



Making the Grade Report Out

A National Six-Point Plan
to Regain America's
Infrastructure Leadership

*"Never doubt that a small group of committed
people can change the world. It is the only
thing that ever has."*

—Margaret Mead, Anthropologist



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Making the Grade

A National Six-Point Plan to Regain America's Infrastructure Leadership

Executive Summary

Making The Grade represents the consensus of many who attended the meeting “Executing a Sustainable Infrastructure Vision” convened by the White House Council on Environmental Quality (CEQ) initially in 2012. The *Making the Grade* roundtable that followed in 2013 was comprised of experts from 45 companies representing the scope of the U.S. infrastructure industry—planning, engineering, construction, and technology—and their counterparts from local governments, professional organizations, think tanks, financial advisors, academic institutions, and others. Participants agreed to an ambitious goal: describe a new vision and path forward for regaining and sustaining America's public infrastructure leadership.

A vision that:

- Promotes, as a national imperative, regaining America's infrastructure leadership through a renewed commitment to infrastructure development for the long term
- Rekindles the foresight, initiative, investment, innovation, and hard labor that went into the development of a national public infrastructure that has served as the foundation for economic expansion, prosperity, and opportunity for successive generations of Americans
- Encourages fresh thinking about project financing and planning that balances the economic, environmental, and social costs and benefits of new infrastructure investments
- Improves the utility and productivity of infrastructure—both new and old—by applying the latest in systems planning and integrated technologies
- Tackles historic road blocks to effective regional and national scale infrastructure
- Embraces modern delivery methods and approaches that promote efficiency in project delivery and discourage unnecessary administrative and liability burdens on stakeholders
- Renews Americans' historically shared sense of responsibility and enthusiasm for public works by employing capital and natural resources efficiently



The Roundtable's vision is supported by a national six-point plan that answers the CEQ's call for broad-based recommendations to support greater investment in national infrastructure:

1. **Make Infrastructure leadership a presidential and cabinet priority** to convey and support the vision, arbitrate competing interests, and remove obstacles to success
2. **Form U.S. infrastructure regions** to integrated infrastructure agendas and efficiently allocate capital and natural resources
3. **Establish a national infrastructure bank** to accelerate projects that can align with the visions goals, i.e., innovation, and prudent use of capital, modernize project delivery methods, and societal benefit, among others
4. **Sell opportunity bonds** to raise more infrastructure capital to fulfill our generational obligation
5. **Create a national infrastructure index** that clearly articulates our current state, ambition, and the relative contribution of proposed projects and programs to encourage long-term, sustainable ROI through transparency
6. **Engage the American people** to build support for the importance of infrastructure policy

This report contains highlights of the thinking that led such a large group of experts to reach these conclusions. The names of these organizations can be found in the Appendix.



The Challenge: Why Failure is Not an Option

America's infrastructure

What will it take to restore our national imperative of building for the future? Do Americans realize infrastructure's importance to economic stability and growth? How can we jumpstart a fresh look at the issues? A symposium of public-private infrastructure industry leaders examined these and other questions and agreed the time has come to issue an experts' consensus report on the seriousness of the status quo and the pressing need for change. For purposes of this summary discussion, the participants define infrastructure as the basic public physical and organizational structures needed for society to function. Examples include: drinking water, wastewater, waste disposal (both solid and hazardous), telecommunications, energy, streets, roads, highways, bridges, transit, rail, aviation, schools, parks, levees, ports, and inland waterways.

Most of us seldom give public infrastructure a thought—until it fails. Highway infrastructure matters only when our commutes become congestion nightmares. A water main only gets our attention when 100-year-old pipes burst and suddenly there's no water for a shower. Stormwater drains are invisible until one too many downpours turn streets into rivers and create costly bills for homeowners with flooded basements.

The deplorable state of the nation's public infrastructure was given a cumulative grade point average of D+ in 2013 by the American Society of Civil Engineers (ASCE). A grade of D is defined as "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 significant concern with strong risk of failure."¹

Such near-failing grades also have devastating social and economic consequences. The annual cost of the status quo, with ever-increasing water main breaks, electricity failures and transportation delays, is estimated to rise

PUBLIC WORKS = SHARED RESPONSIBILITY

"Maintaining and modernizing our infrastructure is one of the essential roles of government. From Franklin Roosevelt to Ronald Reagan, building the networks that connect our families and businesses to one another has long been a bipartisan issue."

—ASCE President Randall S. Over, P.E.

ASCE Press Release Wednesday, January 29, 2014, Statement on President Obama's State of the Union from the American Society of Civil Engineers

AMERICA'S TRANSPORT INFRASTRUCTURE: LIFE IN THE SLOW LANE

America is known for its huge highways, but with few exceptions (London among them) American traffic congestion is worse than Western Europe's. Average delays in America's largest cities exceed those in cities like Berlin and Copenhagen. Americans spend considerably more time commuting than most Europeans; only Hungarians and Romanians take longer to get to work. More time on lower quality roads also makes for a deadlier transport network. With some 15 deaths a year for every 100,000 people, the road fatality rate in America is 60 percent above the OECD average; 33,000 Americans were killed on roads in 2010.

—*The Economist*, April 2011

to \$1.2 trillion for U.S. businesses and \$611 billion for all American households by 2020.² Putting the situation into perspective on the ground in just two vital infrastructure sectors, roadways, and water/wastewater:

- Currently, 42 percent of major U.S. urban highways are congested. What is the cost for that? \$101 billion in lost worker productivity and wasted fuel spent idling in traffic every year. Meanwhile, an \$846 billion gap in roadway investment continues to grow. By 2020, we will triple the time stuck in traffic and risk economic gridlock in some of the nation's densest urban corridors.
- An estimated 240,000 water main breaks every year are symptomatic of an aging and overburdened water infrastructure system, some of which dates to the 1880s. Without extra investment to close the gap, 700,000 U.S. jobs will be at risk by 2020 along with \$416 billion of the nation's gross domestic product (GDP).³
- ASCE's executive director Patrick Natale described the underlying data (see accompanying chart) that supported the 2013 report card, noting that deteriorating infrastructure has a cascade effect across the economy, "negatively affecting business productivity, gross domestic product, employment, personal income, and international competitiveness."⁴

Natale said that most of these changes aren't "something dramatic you will notice overnight, but a gradual worsening of conditions over time. Your commute will become less reliable; your shipments will take longer. You may experience more electrical outages and water issues. And these things cost us something." He warned: "The message is clear: if we don't invest now, we all end up paying more in the long run."

What is needed is a renewal of the national consensus to invest in the public infrastructure that made this the world's leading economy and provided unprecedented opportunity for successive generations of citizens. When he was asked what the infrastructure challenge is, former U.S. Transportation Secretary Ray LaHood said:

"We're not number one anymore. We're number 14 (according to the World Economic Forum). Bridges are falling down, roads are crumbling.... [We're] not creating any jobs. We're not creating any opportunities. We're not rebuilding America. America is falling apart."⁵

It wasn't always like this.

SPECIFIC ECONOMIC IMPACTS BY 2020

	Surface Transportation	Airports	Inland Waterways & Marine Ports	Electricity	Water/Wastewater
Business Sales (billions)	\$1,700	\$580	\$1,335	\$847	\$734
GDP (billions)	\$897	\$313	\$697	\$496	\$416
Jobs (in the year 2020)	877,000	350,000	738,000	529,000	669,000
Disposable Income (billions)	\$930	\$361	\$872	\$656	\$541
Value of Exports (billions)	\$114	\$54	\$270	\$51	\$20

Note: Job losses depicted here are for 2020 only; other effects are cumulative.

A proud history

The United States has an illustrious history of public infrastructure leadership. The nation was built by a combination of foresight, innovation, and hard labor that went into the development of its infrastructure. Economic expansion, prosperity, and opportunity for successive waves of immigrants followed the planning and construction of the public transport needed to encourage trade and settlement of a new nation. Beginning in the 18th century, much of the country's success revolved around establishment of America's infrastructure framework—canals, roads, rails, utilities, and other infrastructure needed to support a fast-growing economy. Call that infrastructure 1.0.

By the mid-20th century, infrastructure 2.0 was in full swing, thanks to the development of several innovative infrastructure efforts, such as a massive network of locks and dams that would prevent severe flooding and transport water to growing states, as well as the world's largest aviation system. From the Great Lakes to the Gulf of Mexico, the Atlantic to the Pacific, and later, Alaska and Hawaii, growth and opportunity for all Americans was made possible by bold investments in public works.

In 1956, a farsighted President Dwight Eisenhower led the nation to create a Federal Highway Trust Fund that set off two decades of development of advanced roadways to connect the states and pave the way for post-war prosperity. Safety and maintenance innovations were introduced, including new roadway surface materials and advances in design and engineering of roadbeds and on- and off-ramps. From a president's early vision for great public works that would support the nation's peacetime recovery, the U.S. Interstate Highway System has grown to 47,000 miles.

Unfortunately, much of these public investments are outdated and in need of repairs.

Well-studied obstacles

How a nation that was once the world's model for public infrastructure development could decline to near-failure has been the subject of much study, discussion,



Easton & Northern Railroad, Lehigh River Bridge, Spanning Lehigh River, Easton, Northampton County, PA. Library of Congress, Prints & Photographs Division, HAER PA,48-EATO,13—5

and debate. The list of obstacles to infrastructure modernization and improvement certainly includes federal fiscal constraints and similar budget pressures at the state and local levels. However, something else less tangible but even more important has been at play in recent years: erosion of the political and public will to invest in the future.

Lack of political will. Americans resist paying higher taxes and fees, and want to see policymakers do more to address budget deficits and debt, but at the same time, the most recent Pew Research polling on the topic, 38 percent of the public wanted to see more spending on roads and infrastructure. But 43 percent still favored the status quo of keeping spending at the same level. These findings in February 2013 mirrored public sentiment in 2011.⁶

The consistent theme is lack of political consensus and majority public support. America lacks a national strategy that bridges the fragmented governmental, political and societal divides.



Chickamauga Dam and powerhouse. Library of Congress Prints and Photographs Division, LC-USW33-015618-ZC



Aerial view of four-level interchange at intersection of Arroyo Seco Parkway and Highway 101, Hollywood Freeway. Library of Congress Prints and Photographs Division, HAER CAL,19-LOSAN,84—1

Poor understanding of economic growth. A

growing number of experts, from think tanks and independent government bodies, are concerned that the public is not sufficiently informed about the strong correlation between infrastructure investment and economic growth.

The United States currently spends just under 2 percent of its Gross Domestic Product (GDP) on infrastructure, while most estimates show Europe at closer to 5 percent. Emerging market economies such as India and China invest at much higher rates, from 9 to 11 percent, according to some estimates. The current World Economic Forum Global Competitiveness Index ranks the United States 14th in infrastructure quality, behind Singapore, the United Arab Emirates, and Hong Kong, along with a number of European nations like France and Germany.⁷ The WEF index includes infrastructure based on its strong correlation to productivity and economic growth, among other business opportunity factors. Research shows that infrastructure investments create prosperity over time. A study by the Federal Reserve Bank of San Francisco for a National Bureau of Economic Research conference, *Roads to Prosperity or Bridges to Nowhere? Theory and Evidence on the Impact of Public Infrastructure Investment*, analyzed data from state-level highway projects from 1993 to 2010 to determine what, if any, impact these projects had on localized GDP. The 2012 study found that federal grants had a significant, positive impact on local GDP as well as a corresponding positive benefit to state infrastructure development. The economic multiplier effect continued for six to eight years after the initial investment. The researchers noted that:

- The front-end economic boost was evident only for spending during recessions, not when the economy is expanding. However, multiplier effect increases to local GDP continued for years after spending in economic expansions as well as recessions.
- This effect is not permanent: within 10 years after the initial investment, local economies had returned to previous levels.⁸

In other words, infrastructure investment is not a once-



and-done activity, but must be planned and carried out for the long term to maintain steady support for future needs and ensure a healthy economy over time.

Risks of the status quo. Veteran government officials including La Hood and former Pennsylvania Gov. Ed Rendell understand all too well the risks of the status quo and the cost of major failures which result. As Rendell recently explained, after a disaster that cost lives, Americans briefly focus on the importance of infrastructure investment—

“And then nothing happens. Interstate 95 was closed for three days in 2008 because, by accident, a PennDOT contractor . . . saw a crack in one of the piers holding up one of the bridges of I-95. It took three days to steel-reinforce that bridge. I-95, it looked like a horror movie. In the broad daylight, you could see the [Philadelphia] city skyline in the background, and not one vehicle [on a three-mile stretch]. That bridge gets 75,000 cars and trucks a day. And the 22 miles of I-95 that goes through Philadelphia —

HIGH COST OF MAJOR FAILURES

2003 – Electrical blackouts in the Northeast contributed to at least 11 deaths and cost an estimated \$6 billion.

2007 – The I-35W bridge collapse in Minneapolis cost 13 deaths and 145 injuries. The state estimated economic losses at \$400k to \$1 million per day (it took 13 months to rebuild).

2013 – The I-5 Skagit Bridge collapsed due to an over-height truck hitting the bridge at a “fracture-critical” design with non-redundant load-bearing beams causing \$8.5M in damage and economic impact estimated at \$1M a day (temporary bridge opened in ~ 4 weeks).

there are 15 bridges that support it. The price tag to revitalize all of them — and all of them are older than 40 years . . . would be \$10 billion. The city's capital budget for everything, police stations, fire stations, potholes, is \$180 million.”⁹

Rendell pointed out that the Commonwealth of Pennsylvania had just passed a gas tax increase that is going to provide an additional \$2.3 billion in transportation funds for the entire state, an amount that remains inadequate relative to need.

“Where are we going to get the \$10 billion to ensure that piers don't collapse, causing a tragedy that would dwarf what happened in Washington [state] or Minneapolis? Where are we going to get that money? Ray [LaHood] is right. It is a disaster.”

Clearly, infrastructure deterioration leads to more potential failures we cannot afford. Adding to the risks from age- and use-related deterioration is the enormous added stress on infrastructure posed by an uptick in severe weather events. These environmental shifts highlight the need to not only maintain and rebuild, but also to renew and update our infrastructure, to adapt to the exigencies of climate change in the coming decades.

The challenge we share is how to achieve the needed forward-thinking, long-term approach. At one level, it appears that there is more talk about the problems and barriers than discussions about solutions.

But there are hopeful signs.



PUBLIC WORKS = SHARED RESPONSIBILITY

We found that unless new investments are made, the nation's deteriorating surface transportation will cost the U.S. economy more than 876,000 jobs and suppress our GDP by \$897 billion by 2020. Because, as the president said, 'first-class jobs gravitate to first-class infrastructure.'

—ASCE President Randall S. Over, P.E.

ASCE Press Release Wednesday, January 29, 2014, Statement on President Obama's State of the Union from the American Society of Civil Engineers



The Way Forward: Reimagining Infrastructure

In just the past two years, government and infrastructure leaders have renewed calls and discussions about how federal projects can help lead the way out of America's dangerous status quo.

Following sessions convened by the White House Council on Environmental Quality (CEQ),¹⁰ a group of 50 companies representing the scope of the U.S. infrastructure industry—planning, engineering, construction, and technology—got together in a multiday symposium in mid-2013 with representatives from local governments, professional organizations, financial advisors, academics, and policy experts to begin the deliberations that could answer the CEQ's call for recommendations to support greater infrastructure investment.

The result of their roll-up-the-sleeves discussions and brainstorming is summarized in this report. Obviously, a brief document cannot capture the full measure of viewpoints and ideas shared among symposium participants, much less presume to speak for every individual expert who attended. This report does, however, reflect the consensus of the attending organizations that the world-class infrastructure America needs to maintain its leadership in the future cannot be achieved using the same old approaches that worked in decades past.

Underpinning the findings that emerged from the symposium was a clear agreement among participants that all Americans need to be engaged in reimagining the future of our infrastructure in order that the nation's next 200 years are as prosperous as the past two centuries.

The symposium produced a six-point approach that requires new thinking on the part of the American public and participation by both public and private sector leaders to develop a common vision and strategy for America's infrastructure future. In the face of a growing array of community and other special interests, it is

imperative that infrastructure planning involve much broader definitions of stakeholders and participants in the process. Only in this way can the vision become shared and broad agreement be reached. The time has come to reimagine our ideas about infrastructure and recapture the national consensus Americans once celebrated:

a civic responsibility and pride in public works.

Indeed, as participants discussed, raising the dismal D+ grade tomorrow hinges on the actions we collectively take today for the simple reason that it requires many years (in some cases a decade or more) to plan and build the infrastructure that future generations will need.

The America built by previous generations and the America we want for future generations depend upon the same things: a common vision and strategy. Somehow the fabric of consensus needed to achieve these essentials has frayed over the last two decades, and must be woven anew.

Time for a new approach

Think about it: to continue a cycle of incremental upgrades or Band-Aid approach to fixing infrastructure issues as failure occurs, only increases our reliance on a failing system designed more than 50 to 80 years ago. Economic and societal needs have changed. What worked then, does not work now. Failure to prepare for extreme weather events has cost the U.S. \$1.15 trillion in economic losses from 1980 to 2010 and could cost another trillion in coming years, a Department of Homeland Security official told a Senate panel on February 12, 2014, in the middle of one of the worst winters on record in many parts of the

country. “According to the U.S. Global Change Research Program, future impacts of climate change project national economic losses on the order of \$1.2 trillion through 2050,” said David Heyman, DHS’s assistant secretary for policy.¹¹

Repeatedly treating symptoms rather than solving problems also makes these vital infrastructure systems more susceptible to natural disasters such as the devastating “Superstorm Sandy” that struck the Northeast and Mid-Atlantic in 2012, and others around the world (see Chart 1). Not to mention the economic and physical impact across many sectors (as shown on chart 2). The increasing stress on public infrastructure from the rising number of extreme weather events, including massive storms and floods to severe tornadoes, wildfires, and mudslides, is by now abundantly clear. Damage to infrastructure across the country is mounting at a time when public budgets are tight, and Americans struggling to recover from recession cannot afford the added drag on the entire economy and their personal pocketbooks.

ASCE looks at public infrastructure as the “nervous system” of the nation. Yet these vital services are compartmentalized in every respect—from ownership to accountability for operations to maintenance and improvements.

For instance, the serious challenge of planning and designing for improved resiliency across essential services like energy is only made more complicated by the myriad public and private entities involved in a complex web of responsibility. Resiliency is the ability to: (1) plan for and mitigate disaster; (2) ensure continuity of essential operations through a stressor event; and (3) prevent or minimize long-term impacts, such as an economic slowdown.

Siloed responsibilities only exacerbate these challenges, as symposium participants agreed. Whether the discussion is about improving infrastructure resiliency to withstand natural disasters or to keep the nation’s economic leadership in a highly competitive global

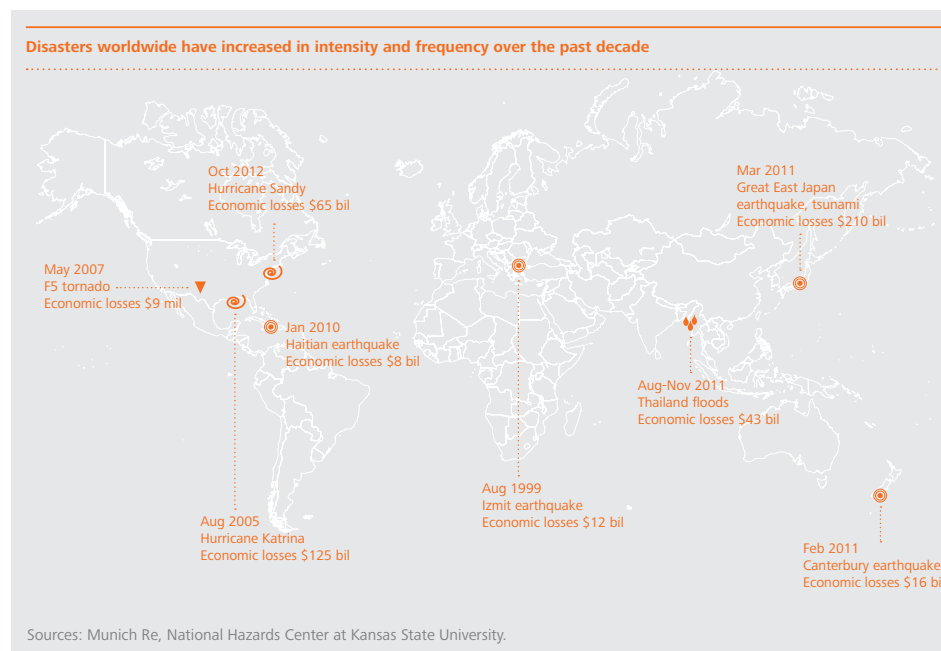


Chart 1: Depicted weather-related losses— from PriceWaterhouseCoopers report showing recent specific disasters

Total loss and damage from hydrometeorological disasters, by affected sector (1972-2013)

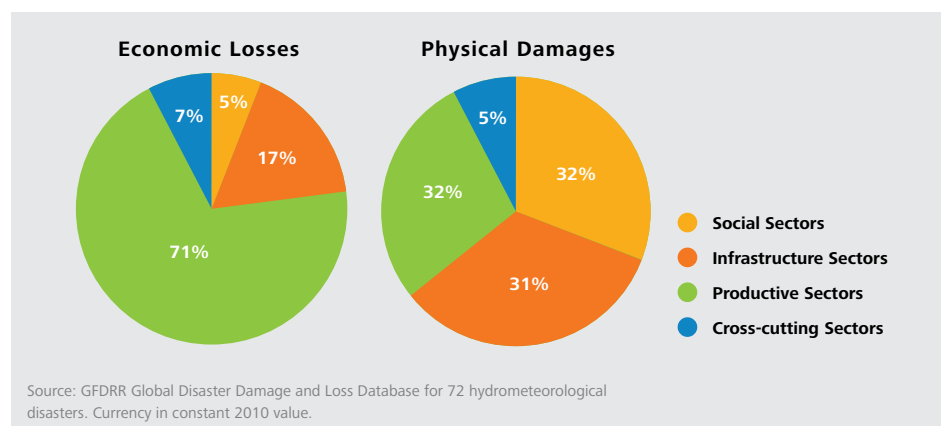


Chart 2: Breakdown of hydro-meteorological losses and damages by sectors – from PriceWaterhouseCoopers report showing recent specific disasters

environment, there is consensus that breaking down jurisdictional and operational barriers and looking at infrastructure in more integrated ways are key factors in meeting these challenges.

The issues, as ever, are funding and accountability. But as we have seen, failure to overcome these issues is not an option.

By investing an additional \$157 billion per year from 2014 to 2020, ASCE estimates that the nation can prevent a number of economically unacceptable outcomes. These include a \$3.1 trillion loss in GDP with \$1.1 trillion loss in total trade, a \$3,100 per year drop in disposable income per U.S. household, resulting in a \$2.4 trillion decline in consumer spending, and worst of all, the 3.5 million losses in American jobs during those seven years. The resulting return on that investment would be almost 6 to 1.

While this level of investment may seem daunting, there are ways to make our infrastructure investment dollars go farther and better serve our communities in the future. We must find ways to apply newer design and engineering thinking and approaches and combine these new ideas with modern technologies that enable us to reimagine our nation's infrastructure.

New technologies, new thinking

There is momentum in the infrastructure industry to help alleviate the nation's infrastructure challenge by breaking out of outdated molds of engineering design and associated delivery principles. America's infrastructure not only needs to be constantly maintained but also upgraded to meet new demands. Symposium participants agreed that new technologies and processes have evolved for the design, engineering, construction, operations, and maintenance of infrastructure that are superior to previous ways. These new technologies and processes help us approach infrastructure as integrated, networked "smart" systems rather than isolated civil engineering projects.

The methods, standards, and approaches that have served the nation well for many decades are now outmoded and can actually stifle innovation in

EU'S 'SMART' INFRASTRUCTURE POLICY

Early in 2014, the European Parliament approved a Directive for Public Sector Procurement that encourages public authorities to consider using Building Information Modeling (BIM) in public works. The Directive puts in place a wide range of goals and outcomes that must be achieved in all 28 European Member States. The BIM amendments create the opportunity for all EU Member States to recommend, specify or mandate the use of BIM for publicly funded construction and building projects in the European Union by 2016.

Malcolm Harbour, a member of the European Parliament from the UK and Chairman of the Internal Market and Consumer Protection Committee who led the Parliament's agreement on the Directive, said:

"Public procurement will no longer be a question of simply accepting the lowest price. Smart customers will work with smart suppliers to provide better solutions, better tailored to meeting customer needs in more innovative ways."

infrastructure development that can ultimately save money and time and improve public outcomes. This list is not exhaustive but illustrative of the issues that require equal participation and commitment by government agencies at the federal, state and local levels as well as infrastructure industry participants:

- Siloed people, workflows, applications, and processes cause redundancy, reduce productivity, and result in information conflicts and increased project costs.
- Limited private investment in public infrastructure projects due to a track record of inconsistent performance in meeting project time/budget goals and a lack of transparency about the project pipeline process.
- Increasing data from smart technologies are overwhelming our current infrastructure systems and with no funding to address, preventing the extraction and application of the newest and most valuable Internet-based technologies.
- Equally important, public policies at all levels of government that lock in outmoded approaches to overall project delivery including design and engineering, construction, as well as asset management of public infrastructure projects.

In an increasingly connected world, economic imperatives and resiliency imperatives are coming together. Leaders in the infrastructure industry have spent much time thinking about how innovative strategies in planning, design, and maintaining the asset can better leverage our manmade and natural systems to create infrastructure that is better able to withstand disasters, both natural and man-caused, and recover more quickly. U.S. leadership in developing state-of-the-art resilient infrastructure also could have the added benefit of prompting new economic opportunities in the global export of infrastructure technology and consulting expertise in much the same way the Dutch are recognized as the world leader in coastal water management engineering, design and construction technology.

Already, advanced technologies are available across the entire spectrum of infrastructure development—from the opportunities big data provides to analyze more complex risks and problems to avoid wasting time and money, to the Building Information Modeling (BIM) processes that can stretch infrastructure investment dollars throughout the design and engineering and construction phases along with introducing predictive asset management approaches to prolong the infrastructure life once built. In the European Union and the U.K., BIM is already

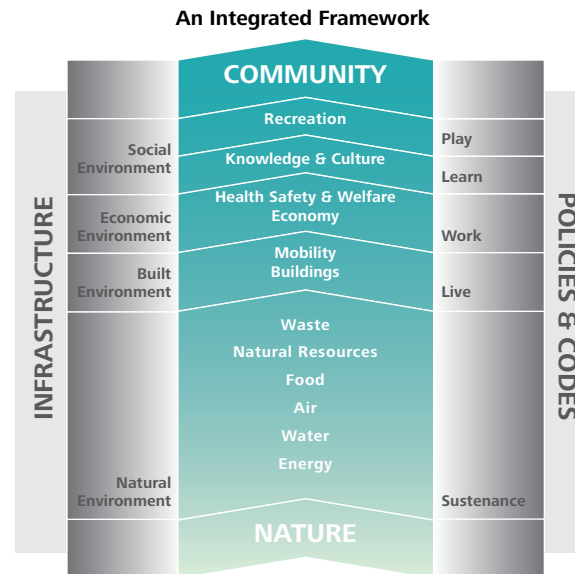
proving its worth along with asset management frameworks like PAS 55, the British Standards Institute (BSI) publically available specification for the optimized management of physical assets which has been migrated to the ISO55000 standard.

Study after study shows upwards of 25 percent of a projects total cost can result from change orders, rework, and design clashes discovered during the construction phase, resulting from lack of communication among project participants, often mandated by public policies. Alex Wittenberg, head of Oliver Wyman Global Risk Center, said, "Better management of large investment projects could free up \$5 trillion, or about 10 percent of the total required infrastructure investments, for other purposes by just minimizing the cost overruns and delays." New technologies and processes for the design, engineering, construction, operation, and maintenance of infrastructure go a long way to aiding in better management of infrastructure assets.

Drivers of change

Clearly, changes are needed across the infrastructure industry and must be supported by new thinking, approaches and policies among government, financiers, and community participants if we are to reimagine it for future generations. Much of what is required involves operationalizing modern methods for how infrastructure projects are initially conceived and then managed through their lifecycle in addition to the standards and policies that are applied. Below are highlights of the needed improvement areas identified during the symposium which underpin the overall six-point plan:

- **Start with integrated infrastructure planning:** The key to integration at the actual design, engineering, construction, operation, and maintenance is to start by empowering planners to envision and model the data-informed city in an integrated framework of infrastructure systems. It is important to keep in mind that infrastructure, especially at the national level, can be iconic and awe-inspiring, but also requires us to take a leap of faith and imagine "what could be." With the intelligent technologies



currently available, we have the capability to build infrastructure for lower carbon and greater sustainability and longevity. And as we think to the future, advanced technologies working in harmony will enable us to push existing boundaries and drive further innovation. Roadways are a good illustrative example of how reimagining infrastructure leads to viewing infrastructure more broadly, as a framework of integrated systems, and how such a reimagining can better serve our communities, and thus, the nation. Consider what will be needed to deliver on the promise of the Internet-connected cars that are already on the roads, and the autonomous vehicles that are now being tested. Consider the dangers that growing congestion on the nation's roads pose, and the urgency of the need to rethink how we manage traffic flows in cities, suburban communities, and on major highways and interstates as the U.S. population continues to grow (estimated at 1.5 times the 2005 population to some 440 million people by 2050). Consider the need to expand and integrate mass transit with daily commuting and commercial traffic. Consider the benefits that would come from making smart roadways a reality. Now add into this

reimagining exercise the vital infrastructure that runs along and under the roadways—below the surface, the unseen city.

At street level, networks of smart roadways can link vehicles and control systems with supporting data security and de-identification of personal data to provide operations support for traffic management, police, fire, and rescue units, among other important services. Better traffic control will mean less congestion, fewer accidents and loss of lives and property, and improved productivity.

With such approaches, a virtual road map can be applied to transform an inert ribbon of concrete or asphalt into a quasi-sentient information system. Based on how quickly intelligent vehicles and traffic system technologies develop, it will not be long before traffic control begins moving from the physical, ground-level infrastructure

INFRASTRUCTURE OF THE FUTURE IS HERE ... ALMOST

- A roadway that can charge electric vehicles as they drive along? Already in prototype and working in South Korea.
- Pavement/sidewalk that changes color to illuminate at night or warn of wet surface temperatures below freezing? Already prototyped in Norway, where roadway lines are painted with photo-luminescent powder to make lanes glow brightly in the dark—a lifesaver for a sun-starved country during pitch-black and rainy winters.
- Concrete coatings that repel water or materials to delay freezing on pavement? Already in R&D at two U.S. universities
- Solar roadways to store excess energy in or alongside to reduce fossil fuel use? Already in prototype in the U.S. with Federal Highway Administration grants

exemplified by traffic lights, signs, and crosswalk lights to integrated, embedded infrastructure that will reside not only inside vehicles, but utilities, pavement, and sidewalks for future car-less transportation modes.

*Now this infrastructure begins to be seen as a system in a framework of integrated systems based on connective technologies.*¹²

Below street level, consider the cost-effectiveness and the time and rework that can be saved by planning, developing, and financing interconnected water, sewer, gas, and electric lines at the same time that surface streets and sidewalks are being developed, replaced, or modernized.

Revolutionary advances in machine-to-machine (M2M) and vehicle to vehicle (V2V) communication technology (such as radio frequency identification (RFID) tags and embedded

sensors) have given us an unprecedented opportunity to accelerate improvements in vital services such as electricity and water. Smart electric meters, self-reporting leaky pipes, and intelligent pavement are just a few examples of what is possible.

Private sector organizations have harnessed technology to integrate processes and services, recording dramatic increases in efficiency and productivity. Why shouldn't the public sector? The technology is available; new engineering design and management techniques are tested and ready. All that is needed is the political and policy leadership to make it happen.

Most importantly, integration principles can be leveraged to build public support for more infrastructure investment. By approaching integration holistically and



Keystone Parkway Project BIM Model. Image courtesy of Above All Photography and American Structurepoint Inc.

CO-DESIGNING RECOVERY: GREENSBURG, KANSAS

"...[V]ery little consistency currently exists in the financing of critical infrastructure worldwide. I think one of the tensions is, 'How do you use public money that benefits private companies?'" says FEMA's [David] Miller, [associate administrator for the Federal Insurance and Mitigation Administration]. "And my answer is to turn that question on its head so it becomes, 'How do I invest in private industry in order to provide for the public good?' And that is a discussion that we have to have. We've got to make the case to business that it's in your interest to make this investment."

Bob Dixon, the mayor of Greensburg, Kansas, agrees. Dixon led Greensburg's long-term rebuilding effort after a Level 5 tornado—with 205 mile-per-hour winds—destroyed 95 percent of the city in May 2007. In the aftermath of a disaster, he says, "there's a tendency for all of us to want to get back to some sense of normalcy as quickly as we can." Dixon cautions however, against making life-changing decisions while the community is still coping with "a whole variety of emotional issues."

Dixon stressed the importance of community engagement and co-designed solutions for resilient infrastructure in the aftermath of a disaster. "We had the whole community—city, county, schools, hospitals—all collaborating together. So we had the opportunity to really pull together and plan our long-term recovery effort along with FEMA and other agencies. It wasn't just a boiler-plate plan from Washington, DC."

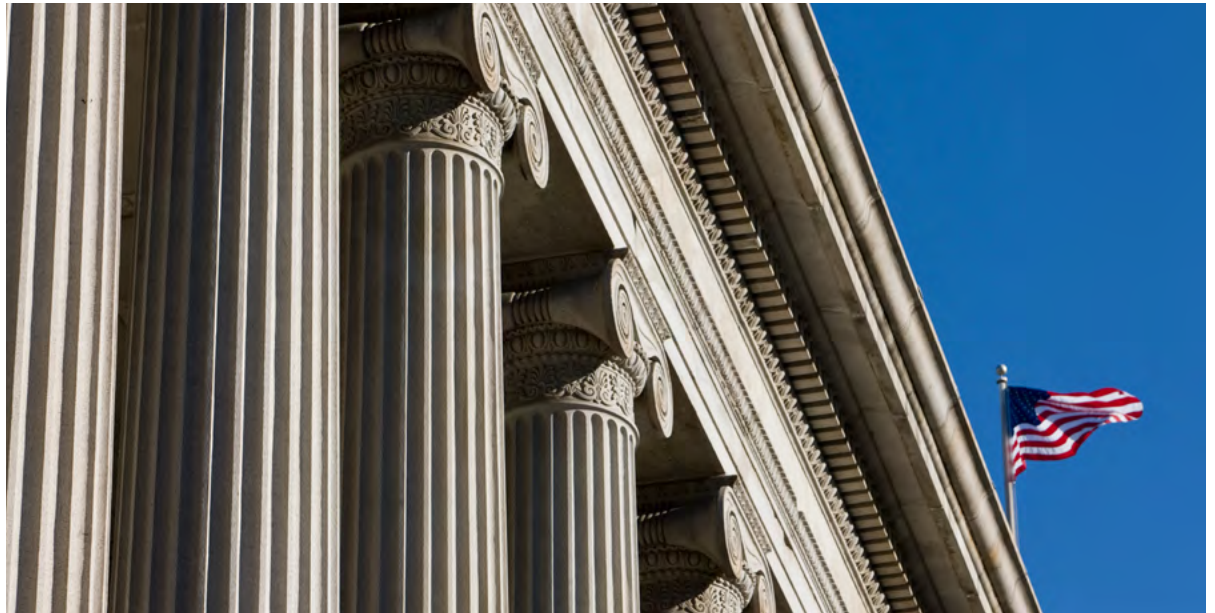
In describing the role of the private sector in Greensburg's recovery, Dixon says, "Partnerships with the private sector are highly critical in disaster recovery because it's not just about the buildings. You still have to have a community that is sustainable, that is resilient, that will be able to endure and continue. You can build back the buildings but you've got to have the people to inhabit the buildings. You've got to have a vibrant economy so we need to make sure that we involve private enterprise in the process."

involving communities of interest in the planning and development process, innovation is stimulated and more good ideas come to light. (See the case study of how a community in Kansas put these principles action following a devastating disaster.)

- **Modernize project planning and delivery approaches:** Traditional design-bid-build approaches have been in use for many decades, and yet the world has changed. The purpose for and demands on infrastructure have changed, but the protocols for developing public projects have not kept pace. The failure to adopt modern delivery methods and supporting technologies such as BIM and introducing good asset management practices, at the planning and financing stage of the project, to ensure the infrastructure assets are operated and maintained efficiently through their lifecycle has led to an inefficient and liability-ridden process that is estimated to add 15 to 25 percent to the final project cost. Contributing to these added costs are the outdated policies, often required by law or regulation, which prevent contractors from working directly with planners and designers during the initial phases. The result is misalignments and errors that must be corrected in the field rather than in the

office, forcing costly and time-consuming redesigns and change orders. Additionally, fast tracking infrastructure projects that support sustainable approaches to planning, design and construction, taken together with asset management through the life-cycle of the asset, are relatively new—and important—ways of thinking. This approach of combining the economic, social, and environmental co-benefits often referred to as the triple bottom line, should be given review priority and fast track approval due to its more comprehensive infrastructure assessment.

- **Apply the triple bottom line:** Infrastructure can earn more than financial returns. While reports show that pension funds that invest in infrastructure earn returns upwards of 10-12 percent, such investments can achieve more by the triple bottom line analysis. Public resources used to leverage private resources can accomplish social and environmental goals as well. In addition, the triple bottom line approach is increasingly seen as a benefit to the private sector, as sustainability is an important measure of business growth. Recently Matthew Yates, Head of Transport Planning & Projects, Transport for London stated for Crossrail 2, they are going to require added social, economic, and environmental/development impact assessment for plans submitted to articulate wider benefits. The goal is to achieve a ROI ratio of £4 return for every £1 investment. Moving forward, private investors will be more interested if triple bottom line is undertaken as it presents a more holistic business case.
- **Call for investment and financing:** The business and financial models that control the interactions among stakeholders were established for an earlier America that no longer exists. Infrastructure needs to be framed as essential to the economy and to job growth, and should encourage use of intelligent technologies that foster innovation to build smart, sustainable communities. To overcome the gap in financing there needs to a broader range of financing options that encourage private sector and direct public pension fund investment into investing into infrastructure in the



USA. This could transpire in a number of ways, some of which are listed below:

- » National infrastructure bank
- » Sale of “opportunity” bonds
- » Tax reform that encourages private investment in infrastructure
- » Direct investment of public pension funds into infrastructure

These types of funding arrangements could promote private and/or public financing (i.e., direct investment of public pension funds) opportunities with government funding or guarantee support that align all parties have “skin in the game.” Through this alignment risk can be structured to allocate to the party that can best manage it through the life of contractual arrangement. This type of alignment is crucial to ensuring the best value for money and level of service to the public. A project that is fully funded at the federal level offers no incentive to the private sector, let alone to governors, state legislatures, or mayors to change approaches or try innovative methods.

- **Nurture public-private partnerships:** Much is being said about the benefits of public-private partnerships. Known as PPPs and categorized as shared risk and reward approaches, they are transforming how infrastructure contracts are formed and are emerging as a reliable way to bridge funding gaps. Importantly, PPPs are recognized as an innovation that can reduce project lifecycle costs, accelerate delivery due to the integrated delivery approach, and improve long-term operation and maintenance, because they are focused on achieving long-term performance and profitability through the availability and performance of the asset to provide a level of service to the public. As a result, PPPs require tighter integration among planners and designers, financiers, contractors, and owners. Only about two-thirds of the states currently have the necessary frameworks in place to support public-private shared risk and reward approaches, as opposed to a shifted risk approach. All 50 states should be encouraged to adopt legislation permitting the state and local government use of PPPs to help close infrastructure development gaps while also leveraging



A 3D planning model of Los Angeles CA. Image courtesy of Autodesk Inc.

a single unified PPP framework for all federal, state, and local projects, following the example of West Coast Infrastructure Exchange. In addition, training of public officials and private business is needed in the best practices for structuring and operating PPPs.

- **Tap into community vision:** Design has long been a driver and shaper of human change. Today, cloud, mobile, and social computing are changing how we design, interact, and think about our future infrastructure needs. Collaborative engagement is an important concept in creating this strategy for change. The process begins locally, one project at a time, when the public and private sectors reach out to and involve their

communities of interest—starting at the very beginning of an infrastructure project and well into its operation. Visual technologies can assist by providing “virtual reality” scenarios to help community members understand and evaluate the impact of a particular infrastructure project on their lives, homes, and businesses, putting the designs in their context. There are many advantages; consider the following: the public can virtually drive on a new highway or go through a new traffic pattern on a laptop, iPad, or iPhone, and reviewing agencies can understand impacts and mitigation planning and issue approvals faster, long before construction begins.

“In the mind of the beginner there are few opinions. In an expert, there are many. All innovations come from the beginner’s mind.”

—John Kao, Strategist / Futurist

Getting started today

The goal of *Making the Grade* is to provide an initial vision and a path forward using an actionable agenda. This can serve as the foundation from which federal, state, and local policymakers, working with their constituents and the infrastructure industry, can discuss and build a new strategy for U.S. infrastructure development.

At the federal level, a variety of approaches are in discussion in Congress or being proposed by the current administration, including some that relate to the six-point plan described below.

Approaches to expanding financing for public infrastructure projects include the familiar—raising the federal gas tax that the U.S. Highway Trust Fund has depended on for many decades, and which has not been raised since the administration of former President Ronald Reagan—and the more novel. Among the new(er) ideas include: taxing fuel wholesale at the refinery level, imposing a vehicle mileage tax, or applying a carbon tax. One of the latest ideas is a proposal that would allow U.S. corporations that have stockpiled billions of dollars abroad to bring those profits home at a reduced tax rate, with that revenue going to rebuilding the nation’s infrastructure.

All of these ideas are welcome, but none are a comprehensive approach to the nation’s infrastructure needs.



A National Six-Point Plan

These six recommendations are put forward as a way to begin meeting the challenges of the nation's infrastructure decline, with the goal of restoring it to a grade of B or better as a standard of engineering excellence. In no way do the participating organizations believe these and these alone are the solutions, only that these six recommendations, effectively acted upon, will create the momentum needed to bring on even more innovation and even more thoughtful solution sets.

1. **Make infrastructure a presidential and cabinet-level priority.**

Unify integrated strategy and encourage best practice standards at all levels of government

Policymakers are urged to approve the enabling legislation to establish a person (czar) or department who's responsibility is to convey and support the vision, arbitrate competing interests, and remove obstacles to success for an integrated network of systems that support the nation's infrastructure operations and its imperatives. This role will also include unifying and requiring best practice standards and policies between public and private infrastructure projects. MAP 21, the Moving Ahead for Progress in the 21st Century Act (P.L. 112-141) and the U.K. creation of a Chief Construction Advisor to the Prime Minister provide models for this legislation.

"We need to see our work on innovation as involving disciplined practice, not the quest for short-term wins or mere shifts in organizational public relations."

—John Kao, Strategist / Futurist

The goal is to spread adoption and standardized practices in the use of the latest tools, technologies and approaches to infrastructure projects. But the federal government cannot accomplish this alone. Cities and states have to be encouraged to create their own Chief Infrastructure Officers, not just a Resiliency Officer, but one whose job is to provide the same priority focus on all public and private infrastructure projects unique to their regions, environments, and state goals and visions.

2. **Form U.S. infrastructure regions.**

Remove barriers to advance integrated infrastructure agendas

The future demands of infrastructure planning require us to integrate infrastructure planning into basic urban planning, which allows us to consider and overcome the obstacles of borders and boundaries, using public-private partnerships and other innovative means of encouraging wider participation and collaboration, from planning through to financing and building needed projects. Such large regions as the Northeast Corridor, the Northwest (aka Cascadia), and the Great Lakes Region, to name a few, require a collaborative approach to regional issues on important infrastructure issues like resilience and disaster planning, water, roads, transit, and rail.

Cross-boundary collaboration also is required to plan for the future of cities and surrounding suburban and

exurban areas, covering unified agendas that make the best use of public and private partnerships.

Widening the boundaries of infrastructure planning also facilitates the development of infrastructure solutions that can integrate larger (non-politically bounded) natural systems into hybrid infrastructure networks that are more environmentally sensitive, resilient, and perhaps even more efficient, while expanding public amenities through revitalized green space networks.

To support this regional approach PPP centers of excellence or agencies should be set up with the mission of reviewing proposed PPPs to assess whether they're a good deal for taxpayers and governments, and to look at the long-term fiscal impact of the deals. These centers are points for education of government staff and officials. These agencies could also provide government entities draft contracts and project management service for the projects if a state/local government entity doesn't have the capability to handle the PPP procurement or contracting arrangement. The United States has only a handful of these offices throughout the country, but these agencies are commonplace in countries where PPP delivery of infrastructure is common practice.

3. Establish a national infrastructure bank.

Fast-track projects with innovative approaches & clear public benefits

Calls are growing for the creation of a U.S. infrastructure bank approach to provide best practice-

"The illiterate of the 21st century will not be those who cannot read and write, but those who cannot learn, unlearn, and relearn."

—Alvin Toffler, American Writer and Futurist

based financing for important infrastructure efforts. The underlying principle is that an infrastructure bank would require lifecycle triple bottom line performance-based planning, design construction, and asset management practices using business case analysis to foster innovation. In some countries where government funding is involved, a certain capital value threshold triggers this analysis automatically to assess the best delivery method that provides the best value for money and level of service to the tax payer. A good example is British Columbia, Canada, which has a threshold for a project of \$50 million or greater.

A national infrastructure bank also would effectively prioritize public-private partnership investments in projects that achieve economic, social and environmental benefits, using the ENVISION™ infrastructure rating system championed and founded by the [American Council of Engineering Companies](#) (ACEC), the [American Public Works Association](#) (APWA), the [American Society of Civil Engineers](#) (ASCE), and the [Zofnass Program For Sustainable Infrastructure at Harvard](#) while encouraging innovation in the planning, design, and delivery of major infrastructure building efforts.

4. Sell "opportunity" bonds.

Raise more infrastructure capital to fulfill our generational obligation

Much has been said about the obligation each generation has to leave a sound legacy for future generations. Given the enormous infrastructure deficit we face, which ASCE currently projects at \$3.6 trillion by 2020, policymakers should consider the issuance of debt securities—similar to war bonds—or tax repatriation incentives to fund high-value infrastructure projects, and at the same time, provide capital for the national infrastructure bank.

As an example, [The Partnership to Build America Act](#), first introduced in the U.S. House and then the Senate, would create a new American infrastructure Fund to provide loans and guarantees to state and

SUSTAINABLE INFRASTRUCTURE

"Our infrastructure is in need of attention and we know it. The challenge, however, goes far beyond simply fixing that which is broken. Growing population, changing demographics, political unrest in critical parts of the globe, diminished natural resources, and environmental vulnerabilities pressed upon us by externalities like climate change require a different way of thinking. We not only must do better at building what we need, we need to do better in deciding what we need. This is not and cannot be just about us...about this generation and our needs. It must be about future generations and their options as well. That is what the Brundtland Commission meant in 1987 when it gave modern definition to what we now call sustainable development and did so in a voice that expressed both promise and responsibility."

—Bill Bertera, Executive Director, Institute for Sustainable Infrastructure

local governments, nonprofits, and public-private partnerships. The funds could finance infrastructure projects in transportation, energy, communications, water, and education. The Fund would be funded by the sale of \$50B of infrastructure bonds with a 50-year term, paying a fixed 1 percent, and not guaranteed by the U.S. government. U.S. corporations would be incentivized to purchase the bonds by allowing them to repatriate a portion of their overseas earnings tax-free for every dollar they invest in the fund. The multiplier will be set by a reverse Dutch auction which will allow the market to set the rate. No government funds will be used. It will be run by an independent board appointed by the President and Congress. Sponsors estimate the fund would be able to provide up to \$750B in loan guarantees.

If such funding ideas could be joined with a campaign to educate the American people to the importance and value of infrastructure investment to support their future and that of their children, a path to long-term support for infrastructure investment could be cleared.

5. Create a national infrastructure index.

Encourage long-term sustainable ROI through transparency

While the U.S. Department of Transportation has created one for the transportation sector, this needs to be expanded to a broader index including all infrastructure asset types. Clear understanding of why infrastructure is important also carries with it the obligation to track progress and measure projects against understandable published yardsticks. An infrastructure index of national significance, similar to the U.S. jobs index, should be considered to evaluate projects using an agreed-upon set of standards for economic, social, and environmental benefits. Such indices as jobs creation, public health, ability to attract private capital, and long-term sustainable ROI are examples.

Infrastructure rating systems such as ENVISION™ from the Institute for Sustainable Infrastructure¹³ are

tools for public administration of infrastructure that include metrics for this triple bottom line approach, in part because such systems encourage maintenance thinking over a short-sighted investment view.

6. Engage the American people.

Build voter support for the importance of infrastructure policy

A public service campaign to educate all stakeholders on the vital role infrastructure plays in the lives of all Americans underpins the entire effort to reimagine America's infrastructure future. The effort needs to focus not only on what infrastructure is and what it does for everyone, but why a new vision and strategy for the nation's infrastructure, combined with a renewed commitment to public works is the best way to ensure our rights to life, liberty, and the pursuit of happiness.





Final thoughts

The near-failing D+ grade earned by the nation's infrastructure in 2013 should not discourage us from starting anew to redefine how we create a better future for America's public works. The collective authors of *Making the Grade* do not intend that this report be viewed as "the solution."

Rather, it is a consensus for a fresh look. Today only about 1 percent of private investment is targeted towards infrastructure. Contrast that with 5 percent for real estate. If private infrastructure investments matched real estate it would infuse almost \$1 trillion into infrastructure via equity, and banks would be more than happy to fund the rest. But this requires us to remove the roadblocks discussed in this report to unleash the power of private sector participation.

Based on the rich discussions, findings, and presentations of 50 people representing some 45 organizations at the infrastructure symposium, several clear themes emerged that are summarized in *Making the Grade*, and that coalesced into the future vision and six-point national agenda for action.

The hope of all the participants listed in the Appendix is that this report can reinvigorate conversation around a decades-old challenge:

How can America build infrastructure for the future?

We believe many of the answers will be found, first, in reconnecting the American public with the many economic and social benefits of infrastructure investment; and second, engaging public and private sector leaders in closing the political divides to act upon the public will to invest.

Today's challenge is to renew our vision of what public infrastructure does and can do, in order to enhance and find synergies between our socially and environmentally connected worlds. We must redefine infrastructure beyond the delivery of services, and toward the ultimate possibilities of infrastructure as a definer of public spaces and amenities. Only then can infrastructure be celebrated

*"We need a new word for failure, like learning. And we need to keep in mind the search for what is essential. In the search for knowledge, every day something is gained. In the search for mastery, every day something is lost"*¹⁴

—John Kao, Strategist / Futurist

"When we build, let it not be for present use alone. Let it be such work as our descendants will thank us for."

—John Ruskin, Philosopher

as a framework for our civic life. As Americans, we should not settle for efficient delivery of up-to-date services but instead demand that these significant investments aim higher to embody our civic aspirations.

Participants in *Making the Grade* believe that the best outcome from this report and their ongoing deliberations is a fresh look at America's infrastructure challenges, and a response to their call to action by the American public and policymakers to establish a shared commitment to take the long view, and start building for the future today. Now is the time to begin...

Appendix

Footnotes

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Commentary from Report Signatories

"Rarely have I read a document in which the words more powerfully complement the purpose—this is a true blueprint for the work that will lead our country forward, creating real value now and for the next generation—by 'regaining' and 'sustaining' public infrastructure leadership."

—Norman Anderson, President and CEO, CG/LA Infrastructure

"Our infrastructure has fallen behind the rest of the world, threatening our economic vitality and even becoming a danger to our citizens. We can't rely on the same old way of doing things. We need to bring a renewed spirit of innovation and purpose to this challenge. We believe the Making The Grade report provides the right framework, fresh ideas, and infusion of energy needed to jumpstart this discussion and create action as a unified industry. We look forward to working closely between the private and public sector to start implementing our recommendations with all due haste."

—Terry D. Bennett, LS LPF MRICS ENV SP LEED®AP, Senior Industry Strategist for Infrastructure, Autodesk

"We not only must do better at building what we need, we need to do better in deciding what we need. The Making the Grade Report shows us a way forward in doing just that. This is not and cannot be just about us ... about this generation and our needs. It must be about future generations and their options as well."

—Bill Bertera, Executive Director, Institute for Sustainable Infrastructure

"We can't solve today's challenges, let alone tomorrow's, with yesterday's thinking. It's well documented that our critical human infrastructure receives failing grades today and needs attention. Through a combination of new and integrated project delivery models and technical and financing innovation we have the ability to address the significant challenges we face. It will take true collaboration among government, industry, the private sector and the public, but investments in infrastructure will lead to strong returns. This work has been started with the Making the Grade report, and it must continue."

—Ralph Eberts, Executive Vice President, Managing Director of Water Americas, Black & Veatch

"Innovation in infrastructure requires long term effort and attention to the capabilities that must be developed among a coalition of stakeholders to achieve that goal. US infrastructure in particular is a "wicked problem" - complex and open-ended - that requires a guiding framework and a high level of collaboration and originality for its resolution."

—John Kao, fmr Harvard Business School Professor and Chairman, Institute for Large Scale Innovation

"21st-century success depends on 21st-century infrastructure. Making the Grade outlines a thoughtful, balanced, and timely program for addressing this critical need."

—Dr. James A. Moore, SVP/Director National Community Planning & Urban Design, HDR

"Infrastructure systems are the backbone of our economy and a critical part of our daily lives. While it's tempting to assume that we should just address the largest funding gap first, it's important to remember that all of our infrastructure is linked and each sector has a significant role to play. We need leadership from federal, state and local levels of government who will communicate the urgency of revitalizing our nation's infrastructure, craft innovative solutions, and make the investments the system needs so that the United States is competitive on a global level. Industry efforts like the Making the Grade Symposium and its report help head us in this direction."

—Patrick Natale, P.E., F.ASCE, F.ASAE, CAE, Exec Director of American Society of Civil Engineers

Making the Grade Infrastructure Symposium 2013—Attending organizations

American Public Works Association	Jacobs
American Society of Civil Engineers	Jonathan Rose Companies
American Structurepoint	Kiewit
Anchin, Block, & Anchin	Malachite
Arcadis	Parsons Brinckerhoff
Arup	Polytechnic University of NYU
ASLA New York Chapter	Riverkeeper
Autodesk	Skanska
Berger Group	Stantec
BioCities	Syska + Hennessey
Black & Veatch	Tectonic Engineering
Brookings Institution	Transportation Issues Daily
City of Boston, MA	NY Chapter Urban Land Institute
Dewberry Companies	VHB (Vanasse Hangen Brustlin)
Ernst + Young	Weidlinger
Forum for Urban Design	
Genivar/WSP	
Golder	
Granite	
Grimshaw Architects	
Harrisburg Area Community College	
HatchMottMacDonald	
HDR	
HNTB	
Impact Infrastructure	
Indiana University of Pennsylvania	
Infrastructure USA	
Institute for Large Scale Innovation	
Institute for Sustainable Infrastructure	