays cost the country \$160 billion in wasted time and fuel in 2014. One out of every five miles of highway pavement is in poor condition and our roads have a significant and increasing backlog of rehabilitation needs. After years of decline, traffic fatalities increased by 7% from 2014 to 2015, with 35,092 people dying on America's roads.

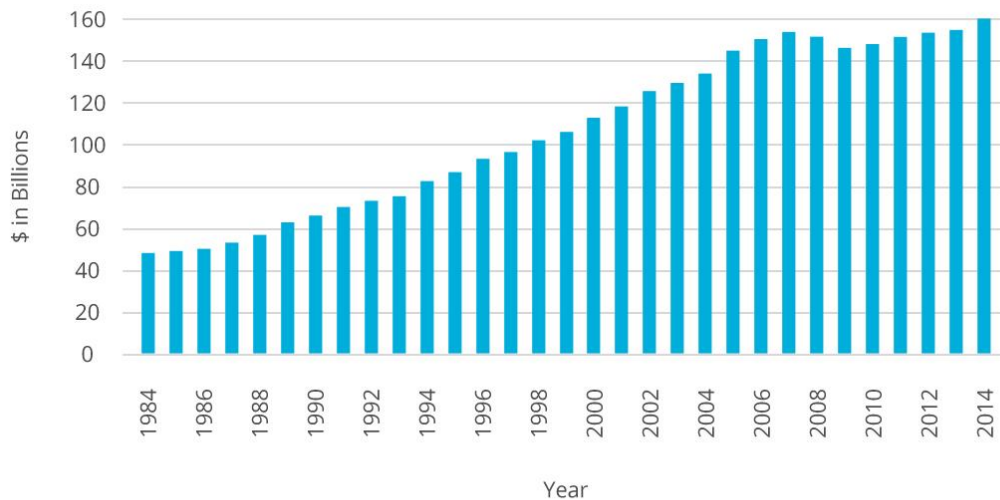
CAPACITY & CONDITION

With over four million miles of roads crisscrossing the United States, from 15 lane interstates to residential streets, roads are among the most visible and familiar forms of infrastructure. In 2016 alone, U.S. roads carried people and goods over three trillion miles—or more than 300 round trips between Earth and Pluto. After a slight dip during the 2008 recession, Americans are driving more and vehicle miles travelled is at its second highest-ever level, second only to 2007.

With more traffic on the roads, it is no surprise that America's congestion problem is getting worse, but adding additional lanes or new roads to the highway system will not solve congestion on its own. More than two out of every five miles of the nation's urban interstates are congested. Of the country's 100 largest metro areas, all but five saw increased traffic congestion from 2013 to 2014. In 2014, Americans spent 6.9 billion hours delayed in traffic—42 hours per driver. All of that sitting in traffic wasted 3.1 billion gallons of fuel. The lost time and wasted fuel add up—the total in 2014 was \$160 billion.



Total Cost of Congestion 2014 Dollars



20% of the nation’s highways had poor pavement condition in 2014. Urban roads are in far worse shape than rural roads due to greater volumes of traffic; 32% of urban roads are in poor condition, compared to 14% of rural roads. Driving on roads in need of repair cost U.S. motorists \$112 billion in extra vehicle repairs and operating costs in 2014.

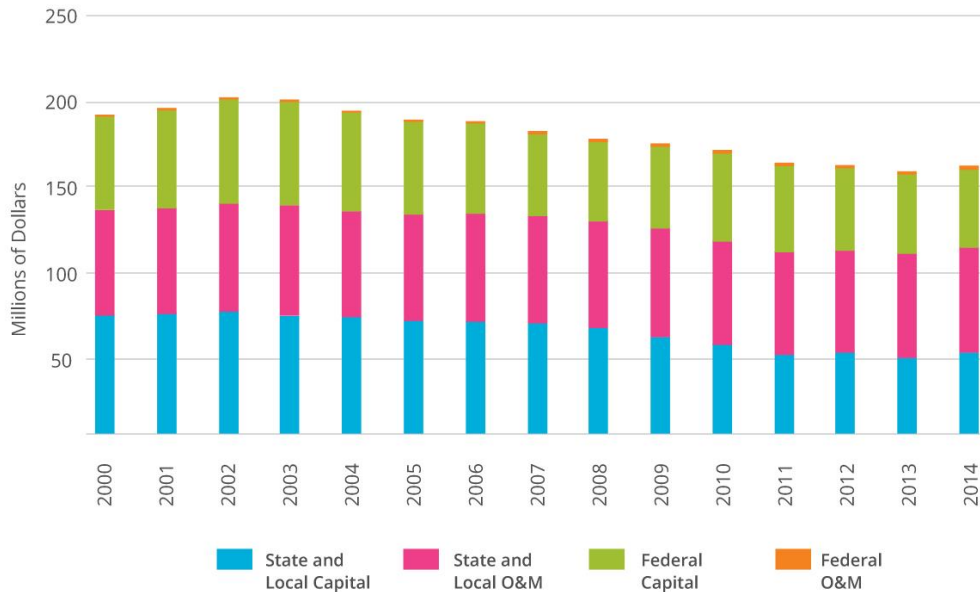
In some areas, state and local governments have reconsidered road materials, converting some low-traffic, rural roads from asphalt to gravel. These roads were mostly paved when asphalt and construction prices were low, but with construction costs rising faster than infrastructure funding, converting the roads back to gravel is a more sustainable solution for maintenance. At least 27 states have de-paved roads, primarily in the last five years.

FUNDING & FUTURE NEED

The U.S. has been underfunding its highway system for years, resulting in a \$836 billion backlog of highway and bridge capital needs. The bulk of the backlog (\$420 billion) is in repairing existing highways, while \$123 billion is needed for bridge repair, \$167 billion for system expansion, and \$126 for system enhancement (which includes safety enhancements, operational improvements, and environmental projects). The Federal Highway Administration estimates that each dollar spent on road, highway, and bridge improvements returns \$5.20 in the form of lower vehicle maintenance costs, decreased delays, reduced fuel consumption, improved safety, lower road and bridge maintenance costs, and reduced emissions as a result of improved traffic flow.



Public Spending on Highway Infrastructure



The federal government is a major source of funding for the construction of highways through the federal Highway Trust Fund and competitive grant programs for specific projects, like TIGER. In 2014, the federal government spent \$43.5 billion on capital costs for highway infrastructure (including bridges) and state and local governments spent \$48.3 billion. State and local governments are responsible for the operation and maintenance (O&M) of highways (with the exception of roads on federal lands). They spent \$70 billion on O&M in 2014, while the federal government spent \$2.7 billion.

Federal investment in highways has historically been paid for from a dedicated, user fee-funded source, the Highway Trust Fund. However, the Trust Fund has been teetering on the precipice of insolvency for nine years due to the limitations of its primary funding source, the federal motor fuels tax. The tax of 18.4 cents per gallon for gasoline and 24.4 cents for diesel has not been raised since 1993, and inflation has cut its purchasing power by 40%. Between 2013 and 2017, 17 states and the District of Columbia raised their motor fuels taxes. A number of states are exploring other revenue sources for funding road investment, including mileage-based user fees. With continued improvements in vehicle fuel efficiency and the popularity of hybrid and electric vehicles, mileage-based user fees present a promising long-term funding alternative to the motor fuels tax.

PUBLIC SAFETY

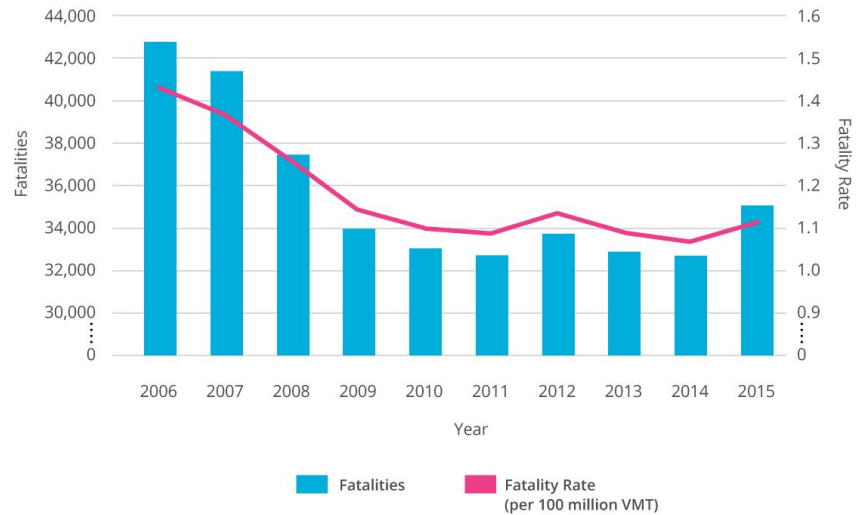
35,092 people were killed in motor vehicle crashes in 2015. Traffic fatalities decreased significantly over the last decade, but abruptly increased by 7% from 2014 to 2015 and preliminary data shows fatalities rose 8% in the first nine months of 2016. 9.5% more pedestrians and 12.2% more bicyclists were killed by crashes in 2015 than 2014, emphasizing the importance of designing streets for the safety of all users.



The recent increase in fatal crashes is not yet fully understood, but communities are trying to save lives through improvements in road design, such as widening lanes and shoulders; adding and improving medians, guard rails, and parallel rumble strips; upgrading road markings and traffic signals; and using new materials, such as high friction surface treatments. Another increasingly popular method communities are using to improve the safety of their roads for all users is the “road

diet,” which reconfigures a road, reducing the number of lanes and adding safety features. For instance, a four-lane, undivided highway could be converted to a two-lane highway with a center two-way left-turn lane. The extra space created by removing a lane can be reallocated for other safety-oriented uses such as bike lanes, pedestrian refuge islands, or designated transit stops. The Federal Highway Administration’s Highway Safety Improvement Program (HSIP) collects data, performs research, and provides funding to states to implement these infrastructure-based safety measures.

Motor Vehicle Fatalities



INNOVATION AND RESILIENCE

New road design, construction, maintenance, and management technologies and techniques are constantly being developed. The Federal Highway Administration’s Every Day Counts program has played an important role in collecting and evaluating new ideas and promoting the deployment of proven, market-ready strategies. These innovations have included the use of 3D engineered models for more accurate and efficient planning and construction; new methods to determine when, where and how to best preserve pavement; and tools to make permitting reviews faster and more efficient. New materials and technology are also helping roads become more sustainable and resilient, such as greater use of permeable paving materials to reduce storm runoff, as well as the use of recycled materials in pavement.

RECOMMENDATIONS TO RAISE THE GRADE

- Increase funding from all levels of government and the private sector to tackle the massive backlog of highway needs.
- Fix the federal Highway Trust Fund by raising the federal motor fuels tax. To ensure long-term, sustainable funding for the federal surface transportation program, the current user fee of 18.4 cents per gallon on gasoline and 24.4 cents per gallon on diesel should be raised and tied to



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inflation to restore its purchasing power, fill the funding deficit, and ensure reliable funding for the future.

- Tackle congestion through policies and technologies that maximize the capacity of the existing road network and create an integrated, multimodal transportation system.
- Prioritize maintenance and the state of good repair to maximize the lifespan of roads.
- State and local governments should ensure their funding mechanisms (motor fuel taxes or other) are sufficient to fund their needed investment.
- All levels of government need to think long-term about how to fund their roads and consider potential alternatives to the motor fuel taxes, including further study and piloting of mileage-based user fees.
- Increase investment and expand the federal Highway Safety Improvement Program to find new ways and further propagate existing methods to make roads safe for all users.

DEFINITIONS

Vehicle miles travelled – the total mileage travelled nationally by all vehicles over one year

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Schools 

53% of schools need improvements to reach “good” condition

OVERVIEW

Every school day, nearly 50 million K-12 students and six million adults occupy close to 100,000 public school buildings on an estimated two million acres of land. The nation continues to underinvest in school facilities, leaving an estimated \$38 billion annual gap. As a result, 24% of public school buildings were rated as being in fair or poor condition. While there have been a number of insightful reports in recent years, state and local governments are plagued by a lack of comprehensive data on public school infrastructure as they seek to fund, plan, construct, and maintain quality school facilities.

CAPACITY & CONDITION

Every school day, nearly 50 million K-12 students and 6 million adults occupy close to 100,000 public school buildings on an estimated two million acres of land. The student population increased by nearly five million between 1994 and 2013, requiring an additional 13,000 K-12 schools. Enrollment is projected to increase by 3% between the 2013-2014 and 2025-26 academic years – rising from 50 million to 51.4 million students. State and local governments face a constant challenge to keep up with operations and maintenance and the need for new construction, in addition to accommodating improved health and safety standards, stronger accessibility requirements, and new technology.

Recent government statistics show that a significant numbers of public school facilities are not in acceptable condition. Among public schools with permanent buildings – 99% of public schools – almost a quarter (24%) were rated as being in “fair” or “poor” condition. But 31 percent of schools have temporary buildings, either in addition to or instead of permanent buildings, and the number of these schools in “fair” or “poor” condition rises to 45%. In more than 30% of public school facilities, windows, plumbing, and HVAC systems are considered in “fair” or “poor” condition. Outdoor facilities such as parking lots, bus lanes, drop-off areas, fencing, athletic fields, and sidewalks are also problematic. 36%



of school parking lots are in “fair” or “poor” condition, as well as 32% of bus lanes, 31% of athletic facilities, and 27% of playgrounds. More than half (53%) of public schools need to make investments for repairs, renovations, and modernizations to be considered to be in “good” condition.

In many cases, planning is lacking, as four in 10 public schools currently do not have a long-term educational facilities plan in place to address operations and maintenance. The main reason for repair, renovation, or modernization work on school facilities relates to improving energy efficiency as well as technology infrastructure.

FUNDING & FUTURE NEED

School funding varies widely by state. Five states pay for nearly all of their school districts’ capital costs, 12 states provide no direct support for districts for capital construction responsibilities, and in the remaining 33 states, the levels of support vary greatly. The federal government contributes little to no funding for the nation’s K-12 educational facilities.

While school districts collectively invested as much as \$49 billion per year in school facilities from 2011 to 2013 for new facilities and capital construction, it is estimated that the nation should be spending \$87 billion per year to renew facilities so they provide healthy, safe, and modern learning environments—leaving a \$38 billion annual investment gap. In addition, districts need to spend \$58 billion annually just to maintain and operate the current inventory of facilities, along with an estimated \$77 billion annually to upgrade existing facilities to reduce the backlog of deferred maintenance. Another \$10 billion per year is needed for new construction to accommodate the anticipated increase in enrollments in the coming decade.

Following the 2008 recession, many states reduced overall funding per student and have not restored it, even as enrollments and needs have grown. During the 2014 school year at least 31 states provided less funding than in the 2008 school year, and in at least 15 states, these cuts exceeded 10%. Local government funding also fell in at least 18 states over the same period. While local funding did increase in 27 states, those increases rarely counteracted state-level cuts. And, while most states increased funding per student in 2015, 12 states imposed new cuts.

Facing tight budgets, school districts’ ability to fund maintenance has been constricted, contributing to the accelerating deterioration of heating, cooling, and lighting systems. Deferred maintenance and decisions to choose less expensive temporary fixes are ultimately costing school districts more money in the long-term.

PUBLIC SAFETY & RESILIENCE

In many instances school buildings also serve communities as emergency shelters during man-made or natural disasters. This secondary function has a significant role in public health, safety, and welfare, and requires facilities that are maintained to function in emergencies and resilient to quickly recover. Many schools require upgrades to effectively fulfill this important community purpose, including windows that can withstand high winds, structures designed to survive earthquakes, and rooms specifically designed as shelters from tornados.



RECOMMENDATIONS TO RAISE THE GRADE

- Governments at every level should regularly assess the needs of their public school facilities and publish this data.
- Maximize flexibility for states to use funds for a variety of projects that should include greening and energy efficiency upgrades, asbestos abatement and removal, improvements to after-school facilities and community spaces, and modifications to comply with the Americans with Disabilities Act.
- Continue to encourage school districts to adopt regular, comprehensive major maintenance, renewal, and construction programs, and implement preventative maintenance programs to extend the life of school facilities.
- Expand federal and state tax credits and matching funds to support increased use of school construction bonds and simplify the process for local school districts to obtain facility construction financing for improvements and modernizations.
- Explore alternative financing, including lease financing, as well as ownership and use arrangements, to facilitate school construction projects.
- Develop capital planning frameworks that can be nimble and responsive to changing technologies and changing demographics, to optimize learning environments and consider the holistic needs of the community.

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2017
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Solid Waste

258 million tons of municipal solid waste generated in one year

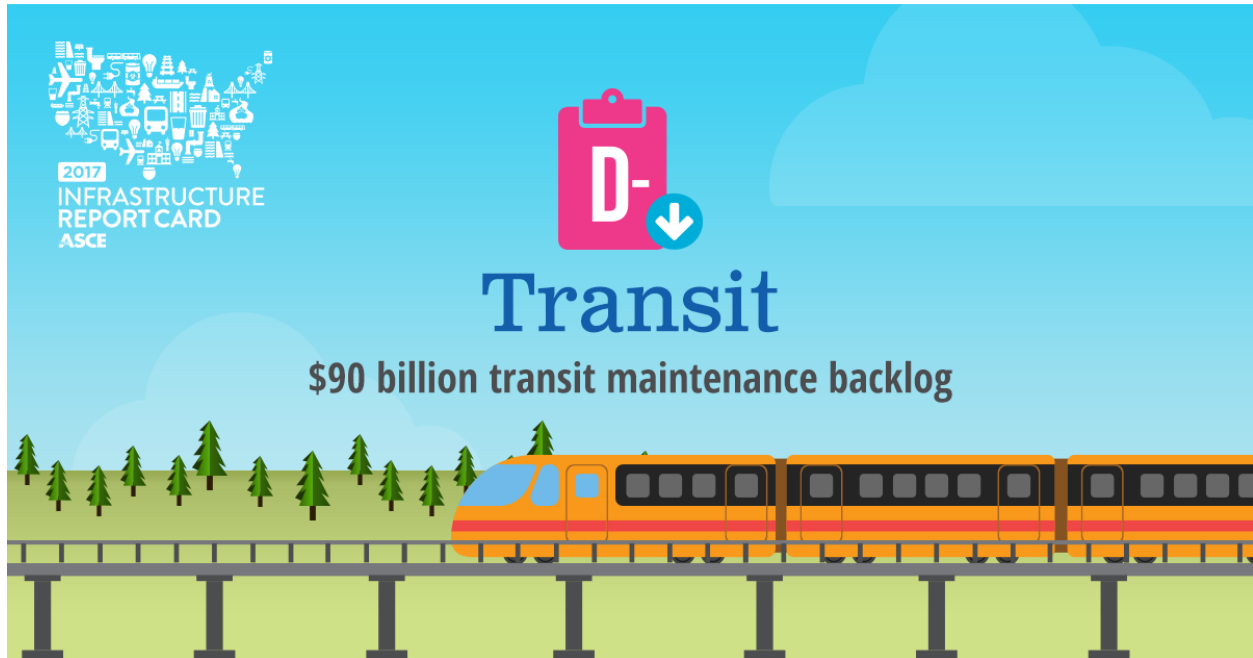
OVERVIEW

Overall management of municipal solid waste (MSW) across America is currently in fair condition. In many cases, the transport and disposal of MSW is self-funded and managed by the private sector, and therefore is sufficiently funded. Americans generate about 258 million tons of MSW annually, of which approximately 53% is deposited in landfills — a share that has plateaued in recent years. Currently, 34.6% of MSW is recycled and 12.8% is combusted for energy production. There is a need to change the way we think of how solid waste is generated, managed, and potentially used as a resource. Americans need to recognize that what is routinely discarded may in fact be a reusable resource.

CAPACITY & CONDITION

Municipal solid waste (MSW) – more commonly called trash or garbage – consists of everyday items that are used and then thrown away, such as product packaging, grass clippings, furniture, clothing, bottles, food waste, newspapers, appliances, paint, and batteries. After these items are removed from the waste stream for recycling and composting, the remainder are deposited into landfills facilities. Americans generated about 258 million tons of MSW in 2014, up from the previous peak of 255 million tons in 2007. The average American produces 4.4 pounds per person per day of MSW, down from the peak of 4.74 pounds in 2000, however that has remained relatively flat over the past 25 years.

Current production and consumption systems do not offer enough incentives for preventing and reducing waste. From product design and packaging to material choices, the entire chain is not designed with waste prevention in mind. Changing the way we think about waste requires effort by all the parties concerned: consumers, producers, policymakers, local authorities, and waste treatment facilities, among others. Increases in recycling can only occur where consumers are willing to sort their household waste and the infrastructure and market is in place to collect and utilize the recycled materials.



This chapter includes commuter rail, which was included in the 'Rail' chapter in the 2013 report card.

OVERVIEW

Transit in America continues to grow, carrying 10.5 billion trips in 2015, and adding new lines and systems every year. Yet the symptoms of overdue maintenance and underinvestment have never been clearer. Despite increasing demand, the nation's transit systems have been chronically underfunded, resulting in aging infrastructure and a \$90 billion rehabilitation backlog. While some communities are experiencing a transit boom, many Americans still have inadequate access to public transit.

CAPACITY & CONDITION

American transit systems carried 10.5 billion passenger trips in 2015. This is a 33% increase from 20 years ago, when transit carried 7.9 billion trips, but is 250 million trips less than in 2014. 11% of American adults reported taking public transportation on a daily or weekly basis in 2015.

Buses are the most common form of public transportation, accounting for approximately half of passenger trips in 2015. The 15 heavy rail (subway/metro) systems comprise the majority of non-bus trips, accounting for over a third of total passenger trips. While transit has higher ridership in urban areas, there are nearly 1,400 public transit systems in rural areas, providing paratransit, bus, commuter bus, and vanpool service. These often-forgotten rural transit systems provide vital mobility to people who do not have access to a car or cannot drive themselves, particularly elderly individuals and people with disabilities.

The extent of transit in the U.S. has been increasing: from 2004 to 2014, 26% more urban route miles of rail modes became available, with light rail and commuter rail seeing almost all of the growth, as well as 11% more urban route miles in non-rail modes. This time period also saw a 17% increase in the number

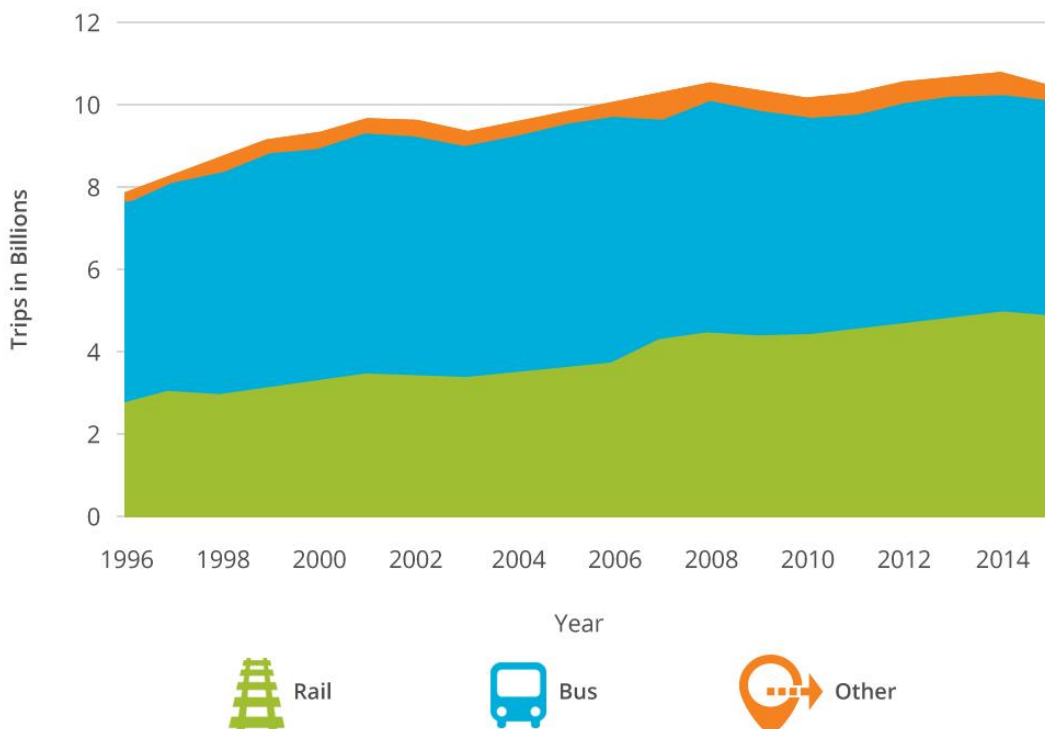


of passenger stations. However, many Americans still don't have access to public transit. Despite 81% of Americans living in urban areas, only 51% of U.S. households reported in 2013 they could get to a grocery store using public transportation.

In order for transit to work well, both the transit vehicles (buses, trains, etc.) and the physical infrastructure (tracks, signals, etc.) must be in good condition. According to the most recent data available, 10% of the nation's urban bus fleet and 3% of the nation's rail fleet are not in a "state of good repair." Transit's physical infrastructure fares considerably worse: 15% of facilities (e.g., maintenance facilities), 17% of systems (e.g., power, signal, communications, fare collecting) 35% of guideway elements (e.g., tracks), and 37% of stations are not in a "state of good repair."

Many transit systems are also experiencing ridership demand beyond what the systems were designed for, creating tension between the ability to expand to meet demand and the need to maintain the existing system. A transit system's condition closely correlates to ridership and financial strength; when transit becomes unreliable, fewer people continue to use it, creating a chain effect of lost support in fares and, over time, less investment in the system due to lower ridership. Several of the older heavy rail systems, including in Washington, D.C., New York, and San Francisco, are confronting the challenges and consequences of rider demand, years of deferred maintenance, and chronic funding problems.

Transit Passenger Trips

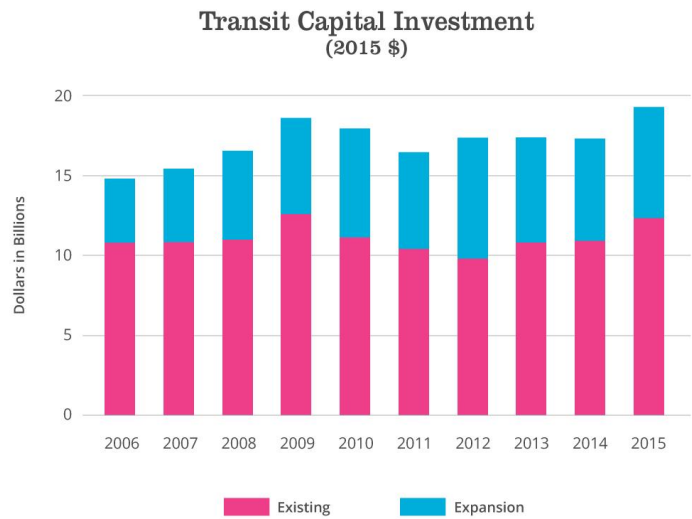


FUNDING & FUTURE NEED

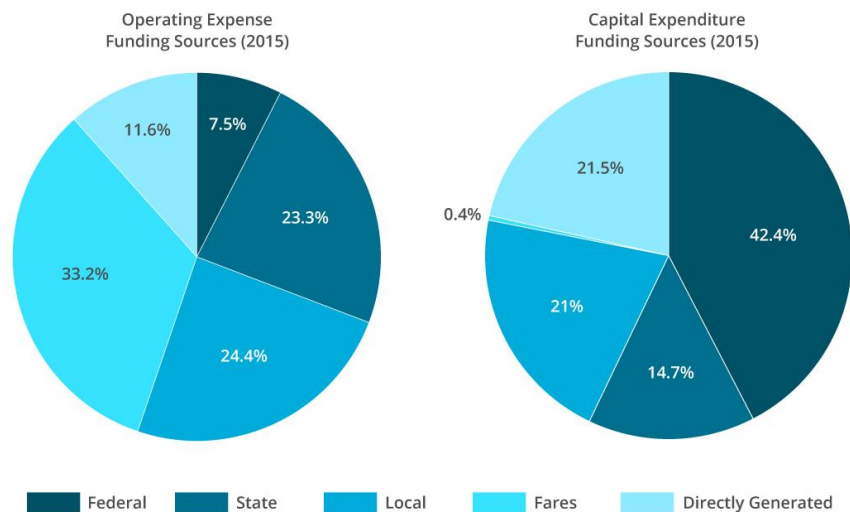


As a result of years of insufficient funding, transit systems across the U.S. are struggling to cope with aging infrastructure and limited funding, creating a massive and increasing backlog. The most recent federal estimate quantifies the backlog of projects needed to attain a “state of good repair” at \$90 billion and is projected to grow to \$122 billion by 2032. The backlog was primarily in **fixed guideway** modes such as rail, due to specialized infrastructure requirements, such as tracks and stations, as opposed to roadway modes, like buses, which utilize existing roads and bridges.

In addition to the fare revenue they collect and other directly-generated revenues (e.g. parking and ad monies), transit agencies may receive money from federal, state, and/or local governments. In 2015, 45% of operating expenses were paid for through fares and other directly generated funds, while 55% of expenses were paid with public funds, primarily from state and local governments. The federal government is an important source of funding for capital expenditures in public transportation; federal funds covered 42% of capital expenditures in 2015, while state and local governments contributed 36% and directly generated funds paid for 22%. The total operating expenses for the nation’s public transportation systems in 2015 totaled \$46.3 billion and total capital expenditures equaled \$19.3 billion. The majority of capital spending in transit (64% in 2015)



Transit Funding Sources



focused on improving existing service, as opposed to expanding it.



- Budget for and fund maintenance and improvements critical to sustaining performance, maintaining reliability and meeting service expectations.
- Use asset management best practices to prioritize projects so as to improve the condition, security, and safety of assets while minimizing lifecycle costs.

DEFINITIONS

Passenger trips – Recognize each time a passenger boards or alights a transit vehicle during travel, while passenger miles measure the total amount of travel.

Farebox recovery – the percentage of transit operating expenses that are covered by revenues from transit fares.

Fixed guideway – a public transportation facility using and occupying a separate right-of-way for the exclusive use of public transportation (examples: rail, ferries, and bus rapid transit).

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OVERVIEW

The nation's 14,748 wastewater treatment plants protect public health and the environment. Years of treatment plant upgrades and more stringent federal and state regulations have significantly reduced untreated releases and improved water quality nationwide. It is expected that more than 56 million new users will be connected to centralized treatment systems over the next two decades, and an estimated \$271 billion is needed to meet current and future demands. Through new methods and technologies that turn waste into energy, the nation's 1,269 biogas plants help communities better manage waste through reuse.

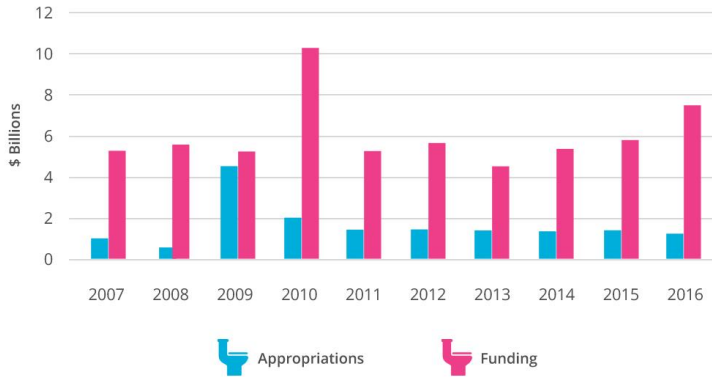
CAPACITY & CONDITION

Wastewater removal and treatment is critical to protect public health. Wastewater treatment processes improve water quality by reducing toxins that cause harm to humans and pollute rivers, lakes, and oceans. Wastewater enters the treatment system from households, business, and industry through public sewer lines and, in many places across the country, stormwater drains.

Wastewater treatment is typically overseen by a community utility or public works department that ensures water quality standards are met before the treated water is discharged back into the environment. In most localities, all publicly-supplied water is treated to meet federal drinking water standards, regardless of whether it will be used for drinking. Nearly 240 million Americans – 76% of the population – rely on the nation's 14,748 treatment plants for wastewater sanitation. By 2032 it is expected that 56 million more people will connect to centralized treatment plants, rather than private septic systems – a 23% increase in demand. In the U.S., there are over 800,000 miles of public sewers and 500,000 miles of private lateral sewers connecting private property to public sewer lines. Each of these conveyance systems is susceptible to structural failure, blockages, and overflows. The U.S.



**Clean Water State Revolving Fund
 Appropriations and Funding**



categories the federal government funds, water services receive less than 5%. It is estimated local governments spend \$20 billion a year on capital sewer expenditures and \$30 billion annually on O&M.

As cities continue to experience population growth, particularly in the south and west, new housing developments are constructed, and rural households switch from septic systems to public sewers, pressure on existing centralized systems and treatment plant infrastructure will require billions of dollars in new

investment to meet federal regulatory requirements. 75% would go toward treatment plant improvements, conveyance system repairs, new conveyance systems, and recycled water distribution; 18% to CSO correction; and about 7% to stormwater management.

Cities and towns across the country report that complying with federal wastewater and stormwater regulations represents some of their costliest capital infrastructure projects. Local governments rely on a mix of funding, including sewer rates, dedicated fees such as stormwater or watershed restoration fees, local taxes, and the federal government. Approximately half of total annual expenditures in the wastewater sector go to operation and maintenance (O&M) and this share will likely rise further against capital investments. Since no federal funding may be used to pay for O&M, the full burden falls on rate payers.

Funding both capital projects and O&M is difficult because the public often does not see or appreciate the modern convenience of wastewater treatment, making it difficult to convey the need for sewer rate increases. Further, the rates charged on monthly bills are generally set by local governments and can be subject to political influence. As a result, wastewater rates often do not cover the full cost of service, particularly as needs rise due to aging systems, a growing number of users, and additional water quality measures. The majority of treatment facility expenses are supported by rate payers, however rising utility bills can present affordability issues. In a 2014 survey of the nation's 50 largest cities, average monthly sewer bills ranged from \$12.72 in Memphis to \$149.35 in Atlanta.

Through the Water Infrastructure Finance and Innovation Act (WIFIA) of 2014, Congress authorized a new mechanism to primarily fund large water infrastructure projects over \$20 million. In December 2016, the WIFIA program received \$20 million in appropriations and began releasing funding opportunities to prospective borrowers in January 2017. EPA estimates that this appropriation will result in approximately \$1 billion in loans supporting approximately \$2 billion in water and wastewater infrastructure investments.



RESILIENCE & INNOVATION

Treatment plants are typically located at the bottom of watersheds or coastal and riverine areas. Given these locations, many utilities have recently undertaken studies to assess vulnerability to more extreme flooding events and sea level rise. For instance, during Superstorm Sandy in 2012, several wastewater treatment plants in New York and New Jersey were inundated with storm surge, causing hundreds of millions of gallons of untreated sewage to spill into neighboring waterways. In the years since, many of these plants and others across the U.S. have developed resilience plans and increased infrastructure fortification against floods and storm surge.

Treatment plants are also rethinking biosolid disposal through nutrient recovery programs. Biosolids are the organic materials left over following the treatment process. Traditionally biosolids were considered waste and transferred to landfills. However, when properly treated and processed biosolids become nutrient rich organic material that can be applied as fertilizer or, through the use of anaerobic digesters and centrifuges, can be pelletized and incinerated at high pressure and temperature for use as energy. According to the American Biogas Council, there are currently 1,269 water resource recovery facilities using anaerobic digesters, with about 860 using biogas as a new energy source to reduce demand and costs from traditional, grid-supplied energy sources. More than 2,440 plants have been identified as ripe for future biogas development projects, which, when combined with other biogas sources such as agriculture, could produce enough energy to power 3.5 million American homes.

Through the advent of new treatment methods such as reverse osmosis, ozone, and ultraviolet light, treated water can be processed quicker than traditional chlorine contact methods. With less processing and holding time, plants can treat more wastewater and often discharge a cleaner, purer product back into the environment.

With heavy rain events in some regions of the country, and water shortages in others, wastewater and stormwater are increasingly reused. New methods and technologies of reusing water have allowed communities to better manage precious water supplies by treating wastewater products to levels required for commercial, irrigation, and industrial uses.

RECOMMENDATIONS TO RAISE THE GRADE

- Reinvigorate the State Revolving Loan Fund (SRF) under the Clean Water Act by reauthorizing the minimum federal funding of \$20 billion over five years.
- Fully fund the Water Infrastructure Finance and Innovation Act (WIFIA) at its authorized level.
- Preserve tax exempt municipal bond financing. Low-cost access to capital helps keep lending for wastewater upgrades strong and accessible for communities large and small.
- Eliminate the state cap on private activity bonds for water infrastructure projects to bring an estimated \$6 billion to \$7 billion annually in new private financing.
- Establish a federal Water Infrastructure Trust Fund to finance the national shortfall in funding of infrastructure systems under the Clean Water Act.
- Preserve the status of tax-exempt bonds. These bonds have funded more than \$1.9 trillion in infrastructure construction in the last decade alone.
- Raise awareness of the true cost of wastewater treatment.



2017 INFRASTRUCTURE REPORT CARD

- Achieve Clean Water Act compliance in a way that minimizes the impact on lower-income residents and on economic competitiveness through bill payment assistance; revisiting EPA affordability guidelines; renewed or enhanced federal and state aid; and redirecting other aid sources to sewer-mandate compliance.
- Support green infrastructure, which provides co-benefits such as water and air quality improvement, aesthetic value to communities, and cost competitiveness.

DEFINITIONS

Clean Water Act State Revolving Fund (CWSRF) — Program added to the Clean Water Act by Congress in 1987 to make funds available to drinking water systems to finance infrastructure improvements.

Clean Watersheds Needs Survey (CWNS) — A survey of wastewater infrastructure investment needs over 20 years undertaken by the Environmental Protection Agency's Office of Wastewater Management in conjunction with the states every four years. The CWNS is required by the Clean Water Act.

Sanitary Sewer Overflows (SSOs) — occasional unintentional discharges of raw sewage from municipal sanitary sewers due to blockages, line breaks, sewer defects that allow storm water and groundwater to overload the system, lapses in sewer system operation and maintenance, power failures, inadequate sewer design, and vandalism. EPA estimates that there are at least 23,000 to 75,000 SSOs per year.

Green Infrastructure — A man-made or natural system to prevent stormwater runoff that allows most precipitation to be absorbed or infiltrated into the ground where it replenishes aquifers, nourishes plants, and supplies water to nearby streams during low flows.

Large Community Water Systems — systems serving more than 50,000 people

Medium Community Water Systems — systems serving 3,301 to 50,000 people

Small Community Water Systems — systems serving 3,300 or fewer people

Water Infrastructure Finance Innovations Authority (WIFIA) — If enacted by Congress, a program that would access funds from the U.S. Treasury at Treasury rates and use those funds to support loans and other credit mechanisms for projects to repair or replace aging drinking water and wastewater infrastructure. The loans would be repaid to the Authority and then to the U.S. Treasury with interest.

Combined Sewer Systems — Sewers that are designed to collect rainwater runoff, domestic sewage, and industrial wastewater in the same pipe.

Combined Sewer Overflows (CSOs) — Contain not only stormwater but also untreated human and industrial waste, toxic materials, and debris when heavy rainfall produces a volume of water that exceeds the capacity of a combined sewer.

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GAME CHANGERS

While all categories of American infrastructure require modernization and improvement, civil engineers, local communities, all levels of government, and the private sector have already started to develop innovative approaches to address our nation's significant infrastructure needs.

To spotlight these efforts, ASCE seeks to continually identify infrastructure Game Changers— groundbreaking infrastructure projects that are transforming the way we plan and build projects across the country and the Report Card's 16 categories.

#GAMECHANGERS

To learn more about Game Changers in each infrastructure category and in your state, visit InfrastructureReportCard.org/GameChangers

INFRASTRUCTURE REPORT CARD HISTORY

The concept of a report card to grade the nation's infrastructure originated in 1988 with the congressionally chartered National Council on Public Works Improvement report, *Fragile Foundations: A Report on America's Public Works*. A decade later, when the federal government indicated they would not be updating the report, ASCE used the approach and methodology to publish its first *Report Card on America's Infrastructure* in 1998. With each new report – in 2001, 2005, 2009, 2013, and now 2017 – the methodology of the Report Card has been rigorously assessed so as to take into consideration all of the changing elements that affect America's infrastructure.

In 1988, when *Fragile Foundations* was released, the nation's infrastructure earned a "C," representing an average grade based on the performance and capacity of existing public works. Among the problems identified within *Fragile Foundations* were increasing congestion and deferred maintenance and age of the system; the authors of the report worried that fiscal investment was inadequate to meet the current operations costs and future demands on the system. In each of ASCE's six Report Cards, the Society found that these same problems persist. Our nation's infrastructure is aging, underperforming, and in need of sustained care and action.



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CATEGORY	1988*	1998	2001	2005	2009	2013	2017
Aviation	B-	C-	D	D+	D	D	D
Bridges	-	C-	C	C	C	C+	C+
Dams	-	D	D	D+	D	D	D
Drinking Water	B-	D	D	D-	D-	D	D
Energy	-	-	D+	D	D+	D+	D+
Hazardous Waste	D	D-	D+	D	D	D	D+
Inland Waterways	B-	-	D+	D-	D-	D-	D
Levees	-	-	-	-	D-	D-	D
Ports	-	-	-	-	-	C	C+
Public Parks & Recreation	-	-	-	C-	C-	C-	D+
Rail	-	-	-	C-	C-	C+	B
Roads	C+	D-	D+	D	D-	D	D
Schools	D	F	D-	D	D	D	D+
Solid Waste	C-	C-	C+	C+	C+	B-	C+
Transit	C-	C-	C-	D+	D	D	D-
Wastewater	C	D+	D	D-	D-	D	D+
GPA	C	D	D+	D	D	D+	D+
Cost to Improve**	-	-	\$1.3T	\$1.6T	\$2.2T	\$3.6T	\$4.59T

*The first infrastructure grades were given by the National Council on Public Works Improvements in its report *Fragile Foundations: A Report on America's Public Works*, released in February 1988. ASCE's first Report Card for America's Infrastructure was issued a decade later.

**The 2017 Report Card's investment needs are over 10 years. The 2013 Report is over eight years. In the 2001, 2005, and 2009 Report Cards the time period was five years.



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and policy guidance for the National Surface Transportation and Revenue Study Commission. Mr. Bennett served as Vice President Infrastructure and Systems at the Long Island Rail Road. As a Principal in two major transportation consulting organizations, Peat Marwick Mitchell & Co (PMM&Co now KPMG-Peat Marwick) and Booz Allen Hamilton, he provided planning and management support for domestic and international passenger rail clients. He is a registered Professional Civil Engineer and holds a B.S. in Civil Engineering and a M.S. in Civil Engineering (Transportation) from the University of California – Berkeley

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Dr. Camp is a research associate professor in the Department of Civil and Environmental Engineering at Vanderbilt University in Nashville, Tennessee. She specializes in enterprise risk management, particularly as applied to infrastructure vulnerability assessments and adaptation planning under future climate and extreme weather conditions, and has led several such projects in this area. Dr. Camp is engaged in a variety of professional activities involving infrastructure condition and resilience. She is the recipient of the ASCE Tennessee Section's 2011 Young Engineer Award, was named ASCE's 2012 Citizen Engineer, and was recognized as the Eastern Region Younger Members Council 2012 Outstanding Younger Member in Community Activities. She received the 2016 Outstanding Engineering Educator Award from ASCE's Nashville Branch. Dr. Camp served on the 2013 Committee for America's Infrastructure and currently serves on the ASCE Excellence in Journalism Award Committee. She is also the 2016-2017 President for the Tennessee Society of Professional Engineers.

SUSAN HANN, P.E., AICP, ICMA-CM, M. ASCE

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Hann is the Director of Planning and Project Management for Brevard Public Schools in Brevard County, Florida. She has also served as the City Manager and Public Works Director for the City of Palm Bay, Florida. Sue holds a bachelor of science in civil engineering degree from the University of Maryland and a master of business administration from Florida Institute of Technology. Hann is a former member of the Board of Directors of the American Public Works Association and currently serves on the Board of Directors of the Institute for Sustainable Infrastructure.

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Herrmann is Partner Emeritus of Hardesty & Hanover, a transportation consulting engineering firm headquartered in NYC specializing in fixed and movable bridges. He is a Fellow of both the Structural Engineering Institute (SEI) and ASCE and served as ASCE's President for 2012. He now serves as SEI's 2017 President on their Board of Governors. An advocate for improving our nation's infrastructure, he has testified before Congress and been interviewed many times by the media, most recently appearing



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on CBS's "60 Minutes" and HBO's "Last Week Tonight with John Oliver." Registered as a Professional Engineer in 29 states, he graduated from Valparaiso University with a BSCE and NYU POLY with a MSCE.

CHUCK HOOKHAM, P.E., M.ASCE

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Hookham is Director of NBD Services at CMS Energy, a large regulated electric/gas utility and non-regulated developer of energy projects, headquartered in Jackson, MI. He has over 35 years of experience in power generation, transmission, and distribution, natural gas and oil pipelines and refineries, and infrastructure systems and has held positions responsible for permitting, design/construction, financing, and operating said facilities across his career. He serves on multiple ASCE and NCEES committees, was pointed to the State Board of Professional Engineers, and is involved in national, state, and local energy policy development.

SAM KITO, P.E., M.ASCE

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Kito was born and raised in Anchorage, Alaska, and has over twenty-five years of experience in engineering, planning and government relations. He has worked in the private sector, and for local, state and federal government agencies. Kito managed the school construction and major maintenance grant and debt programs for the State of Alaska Department of Education. He also worked at the Alaska State Department of Transportation and Public Facilities, where he coordinated the department's legislative activities and resolved conflicts on rural projects around the state. Kito is the ASCE Juneau Branch Past President and has served with the Alaska Professional Design Council (APDC), Alaska Society of Professional Engineers (ASPE), Professional Engineers in Private Practice (PEPP) and the Institute of Transportation Engineers ITE).

OTTO J. LYNCH, P.E., F.ASCE, F.SEI

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Lynch is Vice President of Power Line Systems, Inc. in Nixa, Missouri. For more than 28 years he has participated in the design and construction of numerous high-voltage transmission line projects around the world and was the pioneer in the use of LiDAR in the transmission line industry. Lynch is currently a member of the National Electric Safety Code and virtually all overhead transmission line industry-related ASCE and IEEE standards and committees. In 2012, he was awarded the ASCE Gene Wilhoite Innovations in Transmission Line Engineering Award.

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Matteo serves as the Virginia Department of Transportation's (VDOT) Assistant State Structure and Bridge Engineer for Bridge Maintenance, responsible for establishing policy for the maintenance of over 19,000 of the commonwealth's highway bridges and large culverts. He has 30 years of engineering experience in structural design, bridge maintenance and construction management. Before joining VDOT he worked as an engineering consultant, where he was responsible for the management of an office that performed bridge design, bridge inspection and bridge maintenance services in the mid-Atlantic region. Matteo received his Bachelor of Science in Civil Engineering from the University of Virginia, and his Master of Science in Civil Engineering from the Massachusetts Institute of Technology. He is a registered Professional Engineer in Virginia and California.

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McKeehan is currently a Senior Airport Engineer with Gresham, Smith and Partners in Tampa, Florida. Over his 30-year career, he has held engineering positions in all three project roles (airport facilities engineer, consulting engineer, and contractor). He has managed over \$500 million in completed infrastructure including aviation, healthcare, industrial, manufacturing, and commercial projects. McKeehan is Past President of the ASCE Transportation and Development Institute and is a member of Transportation Research Board Standing Committee AV070, Aircraft/Airport Compatibility.

PETER MERFELD, P.E., M.ASCE

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Merfeld is a licensed professional engineer in Maine with 27 years' experience, including 20 years with the Maine Turnpike Authority (MTA). Since 2000, as Chief Operations Officer for the MTA, he is responsible for all maintenance, engineering, capital construction, public safety, and service plaza operations for the 110-mile Interstate toll road in southern Maine. Merfeld is the chair of the Committee on Maine's Infrastructure for the Maine section of ASCE, which is responsible for producing Maine's infrastructure report card (2008, 2012, 2016). He is a past president for the Maine Section of ASCE, and from 2005 to 2010 served on ASCE's Construction Institute's Claims Avoidance and Resolution Committee. Merfeld was a board director for the Maine Chapter of the Associated General Contractors of America (AGC) from 2003-2012 and has recently completed final term (2009-2016) as a board director for the International Bridge, Tunnel and Turnpike Association (IBTTA).

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Montgomery Mills is Senior Project Manager of Design and Construction for the Birmingham Jefferson Convention Complex. Her career spans 25 years beginning as a project manager with the City of Birmingham, moving into the private sector as a construction manager for site development firm and later building renovations at a local design build firm. In 2010 she established her own consulting firm, Civil Construction Solutions and recently moved into her role at the BJCC giving her an larger platform to



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recommendations related to maintaining infrastructure, reducing risk, and mitigating the adverse impacts from man-made and natural hazards.

KELLEY NEUMANN, P. E., M. ASCE

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Neumann is the Deputy Director for Planning and Engineering at Aurora Water in Colorado. She previously spent over 20 years at the San Antonio Water System in Texas. She has more than 25 years of experience in water and wastewater utilities engineering, with emphasis in utility system planning, and capital planning and development. She has a Bachelor's and Master's degree from the University of Texas.

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Nikolic is an energy and utilities consultant based in Philadelphia, PA. She is responsible for assisting energy and utility clients with the management of projects that modernize the grid, including Smart Grid, Energy Management System, Outage Management System, and Advanced Distribution Management System Projects. Nikolic holds a bachelor of science in civil engineering from Washington State University, a master of science in engineering from Johns Hopkins University, and is a member of ASCE's Engineering Practice Policy Committee.

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Ogden is a Project Manager with the Association of State Dam Safety Officials (ASDSO). Mark has over thirty years of experience in dam and levee safety regulation and policy. His work with ASDSO includes assistance to state dam safety programs and advocacy for dam safety at all governmental levels. He worked for twenty-five years for the Ohio Department of Natural Resources, Division of Water where he served as the administrator of the Water Management Section with responsibility for the Dam Safety, Floodplain Management, Coastal Erosion Permitting, and Canal Operations Programs. Ogden holds a Bachelor of Science degree in Civil Engineering from The Ohio State University. He is a registered Professional Engineer in Ohio and a Certified Public Manager.

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Perrings is a Project Civil Engineer with P/A Design Resources, Inc. in Walnut Creek, California, a Planning, Civil Engineering and Survey Design Firm. His area of expertise is water quality, storm drainage and flood control. Perrings holds a Bachelor of Science Degree in Civil Engineering from Rose-Hulman



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Shelton is currently a Deputy Director for the Gwinnett County Department of Water Resources. She is responsible for a range of water resources engineering programs including drinking water treatment and distribution, and wastewater collection and treatment. Over her career she has been responsible for a number of other programs including public works, stormwater management and environmental protection. She is passionate about protecting public health by ensuring that drinking water and wastewater systems are properly designed, built and maintained. Shelton has been active with ASCE, serving as Georgia Section President and Chair of the Georgia Infrastructure Report Card Committee. She received several Georgia Section Awards, including the Georgia Section President's Award, and the Georgia Section Civil Engineer of the Year. She has also received the Engineer of the Year in Government Award from the Georgia Engineering Alliance. Shelton also currently serves on ASCE's Public Agency Peer Review Committee. She has a B.S. in Environmental Engineering from the University of Central Florida and a M.S. in Civil Engineering from Georgia Institute of Technology.

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Schipper has served as Greater Cleveland Regional Transit Authority's Deputy General Manager for Engineering and Project Management since 2001. He is responsible for the planning, design, and construction elements of GCRTA's Capital Improvement Program. He was instrumental in progressing the nationally recognized \$200 million HealthLine Bus Rapid Transit program from preliminary engineering into final design, construction and operation. Prior to joining GCRTA he was a project principal and project manager for numerous highway, bridge, turnpike and municipal design projects for HNTB and for the City of Irving, TX. He has Civil Engineering degrees from the Rose-Hulman Institute of Technology and the University of Texas at Arlington and is a Registered Professional Engineer in the states of Ohio and Texas. He is a Past President of the Cleveland Section of ASCE. He is currently serving as the President of the Cleveland Engineering Society.

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Stahlman is the Director of Engineering & Construction, as well as, the appointed Port Engineer for America's Central Port. He is engaged in a variety of local professional activities involving regional planning and infrastructure development, is the recipient of the ASCE St. Louis Section's 2011 Young Engineer Award for Professional Achievement, and was recognized as the ASCE Region 7 Outstanding Younger Member Award in 2013. He also serves as a member of the Board of Directors and the Chair of the Upper Mississippi River Basin for Inland Rivers, Ports and Terminals Association (IRPT), and the Vice-Chair of Committee 18 (Light Density & Short Line Railways) for the American Railway Engineering and Maintenance-of-Way Association (AREMA).

NICK TALOCCO, P.E., M.ASCE

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Talocco is a senior engineer at LT Environmental, Inc in Denver, Colorado has been working in the environmental industry for over 17 years, conducting a variety of consulting services that has included: solid waste containments, Colorado Voluntary Clean-up Program (VCUP) applications, soil characterization and material management plans, asbestos inspections and project design, stormwater management plans and inspections, wetlands and threatened and endangered observations, construction dewatering designs, water treatment systems, and contaminated soil and groundwater remediation system feasibility evaluations and design.

MIKE TILCHIN, P.E., LEED G.A., M. ASCE

Washington, D.C.

National Capital Section

Tilchin has 34 years of experience in environmental science and engineering, and in project and program management. As National Manager for EPA Programs, Mike oversees CH2M's work for EPA under Superfund, the water program, climate change, the Great Lakes National Program, and the Office of Sustainable Communities. Tilchin was appointed by EPA to serve on the National Advisory Council for Environmental Policy and Technology (NACEPT) Superfund Subcommittee in 2002- 2004, developing policy recommendations for the Superfund program. He currently serves on the Board of Directors of the CH2M Hill Plateau Remediation Company, which is engaged in cleanup activities at the US Department of Energy's Hanford site in Richland, WA, and the Anacostia Watershed Society, an environmental group dedicated to cleaning up the Anacostia River and improving the quality of life for communities in the watershed through stewardship, advocacy, recreation, and education programs. He also serves on the American Council of Engineering Companies' Superfund Working Group. He is a licensed professional engineer in Virginia.



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ORGANIZATIONS

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