

# Chapter 1

## Public–Private Partnerships and Their Use in Protecting Critical Infrastructure



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### Abbreviations

ASCE	American Society of Civil Engineers
DHS	Department of Homeland Security
EPCIP	European Program for Critical Infrastructure Protection
GAO	Government Accountability Office
IMF	International Monetary Fund
LLB	Lease and Lease Back
NCPPP	National Council for Public–Private Partnerships
OECD	Organization for Economic Cooperation and Development
PFI	Performance-based initiatives
PPP	Public–Private Partnership
US	United States

### Introduction

Critical infrastructure is defined as the essential service or services that underpin and support the backbone of a nation’s economy, security, and health, according to the United States (US) Department of Homeland Security (DHS) (Homeland Security 2013). These services include the power used by homes and businesses, drinking water, transportation, stores and shops, and communications. Sixteen

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critical infrastructure sectors have been identified that compose the assets, systems, and networks, physical or virtual that are vital to physical security, economic security, and national public health and safety including the following:

- Banking and finance.
- Transportation including road, rail, air, and water transportation infrastructure.
- Power including electricity, oil, and gas.
- Information and communications.
- Federal and municipal services.
- Emergency services.
- Fire departments.
- Law enforcement agencies.
- Public works including safe water systems and drainage.
- Agriculture and food.
- National monuments and icons.

In May 1998, an American Presidential Directive set up a national program of “Critical Infrastructure Protection” Homeland Security Presidential Directive 7: Critical Infrastructure Identification, Prioritization, and Protection (Homeland Security 2003), which was updated on December 17, 2013 (The White House 2013). In Europe, the European Program for Critical Infrastructure Protection (EPCIP) was established as a result of the European Commission’s directive (European Commission and Mitigation and Home Affairs 2008). The EPCIP resulted in an agreement in 2004 by the European Council, to establish a program to protect critical infrastructure.

Critical infrastructure in urban areas is particularly important and difficult to protect and maintain. According to Liu et al. (2007), cities and municipalities are complex systems of social, economic, and ecological factors and are at the heart of infrastructure protection. They become very vulnerable when any of their subsystems are destroyed or fail to adapt to new challenges (Coaffee 2010). Critical infrastructure plays a role in protecting against natural disasters, climate change, energy crises, political instability, financial crises, food security, and terrorist attacks and plays an important role in the stability of urban areas. Infrastructure is the backbone of urban economic activity and a necessary input to every economic output. It is critical to every nation’s prosperity and its public’s health and welfare.

An important constraint on providing critical infrastructure for urban areas is the lack of available financial resources; however, a solution often suggested to help provide these resources is the use of public–private partnerships (PPPs). PPPs have the potential to fill the void between typical annual government accounting and capital budgeting. PPPs include both existing facilities and new-capacity facilities, and a commonality among the different types of PPPs is the need for a dedicated revenue stream.

This book will discuss the objectives and legal requirements associated with PPPs. Experts will discuss the elements that make up a successful PPP as well as provide examples where PPPs have failed. These examples will include the application of the PPP concept in the United States, as well as in Europe, the UK, China, South Korea, and in Australia for a wide variety of infrastructure investment.

## **Need to Protect, Repair, and Rehabilitate Urban Infrastructure**

Poor infrastructure adversely affects public health and social service systems as well as business productivity in urban areas. For example, when one part of the infrastructure system fails, the impact can spread throughout the system and economy (ASCE 2016). The US economy relies on low transportation costs. Business costs and, therefore, prices will generally increase if surface transportation systems and ports, airports, and inland waterways become outdated or congested. Deteriorating infrastructure has the potential to take a toll on families' disposable household income and can impact the quality and quantity of jobs in the economy. Travel times will lengthen with inefficient roadways and congested airports and airspace. Greater costs to transport imported goods that supply domestic manufacturers will affect a nation's ability to compete in global markets for goods.

In another example, the reliable delivery of clean water and electricity to businesses and households in urban areas is important to a community's public health in addition to its economic viability. It is a serious problem if water, wastewater, and electricity infrastructure systems deteriorate or fail to keep up with changing demand. Irregular delivery of water and wastewater services and electricity will make production processes more expensive and divert household disposable income to these basic necessities and adversely affect public health. Increased reliance on electricity to support modern data-driven systems and industries is particularly important when the cost of service outages and interruptions is considered.

Every 4 years, the American Society of Civil Engineers (ASCE) (2017) publishes "The Report Card for America's Infrastructure," which grades the current state of national infrastructure categories on a scale of A through F. Since 1998, America's infrastructure has earned persistent D averages, and the failure to close the investment gap with needed maintenance and improvements has continued. The Report Card for America's Infrastructure released in 2017, grades the US infrastructure as D+. As has been discussed, a mechanism that might be useful in order to enhance both the construction and rehabilitation of urban infrastructure is the use of public–private partnerships or PPPs.

### ***Key Characteristics of Public–Private Partnerships (PPPs)***

There is no single definition of a P3. The US Government Accountability Office (GAO) defines a public–private partnership as "a contractual arrangement that is formed between public and private sector partners" (GAO 1999). These arrangements typically involve a government agency contracting with a private partner to renovate, construct, operate, maintain, and/or manage a facility or system, in whole or in part, that provides a public service. Under such arrangements, the agency may retain ownership of the public facility or system, but the private party generally invests its own capital to design and develop the properties. Typically, each partner shares in

income resulting from the partnership. Such a venture, although a contractual arrangement, differs from typical service contracting in that the private sector partner usually makes a substantial cash, at-risk, equity investment in the project, and the public sector gains access to new revenue or service delivery capacity without having to pay the private sector partner.

The National Council for Public–Private Partnerships (NCPPP) (United States Department of Transportation 2017) defines a public–private partnership as “a contractual agreement between a public agency (federal, state, or local) and a private sector entity.” Through this agreement, the skills and assets of each sector (public and private) are shared in delivering a service or facility for the use of the general public. In addition to the sharing of resources, each party shares in the risks and rewards potential in the delivery of the service and/or facility.

## Well-Designed Public–Private Partnerships

Zerunyan (Chap. 2, this volume) argues that the infrastructure in the US is increasingly vulnerable. His argument is supported by the American Society of Civil Engineers (2016), who report that the US infrastructure has suffered years of neglect and needs significant investment. According to Zerunyan (Chap. 2, this volume), this need creates unique opportunities for collaboration between the private and public sectors through the use of procurement and contracting arrangements commonly known as public–private partnerships (PPPs) or alternatively performance-based initiatives (PFIs). A variation on the PPP concept is the Lease and Lease Back (LLB) concept. These approaches can potentially provide a range of benefits or meet major policy objectives for growing cities, counties, and states. Projects can range from forestry and agriculture to transportation and water infrastructures. The World Economic Forum estimates the global infrastructure deficit as \$5 trillion a year. Zerunyan (Chap. 2, this volume) discusses the variations in both PPPs and LLBs, and the range of services they provide.

PPPs have been used for a range of projects in transportation, solid waste disposal, water and sewer services, and more recently parking. These projects are generally fee-generating in nature, for example, actual use of a toll road, water service, and parking. “Social” infrastructures, on the other hand, do not generate revenues, but PPPs may also be used for schools, hospitals, court houses, police and fire stations, prisons, and other public buildings. An attractive feature of PPPs is their ability to save time, money, and effort in the government procurement process.

A key feature of implementing a PPP is the importance of managing risk. If risk is not managed properly, the cost of the project will increase. For example, political risks associated with changes in government, laws or regulations, unanticipated tax increases, or fee impositions are best managed by the government. However,

construction risks, such as faulty design, delays in construction, poor performance, and poor quality are all within the control of the private sector and can be properly managed or insured by it.

Zerunyan (Chap. 2, this volume) presents two very detailed case studies of the use of PPPs in providing government services. The first is the Oxnard Fire Station 8 which is an innovative example of an LLB social infrastructure project, located in Oxnard, California, and is one of the most advanced fire stations in the state. A second case study is the Long Beach, California Courthouse, which is a PPP concession model and the most commonly used and studied PPP methodology. The Long Beach Courthouse is the first social infrastructure of its kind using this methodology in California.

## **Public–Private Partnerships for Transportation**

According to Feigenbaum (Chap. 3, this volume), the private provision of transit services comes in the following three forms:

- Privately financed, operated, and maintained services which are limited to locations in which operating transit services can turn a profit.
- Private service in which the public sector procures a contract with the private sector to design, build, finance, operate, and maintain service.
- The private sector plans and operates transit service via a competitive service contract, often called tendered service.

Fixed-route transit service ranges from heavy rail to other types of fixed route service including local bus service, vanpool, jitney, and ride sharing. Funding for transit is challenging in most countries, and in Europe, Canada, and Japan, public transit is considered an essential government service and supported for economic development in dense, urban areas. Tokyo, Hong Kong, and Singapore have very large private transit systems that are proven to be very successful. High population and employment density and a positive attitude by the government toward the private sector have contributed to this success. Where private provision of service and public–private partnerships are not feasible, contracting-out can deliver lower cost and higher quality than conventional transit operations.

For the future, the combination of ridesharing companies such as Uber and Lyft is going to substantially change transit service over the next 20 years, and some experts believe that automated ridesharing vehicles may be <10 years away. Transit agencies will need to transition from being bus and train operators to mobility providers. It is clear that transportation in the US in 2030 will be very different than it is now.

## Financially Distressed Highway Public–Private Partnerships in the USA

Garvin (Chap. 4, this volume) discusses the increased interest in the US in private involvement in transportation infrastructure investment, development, and management. He examines financial distress and bankruptcy in highway P3s by presenting four case studies of the US highway P3 projects employing the revenue risk model: (1) South Bay Expressway, (2) Indiana Toll Road, (3) SH 130 Segments 5 & 6, and (4) Capital Beltway Express. Each project experienced financial distress, and three of the four ultimately declared bankruptcy. All of the projects received loans, a federal loan under the Transportation Infrastructure Finance and Innovation Act (TIFIA) program. The South Bay Expressway is a toll road and is an extension of SR 125 near San Diego, California. Construction was initiated in 2003 and was completed in 2007. Traffic fell far short of expectations, so the concession company filed for bankruptcy in 2010. The San Diego Associations of Governments now operate the toll road. The Indiana Toll Road serving northern Indiana has been fully operational since November 1956. In 2008 the economic recession hurt toll road traffic so that by 2010 average traffic was 35% lower than expectations. The concession company filed for bankruptcy in 2014. SH 130 is located south of Austin, Texas, and the toll road traffic was roughly 60% below forecasts. The concession company filed for bankruptcy in 2016, but the project emerged from bankruptcy in 2017. The Capital Beltway Express serves as a perimeter highway circling Washington DC. As with the other case studies, actual traffic flows were below expectations. The construction was accomplished with an agreement between the Virginia Department of Transportation and the private sector. Although the project had some initial financial difficulties, it appears to have solved them.

It is unclear how these experiences will impact equity investors, commercial lenders, and TIFIA in future P3 transactions. It is very clear that in the future the involved partners will likely exercise greater due diligence when considering such opportunities.

## Public–Private Partnerships (P3S) for Social Infrastructure

Martin (Chap. 5, this volume) discusses the use of public–private partnerships (P3s) for “social infrastructure” projects in contrast to the traditional use of P3s for transportation. The use of social infrastructure P3s is discussed, in particular their use in public universities, and recommendations on how state and local governments can make greater use of social infrastructure P3s are made.

Examples of social infrastructure are as follows:

- Schools (elementary and high school)
- Universities (dorms, classrooms)

- Libraries
- Parks and recreation facilities
- Housing
- Conventions centers
- Sports facilities
- Correctional facilities (jails, prisons)
- Museums
- Government buildings (all types)
- Others

As with other types of infrastructure, the financing and funding of social infrastructure P3s, it is assumed that the private partner delivers the social infrastructure project and may provide or arrange the financing.

Financing covers the upfront design, construction, and operating costs and funding to pay for the design, construction, and operating costs comes from user fees or availability payments which generally take the form of dedicated revenue streams such as: (1) admission fees to parks, recreation facilities, museums, art galleries, sports facilities, health care facilities, etc. or (2) utilization fees tied to, college and university dorms, housing, etc. If user fees are insufficient to cover the total operating costs of a social infrastructure project (e.g., museum or park), so the government covers the deficit via availability payments.

In the absence of alternative methods to finance and deliver the facility needs of universities, schools, libraries, and government buildings, social infrastructure P3s provide an attractive alternative. However, the use of social infrastructure P3s by state and local governments appears poised to expand dramatically.

## **The Potential for PPPs in Air Traffic Control**

According to Poole (Chap. 6, this volume), most developed countries have converted their air traffic control system from a government organization to a public utility-like organization. These organizations are generally paid for directly by the aviation customers. This approach has produced a number of improvements in performance, productivity, and customer-responsiveness with no adverse impact on aviation safety. However, the United States, which has the world's largest air traffic system, has resisted this trend. He explores the reasons for these changes in other countries and the resistance to this change in the United States.

Air traffic control (ATC) is a critical part of the infrastructure needed for air travel. Prior to 1987 when New Zealand separated its ATC system from the transport ministry, most ATC was operated as part of the national government transport agency. At that point aircraft operators began paying their ATC fees to Airways Corporation of New Zealand, rather than to the government.

In 1938, Congress converted the Bureau of Air Commerce into the Civil Aeronautics Authority (CAA). In 1940, the CAA was split into the Civil Aeronautics

Board (CAB) for economic regulation and subsidy, and the Civil Aviation Authority (CAA), responsible for air safety regulation and operating the ATC system. Both agencies were funded out of general federal tax revenues. In 1958, the CAA became the Federal Aviation Administration (FAA), which remained an independent agency until 1967, when it was folded into the newly created U.S. Department of Transportation (DOT).

Analysts at the federal Government Accountability Office (GAO) and the DOT's Office of Inspector General have documented numerous ongoing problems with the FAA's air traffic system, including:

- ATC Funding Problems include reliance on a set of aviation excise taxes that bear no direct relationship to the cost of ATC services. A second aspect of the funding problem is the FAA's reliance on uncertain annual appropriations from Congress. A third aspect of the funding problem is the inability of FAA to issue *long-term bonds* to finance large capital improvements.
- Governance because the FAA must respond to multiple masters.
- Organizational Culture because despite FAA operating the world's largest ATC system by far, it lags well behind many other developed countries in applying new technology and management methods.

Efforts to corporatize the US ATC system date back to at least 1975 and were attempted in the Reagan, Clinton, the George W. Bush, and Obama Administration. Efforts to reorganize the ATC have been minimal under the Trump Administration.

## **PPPs for Critical Healthcare Infrastructure in Europe**

In the health sector, P3s represent part of the continuum between having the state provide services or the private or commercial provision of services. PPPs are not limited by economic sector, by country, by size, or by timescale. Wright et al. (Chap. 7, this volume) focus on healthcare PPPs in Europe which have been deployed to improve patients' experience through the provision of new infrastructure and innovative services. For purposes of this discussion, the authors have a relatively restrictive definition of what counts as a PPP. They rely primarily on European PPP experience, and therefore that of relatively rich countries and in these countries the state dominates health policy and healthcare finance. A lesson to be drawn is that the decision to deliver services by the private sector actors using PPPs should be done on a case by case basis and should be based on whether or not finance could be accessed on acceptable terms or the services could be supplied better through this mechanism. The decision should not be based on an ideological basis. The authors believe that in a European context, there will inevitably be a stable or increasing role for PPPs and the private sector generally. The heart of a PPP relationship in health is the existence of a scalable, replicable, and sustainable business model.

This PPP model has been most completely developed in the UK, where it is called the Private Finance Initiative (PFI), and has been used to construct more than



a hundred healthcare facilities—with individual projects of up to USD3 billion. The model has been copied in many countries—France, Italy, Portugal, Spain, Sweden in Europe, and Canada and Australia outside Europe, among many others. However, as will be discussed healthcare PPP programs in Europe have proven politically controversial.

In considering PPPs, there are two important dimensions. One is the conversion of services from public to private, and to a lesser degree of the “bundling” of services into a contract. The prospects for PPPs in the European health sector will be based on cost, performance, funding, and political acceptability.

## **PPPs for Fire, Police, and Ambulance Services**

As an extension of the discussion of PPPs for health care, Lam (Chap. 8, this volume) discusses the use of public–private partnerships for fire, police, and ambulance services. There is a growing trend for the private sector to provide emergency services to the public, and this idea has spread to include fire, police, and patient transport. Instead of outright privatization, an option for emergency services is to be supported by public–private partnership (PPP) projects. The United Kingdom has had a number of PPP projects under the umbrella of Private Finance Initiatives (PFI).

As public budgets have become increasingly strained in many countries, some forms of public–private partnerships have been considered as an alternative for emergency services including police, fire rescue, and ambulance services.

Contracting out has always been used to supplement public disciplinary and emergency-relief forces; however, controversy has resulted when governments made it standing policy to outsource the majority of emergency services to the private sector. Examples from the UK, and to a lesser extent, the US, are evaluated.

Lam (this volume) discusses both successful and unsuccessful examples of the application of this concept. According to Lam (this volume) to ensure success, a public body must put maximum effort into the selection of the contractors, their governance, and their monitoring, once the decision to go down the private path is made. Prior to this, the need to consult and engage the public and concerned stakeholders is greater than ever in the modern social-political atmosphere.

## **The PPP Model in Australia**

Australia has initiated approximately 80 PPP projects over the last 18 years, and nearly every political jurisdiction in Australia has developed PPP policies and programs. There is a perception that the PPP concept in Australia has been a success. Grimsey et al. (Chap. 9, this volume) examine the failures and successes of the

public–private partnership (PPP) model in Australia since the year 2000. These programs include roads, water, energy, hospitals, prisons, courts, schools, social housing, and convention centers.

There is considerable support for PPPs in Australia; however, problems have arisen. The authors assess the successes (and failures) of this approach and make an evaluation as to what type of model and size of project seems best suited to the use of PPPs.

At a practical level, a PPP can bring private sector efficiency, regulation through competition, economic pricing of services, filter out “white elephants,” and free up public services. PPPs cannot, however, bring in additional funding for infrastructure except in the case of tolls and charges. Other than toll roads, nearly all PPP projects in Australia are fully funded by Government out of budget appropriations.

Hospitals were among the first PPP projects delivered in Australia. There is also a long history of privately run prisons. Toll roads appeared in Australia in the 1990s and 2000s. A number of lessons learned from the Australian experience with PPPs are as follows: political support is critical and should come from the highest positions in government; PPPs core purpose is to deliver value for money to the tax payer; a core policy statement needs to be supported by clear guidelines that articulate the rules; training the workforce is essential and this applies equally to the private sector as it does to the public sector; having a pipeline of projects to support investment in the market place. The Australian experience has also shown that not all projects are suited to the PPP model.

## **PPPs for the Development of Port IT Infrastructure**

Paik in Chap. 10 (this volume) discusses the use of public–private partnerships (PPPs) for the development of port information technology infrastructure. He uses the Pusan port in South Korea to examine the major problems and challenges faced by the port and discusses how the establishment of a public–private partnership resolved them. Ports are critical to the flow of goods and services, both within and between countries, and as such provide a critical infrastructure that is essential to economic development and national security. Since globalization is expected to continue, a port is increasingly considered the most critical gateway in a national supply chain through which materials and finished goods are transferred among countries. Construction and effective management of ports often involve many participants and enormous resource investments that neither the public sector nor the private sector could do alone.

In the mid-1990s, large trade volumes, coupled with insufficient port capacity, caused frequent freight and ship congestion at the port. Realizing these challenges and issues, the South Korean government concluded that an efficient and accurate information flow would be the key to achieving material velocity and that the use of information technology could enhance the overall operations. The Pusan port community used various strategies and actions in setting up and implementing its information systems. Clearly it was the successful partnership involving the South

Korean government, the data processing specialist, and commercial shipping entities, which made it possible. The IT system developed at the Pusan port further strengthened the linkage of South Korea’s national supply chain to the global marketplace. Port decision makers in other countries should be able to benefit from this case study as a successful example of the use of a PPP for enhancing port operations.

## **PPPs for Critical Infrastructure Development in Hong Kong**

The PPP concept has been applied to many different kinds of projects in Hong Kong including infrastructure development, hospital services, and tourism-related preservation. Although there are several successful PPP infrastructure projects in Hong Kong, including the Tsing Ma Control Area, the Chemical Waste Treatment Plant, and the Asia World-Expo (AWE), other projects are quite controversial. These include the Western Harbor Crossing and the West Kowloon Cultural District. Cheng in Chap. 11 (this volume) presents a general background on PPP establishment in Hong Kong and identifies the trends and lessons learned from these applications. He explores opportunities for expanding PPP services such as China’s One Belt One Road initiative which encourages infrastructure development partnerships along the “new” Silk Road. He also discusses how the government would increase the use of PPPs to facilitate public housing projects in Hong Kong.

Hong Kong is one of the world’s most expensive housing markets. To deal with the climbing rents in Hong Kong’s private property market, the government has attempted to increase the provision of subsidized housing. Several policies have been introduced such as the Home Ownership Scheme and Hong Kong Property for Hong Kong People Scheme. However, these policies have yet to solve the housing problem. To address this issue, the new chief executive of the Hong Kong Special Administrative Region has pledged to launch a starter home program. These units will be constructed using a PPP approach in which the government invites private developers instead of the Housing Authority to develop and construct subsidized homes. The use of PPPs for housing projects has been proposed in other countries. For example, the Thai government is considering collaborating with domestic and foreign investors to develop housing projects through a PPP scheme for low-income earners and the lower-middle class under the Pracha Rat Home project.

## **The “Water-Specific PPP Risk Model”**

Korayem and Ogunlana, Chap. 12 (this volume), have proposed a model to incorporate tangible and intangible variables into a risk assessment process for water infrastructure projects. In the 1990s, market-driven approaches for water resources management were gaining acceptance. The World Bank, International Monetary Fund (IMF), and the Organization for Economic Cooperation and Development

(OECD) introduced privatization as one of their major reform policies. Water became recognized as an economic good or a commodity that should be priced at its cost of provision and its true value to society. However, the water sector has many characteristics that make it challenging for private sector investment. One of these characteristics is the large initial fixed cost capital investment. These high fixed costs lead to economies of scale that contribute to conditions of a natural monopoly. Because of the importance of water supply to society, governments are typically heavily involved in regulating water services, which increases the regulatory and political risks to private companies. Therefore, interest in water infrastructure for investment has been low when compared to other types of infrastructure but nevertheless the Egyptian Government decided to construct a waste water treatment plant in New Cairo. New Cairo is a city that was created in 2000 in the southeastern part of Cairo, in a former desert area, to ease problems deriving from an overcrowded capital. New Cairo covers an area of about 30,000 hectares with a presumed plan to host a population of five million.

In earlier research, the authors had developed the so-called Water-Specific PPP Risk Model. The authors' application of their research to the Cairo WWTP case study is described in this chapter. The model utilizes the Analytical Network Process (ANP) methodology, which contemplates the interdependency between the risk elements.

## **Strategic Management of Public–Private Partnerships**

PPPs have often been used as a financial instrument for a construction or rehabilitation project and are generally structured so that the capital invested in a project is recovered through the cash flows generated by the project itself. Achard in Chap. 13 (this volume) discusses the wide application of public–private partnerships throughout the world, especially for public utility services. Based on this approach, a PPP is characterized by the structure of the project, and the specifics which specify the recovery of the investment by the private partner. In many cases, the cooperation between the public and private parties at both the local and national levels for the provision of important public services is required, as well as the satisfaction of the stakeholders' interests. Typical examples and applications of PPPs in the last 20 years include the construction or rehabilitation of infrastructure all over the world. Other examples include the construction of the tunnel under the English Channel and other important infrastructure in Canada, India, Japan, China, Taiwan, Russia, Brazil, the EU, and the US. The phenomena that has led to the widespread use of PPPs, even though application has been uneven, is related to globalization, the recent financial crises, and the wide spread application and development of the knowledge economy. All of these effects have profoundly modified views about competition in the public sector.

This diffusion of knowledge has led to the introduction of tools, values, and business logic into the public sector, known as New Public Management (NPM). NPM is based on four main principles: the use of private sector approaches in the public

sector; the change from centralized and bureaucratic organizational models to more flexible management systems; the importance of culture in the innovation processes, in terms of both the base of the change process and the role of management; and the need to combine private management tools with the mission and values of public services. The Chinese government has been a strong advocate for using the PPP approach.

## **Public–Private Partnerships in the US Drinking Water Supply**

There are more than 160,000 public drinking water systems in the United States (US), but most Americans receive their drinking water from one of the nation's over 50,000 community water systems (CWS). Three hundred and sixty-one CWSs serve more than 45% of the total population, or approximately 120 million people. The passage of the US Safe Drinking Water Act (SDWA) has been very effective in protecting the public health of American drinking water consumers. It has resulted in the reduction or elimination of exposure from drinking water contaminants ranging from potentially carcinogenic disinfection byproducts to neurotoxic contaminants such as lead. The SDWA provides an outstanding example of the successful collaboration of local authorities (drinking water utilities), state agencies, and the Federal government in protecting the health and welfare of the American public (Allen et al. 2018). Despite the US success in operating and managing water systems, there has been much concern expressed over the state of the nation's infrastructure in general and water supply in particular. Organizations such as the American Society of Civil Engineers (ASCE), the American Water Works Association (AWWA), and the US Environmental Protection Agency (EPA) have estimated that billions of dollars will be needed to rehabilitate and repair US drinking water systems. Clark and Hakim (Chap. 14, this volume) explore the potential use of PPPs for making these investments. They conclude that there are no advantages for water systems to be privatized and that for large water systems there is adequate capital available for infrastructure investment and there are standard mechanisms for acquiring these funds. However, there are thousands of systems that will need major investments for infrastructure investments. They conclude that the PPP concept could be used at the state or regional level to provide the needed drinking infrastructure investments.

## **Summary and Conclusions**

Critical infrastructure is defined as the essential services that underpin and serve as the backbone of a nation's economy, security, and health. These services include the power used by homes and businesses, drinking water, transportation, stores and shops, and communications. In urban areas, critical infrastructure is particularly important and is difficult to protect and maintain. An important constraint on

providing critical infrastructure is the lack of available financial resources, and a solution often suggested to help provide these resources, and as discussed in this book, is the use of public–private partnerships (PPPs).

There is, however, no single definition of a P3. The US Government Accountability Office (GAO) defines a public–private partnership as “a contractual arrangement that is formed between public and private-sector partners” (GAO 1999). These arrangements typically involve a government agency contracting with a private partner to renovate, construct, operate, maintain, and/or manage a facility or system, in whole or in part, that provides a public service. Under such arrangements, the agency may retain ownership of the public facility or system, but the private party generally invests its own capital to design and develop the properties. Typically, each partner shares in income resulting from the partnership. Such a venture, although a contractual arrangement, differs from typical service contracting in that the private sector partner usually makes a substantial cash, at-risk, equity investment in the project, and the public sector gains access to new revenue or service delivery capacity. Public–private partnerships can help fill the void between typical annual government accounting and capital budgeting. PPPs include both existing facilities and new-capacity facilities, and a commonality among the different types of PPPs is the need for a dedicated revenue stream.

The goal of this book is to discuss the potential for the use of PPPs for encouraging major infrastructure investment throughout the world. Clearly, there is great potential for PPPs to help achieve this goal. It makes an attempt to “demystify” the PPP concept and to discuss both the successes and failures associated with PPPs. Hopefully the information presented in this book will assist decision makers in making these important decisions.

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