Chapter 17
Metropolitan Regional Scale Smart City Approaches in a Shrinking City in the American Rust Belt—Case of Pittsburgh, Pennsylvania

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Abstract This chapter describes the smart city example from the City of Pittsburgh, Pennsylvania in the United States. Pittsburgh is a typical city in the rust belt of America that faced decline and shrinkage due to de-industrialization and globalization forces. The economic transformation of Pittsburgh into a post-industrial regime has brought its own set of unique challenges and represent a unique perspective of urban and regional planning approaches that met with varying degrees of success. The purpose of this chapter is to describe the smart city approaches in the context of a Shrinking City that have been shaped by forces of industrial decline, population and job loss, abundance of derelict industrial sites, suburban exodus and racial conflicts, along with shared notions of fighting back to comeback and succeed in the New Economy. After witnessing a prolonged state of industrial and economic decline since the 1980s, Pittsburgh had no choice but adopt planning strategies that would restructure its economy, and transform its large-scale abandoned brownfield sites to create places of vibrant economy and community. Pittsburgh's proactive policies to involve local communities in reusing old and vacant lands for economic transformation and urban greening, as well as using green infrastructure for storm water management and improving the quality of its waterways, resulted in many success stories throughout the region. Thus, our study of Smart City strategies in Pittsburgh focuses on the successes and failures of economic transformation, brownfield redevelopment and urban greening. While it

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is in the process of coming back, the region still faces several challenges, such as a large number of vacant and distressed lands, aging population and infrastructure, which needs to be addressed in the coming decades.

Keywords Deindustrialization · Economic resiliency · Brownfield redevelopment Green infrastructure · Smart city

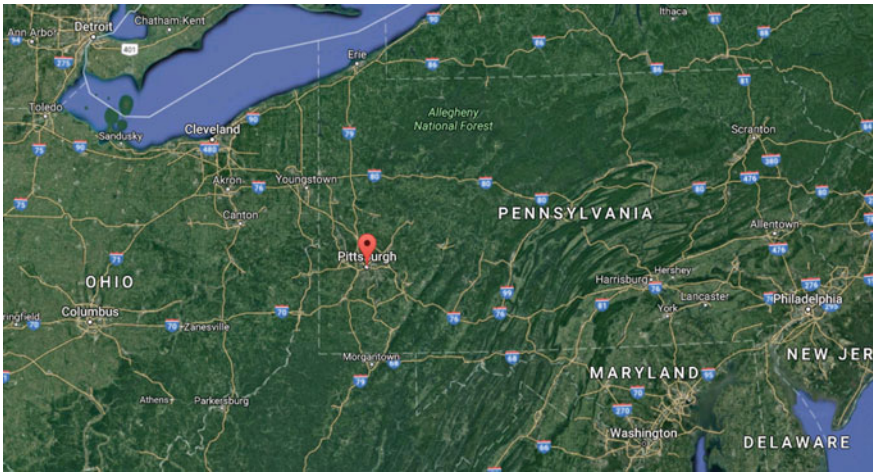
17.1 Introduction

The concept of Smart City (SC) entails the notion of promoting better quality-of-life for residents and sustainability with increase in utilization of advanced Information and Communication Technology (ICT). In urban and regional planning context, SC strategies are increasingly becoming a popular paradigm with its focus on sustainable urban development, sustainable economic growth, environment and social sustainability, and advanced infrastructure capabilities [1]. While there is a wide range of understanding and applications of SC strategies, scholars, practitioners, policy-makers and residents commonly agree on the prevalent use of ICT in such strategies [2]. Nevertheless, the global trends in SC strategies and approaches demonstrate increasing variations that makes it difficult to identify common trends [3].

Our objective in this chapter is to study the aspects of SC approaches at a metropolitan regional scale in the city of Pittsburgh, Pennsylvania (PA) in the United States (US). The story of Pittsburgh entails a typical urban transformation story of a post-industrial city from the Global North, and thus, represents a unique perspective of urban and regional planning approaches with varying degrees of success that can be studied under the domain of SC approaches. The common trends of SC approaches in such type of cities have been shaped by forces of industrial decline, population and job loss, abundance of derelict industrial sites, suburban exodus and racial conflicts, along with shared notions of fighting back to comeback and succeed in the New Economy.

Similar to the industrial cities from Europe, the mid to late 20th century rust-belt cities in the US witnessed a trend of decline in their manufacturing base. With global shift of industrial production to the developing regions of the world and the New International Division of Labor (NIDL), the US rust-belt cities were compelled to rethink their urban and economic development strategies to compete in the 21st century. The dominance of advanced service and technology-based jobs in the New Economy resulted in adoption of economic transformation plans in the old industrial cities that would replace manufacturing jobs with advanced service sector jobs. However, there were more challenges than opportunities in the process of doing so, which set the context of urban and regional planning practices in the rust-belt cities.

Pittsburgh, one such example of a rust-belt city, was once known as the “Steel City” due to its production capacity of raw steel in the world economy (Fig. 17.1). Abundance of natural resources, such as coal, timber, iron, and limestone, and navigable waterways—the Allegheny, Monongahela and Ohio rivers, helped



Pittsburgh is located in the southwest region of Pennsylvania; other old industrial cities in close proximity are: Cleveland, Ohio; and Detroit, Michigan, which are still struggling to comeback in the New Economy. (source: Google Maps, 2017).

Fig. 17.1 Map showing location of Pittsburgh, PA

Pittsburgh emerge as the center of steel industries in the US in between the late 19th–early 20th century (Fig. 17.2). With such comparative advantage of natural resources and navigable waterways, the city burgeoned with large-scale steel mills since the 1870s, and an economic and population base to support these activities. By 1970s, Pittsburgh produced about one-third to half of total steel production in the US [4, 5].

The era of deindustrialization witnessed a geographic shift of steel-manufacturing activities towards lesser developed countries, such as India and China. With international shift of crude steel production, the US witnessed a sharp decline in steel production. In 1973, during its peak the US produced nearly 137 million metric tons (mmt) of raw steel, which sharply declined to 67.7 mmt in 1982 [4], severely impacting the steel mills of Pittsburgh region. Pittsburgh lost its position as the Steel City, and witnessed a continuous trend of decline in its manufacturing-based economy and population since the 1980s.

Decline of its steel-based manufacturing base, led to several other consequences, such as decline in number of jobs, loss of population, brownfield sites, and vacant and abandoned properties [6]. Since the 1980s, the challenge of massive brownfield sites, property abandonment, declining tax base, and increasing poverty and crime, led Pittsburgh to be known as an example of a "Shrinking City" in the rust-belt region. The planners and policy makers had no choice but to focus on adoption of newer sets of strategies that could transform Pittsburgh and make it competitive in the New Economy. The late 20th century Pittsburgh increasingly became successful in adopting many bold policies and strategies that transformed its local economic base towards advanced service sectors: healthcare, higher education, technology, research and development, banking and finance (Fig. 17.3).

Monongahela Wharf, Pittsburgh riverfront ca. 1900-1927.
(source: Historic Pittsburgh Image Collection, Archive Service Center at University of Pittsburgh)

Golden Triangle and Old Point Bridge, Pittsburgh riverfront ca 1900-1910.
(source: Pittsburgh Historic Images, Brookline Collection, http://www.brooklineconnection.com/history/Facts/Point1900.html)

Fig. 17.2 Historic images of Pittsburgh during the Steel era

Pittsburgh Golden Triangle Skyline, 2013: Confluence of Allegheny and Monongahela rivers. (source: Dr. Kevin J. Patrick)

Fig. 17.3 Contemporary image of Pittsburgh in the new economy era

Dating back to the 1980s, Pittsburgh has been adopting various right-sizing strategies to stabilize declining neighborhoods. As a result, the city is able to provide a relatively high quality-of-life to its residents within affordable prices, despite abandonment, blighted areas, crime and poverty [7]. These strategies mostly focused on economic diversification, regeneration of brownfields, urban greening and green infrastructure practices, which form the underlying principles of sustainability in SC concepts. Since the 2000s, with high concentration of employers in the areas of medical research, such as the University of Pittsburgh Medical Center (UPMC); higher education, such as Carnegie Mellon University and University of Pittsburgh; banking and financial sectors, such as Pittsburgh National Bank (PNC); and increasing number of other Fortune 500 companies; Pittsburgh is becoming more successful in transforming its economy. A more recent example of Pittsburgh's increasing competitiveness as an innovation center in the 2010s is Uber choosing Pittsburgh as its research center for experimentation with autonomous cars or self-driving robotic vehicles.

In this chapter, we aim to explore the challenges, successes, and failures of SC strategies in the metropolitan region of Pittsburgh. While it is difficult to distinctly identify the common trends in SC approach at a global scale, it is irrefutable that smart cities are increasingly becoming popular in the US. A recent report by National League of Cities highlighted that in the US "66% of cities have invested in some sort of smart city technology" and "25% of cities that have not invested in smart city technology are exploring it" [8]. At a global scale, many SC programs boast extensive dependency on advanced ICT [2], however, majority of scholars argue that ICT is only one aspect of SC approach. Extensive ICT-based SC programs are indeed more common in the rapidly industrializing regions of the world, such as China and India. However, the strategies to attain smartness in the US rust-belt regions that experienced decades of decline are observed to be unique; emphasizing on lesser ICT dependent ideas of place making, social inclusion, civic

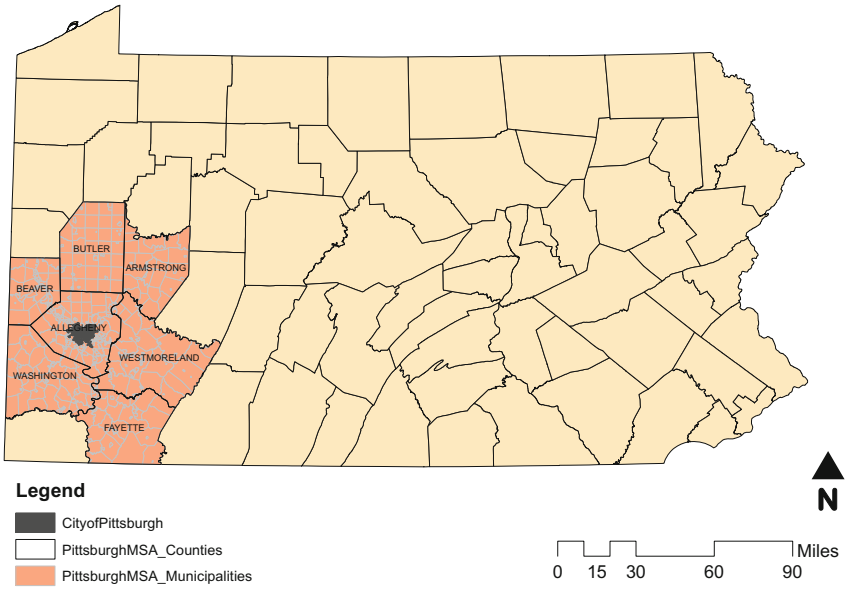
engagement, and entrepreneurship, and integrating them with ICT applications in areas such as urban mobility and green energy.

Our broad goal is to analyze the degree to which Pittsburgh's economic and urban restructuring reflects the principles of SC strategies. We follow the six building blocks of a SC System—smart people, economy, mobility, environment, living and governance, outlined by Kumar and Dahiya [3], as they apply to Pittsburgh. Specifically, our research explores and analyzes SC strategies across the above-mentioned six themes in the Pittsburgh metropolitan area, within two distinctly identified regional planning efforts: (1) Planning for economic resiliency and redevelopment of brownfields, and (2) Planning for urban greening and green infrastructure. In addition, we explore the principles of smart growth that essentially intersect with the themes of SC strategies within these planning efforts.

17.1.1 Study Area and Its Regional Context

The study area delineated for this research includes the Metropolitan Statistical Area (MSA) of Pittsburgh, which comprises of 7 counties—Allegheny, Armstrong, Beaver, Butler, Fayette, Washington and Westmoreland (Fig. 17.4). Among these counties, Allegheny County, home to the City of Pittsburgh, serves as the major population and economic center in the region, and is one of the places where majority of the advanced services and knowledge-based jobs are located. The southern part of Butler county is recently witnessing high growth of advanced services and high-skilled jobs, partly because of its proximity to the City of Pittsburgh and Interstate connectivity. Nevertheless, many communities within Armstrong, Beaver, northern Butler, Washington, Westmoreland, and Fayette counties continue to struggle with issues of brownfields, aging and declining population (Table 17.1). There has also been a proliferation of Marcellus Shale-based natural gas extraction activities in the region since 2005, specifically in Washington County, which brought a short-term boom in the oil and gas industries although they are vulnerable to bust in the future.

The seven-county metro region also consists of 460 municipalities classified into Cities, Townships and Boroughs (Fig. 17.4) [9]. The political landscape, thus, represents a fragmented structure of local governance, and exhibit the challenges of implementing urban policies and strategies at a regional scale. Thus, planning for economic resiliency, brownfield redevelopment, and green infrastructure require overcoming barriers of local governments and jurisdictions through a co-operative model of regional governance and through stronger participation of residents and community organizations. We explore the spatial extent of Pittsburgh's successful planning efforts that essentially follows the principles of smart growth and smart city paradigms.



Map of Pennsylvania showing Pittsburgh Metropolitan Statistical Area (MSA) with the City of Pittsburgh at its core. (source: TIGER/Line Shapefiles, U.S. Census Bureau, 2016)

Fig. 17.4 Map of Pittsburgh Metropolitan Region in Pennsylvania

Table 17.1 Population and economic conditions in the Pittsburgh Metropolitan Region in 2015–16

	Population (2016)	Total employment (2015)	Median household income (2016)	Poverty rate (2016) (%)	Median age (2015)
Allegheny	1,225,365	701,226	$54,357	11.5	41.0
Armstrong	66,486	14,386	$45,879	13.8	45.6
Beaver	167,429	49,345	$51,887	9.7	44.8
Butler	186,847	81,472	$63,345	7.3	42.7
Fayette	132,733	37,436	$40,511	17.5	44.2
Washington	207,981	84,328	$57,534	9.7	44.2
Westmoreland	355,458	126,336	$54,142	9.8	46.8

Source U.S. Census Bureau, 2015–16, data accessed from https://datausa.oi

17.1.2 Rise and Fall of the Steel City: Historical Background of Urban Planning in Pittsburgh

Pittsburgh's recent history could easily be seen as a story of persistent loss and decline. From its humble beginnings in 1760 as a fort community of 149, Pittsburgh rose during its boom epoch of iron and steel to be the sixth largest city in the US.

By 1950, City of Pittsburgh's decennial population had peaked at 676,806. The suburban exodus that faced all industrial cities was exacerbated in Pittsburgh by the gradual collapse of the steel industry. By 2010, the population of the city had fallen 305,704, a loss of more than 50% of its peak population (Fig. 17.5) [10].

Pittsburgh can also be seen as a tale of two eras in the history of US urban planning. In the early to mid-1900s, when Pittsburgh was thriving with its steel mills and growing in employment and population, the urban environment and quality-of-life started deteriorating very rapidly. In 1944, the Wall Street Journal rated Pittsburgh a "class D" city, with little hope of recovery [11]. By 1950, Pittsburgh's polluted air, riverine environment, sprawling working class, and tangled maze of streets and bridges had singled it out as one of the most blighted and reviled cities in the US. However, Pittsburgh was not willing to resign without a fight. A private-political alliance arose in the early 1950s that gave birth to one of the earliest efforts at what we have come to know as the era of urban renewal.

In 1946, under the guidance of R. K. Mellon, David Lawrence became the first director of the Pittsburgh Urban Redevelopment Authority (URA). It is some of the more recent projects of the URA that this chapter focuses on, but their approach and substance differ substantially to the URA's early years.

The early years of the URA were years of clearance and demolition. Pittsburgh's "Renaissance I" began with the Point Park and Gateway Center project. Point Park at the confluence of the Monongahela and Allegheny rivers was an area of blight and flooding. With the financing of the Equitable Life Assurance society, a thirty-six-acre park and a twenty-three-acre redevelopment site became known as the Gateway Center. Between 1950 and 1960s seven high rise office buildings, a Hilton Hotel, a residential apartment building, and an underground garage filled the once blighted space [12]. Had the Renaissance stopped there it might only have been a story of partially filled office buildings and an enhanced city center, but it did not.

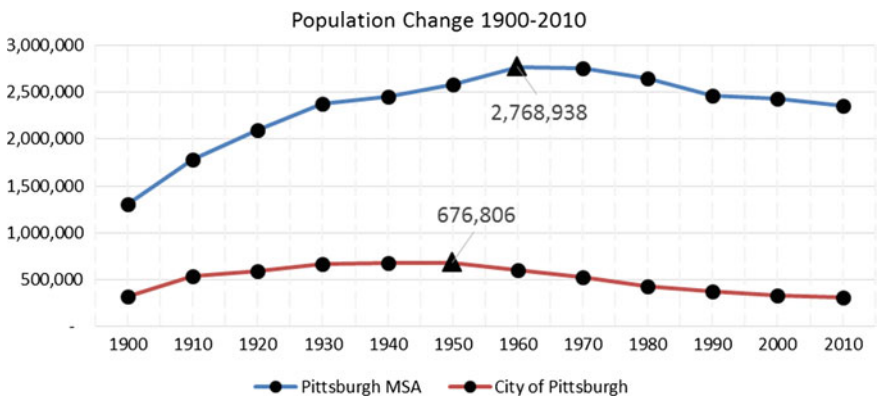


Fig. 17.5 Population change, Pittsburgh city and metropolitan region. *Source* Decennial Census 1900–2010, U.S. Census Bureau

In the Eisenhower era of demolition and highways, the URA set its sights on the Lower Hill district, a predominantly African-American neighborhood. The development of a convention center and civic arena ultimately displaced 1300 buildings, 413 businesses, and 8000 people from the Hill (Fig. 17.6). The population of the Hill fell from 17,334 in 1950 to 2459 in 1990 [11]. The loss of a stable black neighborhood and the concentration of emigres in larger black neighborhoods contributed to making Pittsburgh one of the most segregated cities in the country [13]. The reaction to this form of urban renewal was both local and national. One of the earliest proponents of preserving the legacies of a city and making them livable, Jane Jacobs, wrote in The Economy of Cities that: "so many irrelevant things have been tried here [Pittsburgh]…in immensely expensive urban-renewal and highway programs that have not helped the economy at all" [14]. And indeed, Pittsburgh's population continued to decline precipitously, stores closed, and business fled for the next 30 years.

Failure of urban renewal efforts and continuing trend of manufacturing decline deeply impacted Pittsburgh through the 1980s, 90s and 2000s. The region sharply lost more than 133,000 manufacturing jobs within only 8 years, between 1979 and 1987 [15]. This led to an era when communities after communities experienced financial difficulties and struggled to bounce back in the New Economy. In between 1987 and 2004, five municipalities in the Pittsburgh metropolitan region including the City of Pittsburgh were identified and listed as distressed communities experiencing "severe" financial difficulties under Act 47 of 1987, the Municipalities Financial Recovery Act of Pennsylvania; placing them under State assistance for recovery strategies. These municipalities were: City of Aliquippa (Beaver), Borough of Braddock (Allegheny), Borough of Rankin (Allegheny), City of Duquesne (Allegheny), and City of Pittsburgh (Allegheny), arranged in time-series [16]. Since then, several planning initiatives have been undertaken from local to regional level with assistance from the local, state and federal governments for economic and urban restructuring.

17.1.3 Rise in the New Economy: Present Conditions and Urban Planning in Pittsburgh

The process of economic restructuring was challenging along with the issues of reclaiming, and redeveloping major brownfield sites, where the huge steel mills once stood [6]. Levels of environmental contamination often varied from site to site. While federal level programs provided funding and strategy-framework to clean up contaminated sites, stigma associated with real or perceived levels of contamination often posed difficulty in successful redevelopment of brownfield sites [17]. Nevertheless, many successful examples can be found where new office spaces, research centers, and mixed-used developments were developed over time.

The 1990s and 2000s also brought a change in the planning and a change in the URA's approach to renewal. The early efforts at renewal still left large areas of

Aerial photograph of Lower Hill District in 1956 superimposed with urban renewal plan and the proposed Civic Arena. (source: Fullilove, 2016, https://www.nap.edu/read/23576/chapter/4)

Lower Hill District with the Civic Arena post urban renewal in 1961. (source: Fullilove, 2016, https://www.nap.edu/read/23576/chapter/4)

Fig. 17.6 Urban renewal of Lower Hill District in the 1950s–60s

abandoned factories and decaying neighborhoods. But in planning's new paradigm, brownfields are also treated as an "opportunity". Local governments today to restore the vitality of urban life have turned to a notion of redevelopment that includes infill, mixed use, private-public partnership, and walkability; a framework of smart growth. Smart growth is also smart development. Blakely and Bradshaw tell us that "industry and business regard livability as an important locational factor," and that governments need to "identify their quality-of-life attributes, build on them and effectively promote them to the business community" [18].

Malik Banson, Director of the Kingsley Association, is quoted on the home page of the URA as saying: "Today's URA is not our fathers' URA. Today's URA is not only interested in deals, but most importantly, in where and how the deal develops. They partner with us to support the growth of ideas at the neighborhood level in unique and special ways. They have put 'community' back into community development" [19].

Thus, at the turn of the 21st century, Pittsburgh witnessed a significant change in its planning approaches, shifting towards bottom-up approach, and proliferation of neighborhood level community and non-profit organizations. This was coupled up with remarkable progress with its economic restructuring process, heavily relying on growth of hospitals and healthcare services, high-technology industries, centers of research and higher education (Fig. 17.7). Interestingly, a majority of these sectors are non-profit sectors and are property tax-exempt, and thus not contributing much to ease out the financial challenges for the local governments, particularly for the jurisdiction of the city of Pittsburgh [20]. Nevertheless, revenue generated from income taxes of, and the expanding housing market needed by population base employed in these economic sectors are beneficial for the local governments.

Monongahela Wharf, Pittsburgh riverfront in 2009. (source: Dr. Kevin J Patrick)

Fig. 17.7 Brownfield redevelopment to create the Downtown Innovation District

17.2 Analyzing Smart City and Smart Growth Strategies

We analyze the degree of successes, failures and challenges in Pittsburgh's economic and urban restructuring based on the six themes of Smart City System by Kumar and Dahiya [3]: (i) smart people, (ii) smart economy, (iii) smart mobility, (iv) smart environment, (v) smart living and (vi) smart governance. We also explore the principles of smart growth, outlined by International Economic Development Council (IEDC), to understand to what extent they essentially intersect with the themes of Smart City strategies, based on their relevance to our case study of Pittsburgh.

17.2.1 Smart City System Strategies and Applications

The literature on Smart Cities stress on the need of city-wide or regional scale planning, monitoring and control of advanced infrastructural capacities that efficiently depends on ICT systems. The ICT systems act as the "digital nervous systems" obtaining and processing real-time data on infrastructure (e.g. water supply, electricity, traffic signals and others) and optimizing their functions [2]. As a result, SC strategies with such heavy dependence on ICT systems are expected to "sense and act" [21]. The current trends of investments in cities around the globe with goals to become "smart" widely range across several areas. Some of the most common investments are in the areas of electric supply (e.g. smart energy grid systems), public lighting, water supply management, waste management, natural resource management, transportation and mobility, residential and office buildings, and others. Neirotti et al. [2] argue these as the "hard domain" of SC strategies where placement of ICT systems is crucial for optimal functioning of these systems and to promote overall goals of sustainability. However, there are other areas of implementation for SC strategies, such as public welfare, social inclusion, innovation and entrepreneurship, place making, education, citizenship and civic engagement, asset-based planning, cultural heritage and others, where ICT systems have limited role in successful outcomes (Fig. 17.8). Moreover, scholars argue that ICT systems cannot solely transform cities to "smart cities" without reliance on its residents, and thus ICT systems are only complimentary to "human and organizational capital" [2].

Nevertheless, implementation of SC strategies or smart solutions to city's needs can happen through smart communications, and there have been significant innovations to improve communications across various actors in a city and these have applied a wide array of tools, such as smart city meters for utility management, intelligent traffic signals, e-governance, wifi-kiosks, RFID sensors in pavements, to other measures. The recent survey by National League of Cities reported about 66% of mid-sized US cities have installed tools that come under the "smart" category [8].

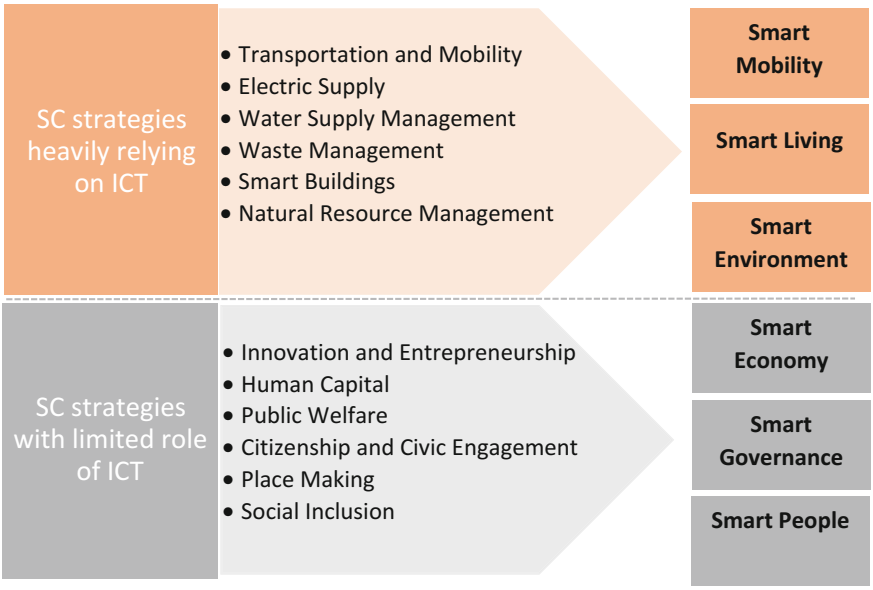


Fig. 17.8 Common areas of implementation for smart city strategies

Moreover, in December 2015, the US Department of Transportation (USDOT) launched "Smart City Challenge" to encourage mid-sized US cities to transform their SC visions into implementable solutions. The common SC applications identified among 78 mid-sized US cities were to address the issues of inadequate transit access to minority and underserved communities, carbon emissions from vehicles, traffic congestion in freeways and arterial streets, and inefficiencies in parking systems. To address these issues, US cities are witnessing a wide range of strategies for implementation of SC visions, such as bringing in autonomous vehicles to improve mobility, electrification of city fleets to reduce carbon footprints, installing vehicle-to-vehicle Dedicated Short Range Communications (DSRC) technology for efficient communication, deploying mobility marketplaces to allow residents to plan for multimodal trips, expanding bikeshare and rideshare options, installing smart street signals that prioritize bus systems and ensure safety of pedestrians and cyclists, and improving real-time tracking of transit systems. In addition, one of the core themes of SC strategies is to emphasize on data collection, processing, analyzing and sharing, where immense amount of data is collected from DSRC infrastructure, crowdsourced data from smartphone users, and installed sensors throughout a city [22]. In 2016, Pittsburgh was selected among the seven finalists for the Smart City Challenge by USDOT, mainly because of its innovative strategies in the areas of infrastructure to support electric and autonomous vehicles, and smart LED street lights with sensors to monitor air quality [23, 24].

It is well understood that adoption of SC strategies will vary from city to city, and few scholars went further to analyze what types of factors determine a city's

adoption of a set of SC strategies. While SC strategies are widely adopted in cities to address their urban problems and find sustainable solutions, scholars have identified a number of factors that can influence a city's adoption of specific sets of SC strategies. Most common of these factors are: economic trends and conditions, demographics trends and characteristics, geographic and location factors, and urban trends and characteristics. In addition, efficient functioning of SC strategies, whether heavily dependent on ICT systems or not, requires human capital. Economic, geographic and human factors thus become crucial to success of a Smart City [2]. From economic perspective, a city witnessing higher economic growth is more likely to channelize its financial resources derived from its GDP and tax base towards investments in "hard domains" of SC strategies. Human capital instigates the city's capacity to innovate and attracts further economic growth. Geographic factors determine the city's viability to implement city-wide networks of smart infrastructure.

Based on these economic, geographic and human factors driving implementation of SC strategies, cities undergoing phases of economic decline and thus, scarcity of financial resources may find it challenging to invest in SC strategies, specifically the ones within the hard domain. In such cases, cities, without a significant amount of tax base and access to financial resources have no other choice but to emphasize on strategies of economic development first to attract more jobs and more population. Thus, fostering an environment of innovation and entrepreneurship, investing in its human capital, along with strategies of social inclusion and civic engagement, which are not necessarily the hard domains of SC, are argued to result in more sustainable forms of economic development and serves as foundations for Smart Cities [2].

17.2.2 Smart Growth Strategies

While the notion of Smart City is a relatively new paradigm in planning, the concept of Smart Growth has remained in the planning arena since the late 1990s [25]. Specifically, in the US planning context, applications and implementations of Smart Growth strategies became more popular and common in practice in the 2000s compared to implementations of Smart City strategies. Essentially, "smart growth is based on mixing land uses, using land and infrastructure efficiently, creating walkable neighborhoods that are attractive and distinctive, providing transportation and housing choices, and encouraging community and stakeholder collaboration in development decisions" [26].

The concept of smart growth emerged as a reaction to prevalence of (1) subdivision type zoning, promoting large single family residential lots and urban sprawl, (2) separation of places of work from places of home, leading to more auto-dependency, and (3) unsustainable pattern of land consumption entailing gigantic shopping malls, office parks and commercial strips, in the planning practices of the 20th century. Such practices were increasingly being critiqued for

promoting social, racial, and economic segregation over space, increasing the costs of infrastructure expansions, and encouraging automobile dependencies and carbon footprints in American cities.

The concept of Smart Growth, as outlined by U.S. Department of Environmental Protection Agency, places emphasis on 10 key principles:

1. Mix land uses
2. Take advantage of Compact Building Design
3. Create a range of Housing Opportunities and Choices
4. Create Walkable Neighborhoods
5. Foster Distinctive, Attractive Communities with a Strong Sense of Place
6. Preserve Open Space, Farmland, Natural Beauty, and Critical Environmental Areas
7. Strengthen and Redirect Development towards existing communities
8. Provide a variety of Transportation Choices
9. Make Development Decisions Predictable, Fair and Cost Effective
10. Encourage Community and Stakeholder Collaboration in Development Decisions.

While the concepts of Smart Growth do not emphasize on dependency of ICT systems, the essential softer domains of SC concepts, based on environment, equity and economy, are visibly present in these aspects. More specifically, smart growth principles of "Compact Building Design," fostering "Strong Sense of Place," providing "Transportation Choices," and encouraging "Community and Stakeholder Collaboration" are areas where Smart Growth principles intersect with the SC strategies. With increase in smart energy grids, DSRC technology, technological platforms to share crowdsourced data from smartphone users, smart streetlights, mobility marketplaces and ridesharing applications, technological platforms to encourage civic engagements, and other applications of SC strategies, Smart Growth principles can also be efficiently promoted and implemented.

17.3 Smart Initiatives in Pittsburgh

As discussed earlier, the approach to urban planning in the City of Pittsburgh and its surrounding region went through many phases of evolution since the early 20th century. The first phase of revitalization post World War era, or Renaissance I, focused on demolition of vacant industrial sites and decaying neighborhoods to create space for office towers, parks and highway systems, but the City had to bear the consequences of social isolation, racial conflicts, suburbanization, and spatial mismatch. Renaissance II, or the second phase of revitalization since the 1980s, shifted the planning focus from demolition and renewal to finding ways to build a strong and diversified economic base for the city, and resulted in growth of

Fig. 17.9 Historic timeline of urban and regional planning phases in Pittsburgh

high-tech industries, education, healthcare, culture and tourism. The more recent phase, or Big Splash, continues to focus on reviving high-end retail and hotels, and offices, housing and amenities [27] (Fig. 17.9). However, Pittsburgh still remained a segregated city at the turn of 21st century, and there is a renewed and stronger vision to promote sustainability with advanced use of technology and SC strategies.

The key challenges identified by the City of Pittsburgh in the 2010s are transportation and economic challenges, which are also tied up with the issues of social disintegration and isolation of low-income and minority neighborhoods that were essentially the consequences of urban renewal and demolition-based planning approaches of the early 20th century. The City of Pittsburgh also identified these areas as potential areas of SC policies. In 2016, City of Pittsburgh recognized the need of collective action to respond to the city's transportation and energy needs efficiently and equitably. SmartPGH consortium was established and envisioned to promote an integrated approach that enables use of new technology to provide economic opportunity, efficient and smart mobility, and better environment for the residents. SmartPGH is also designed as a platform for real-time data sharing by smart phone users. Last year, this program proposed development of a few "smart

spine corridors," which will be dominated by autonomous and connected vehicles, and powered by clean energy [23, 24]. While these smart initiatives are very recent in the Pittsburgh region, such initiatives would not have been possible without the planning visions since the late 1980s that increasingly recognized the importance of economic restructuring and urban greening in a declining city.

In this section, we illustrate Pittsburgh's SC strategies and applications through a number of planning initiatives at a local and regional scale. We focused on two important planning efforts that play crucial roles in planning for shrinking cities: (1) *Planning for Economic Resiliency and Brownfield Redevelopment*, and (2) *Planning for Urban Greening and Green Infrastructure*. While these aspects of planning are not heavily dependent on ICT systems, smart technology and communication techniques are increasingly being applied in the Pittsburgh region to foster innovation and entrepreneurship, promote social inclusion and community engagement, and build and attract human capital. Pittsburgh's story of comeback in the New Economy is set in this backdrop, which is now leading towards further implementation of ICT intensive SC strategies in the areas of mobility, energy, and carbon emission.

The broader metropolitan region of Pittsburgh has already been witnessing a phase of economic restructuring with shift from manufacturing to advanced service based economy since the late 1980s, however the uneven regional pattern of economic and urban restructuring compels us to rethink about their success from the perspective of economic resiliency. We analyze the extent of success and challenges of this economic transformation and the degree of its economic resiliency to be considered as SC strategy. We specifically discuss planning examples of the Bakery Square, Summerset at Frick Park, Southside Works, and Oakland District, where efforts to plan for economic resiliency and redevelop brownfield sites, and integrating them with green infrastructure planning led to creation of a mixed-use neighborhoods, green spaces and diverse economic opportunities that overall contributed to improved quality-of-life of the residents and environmental sustainability.

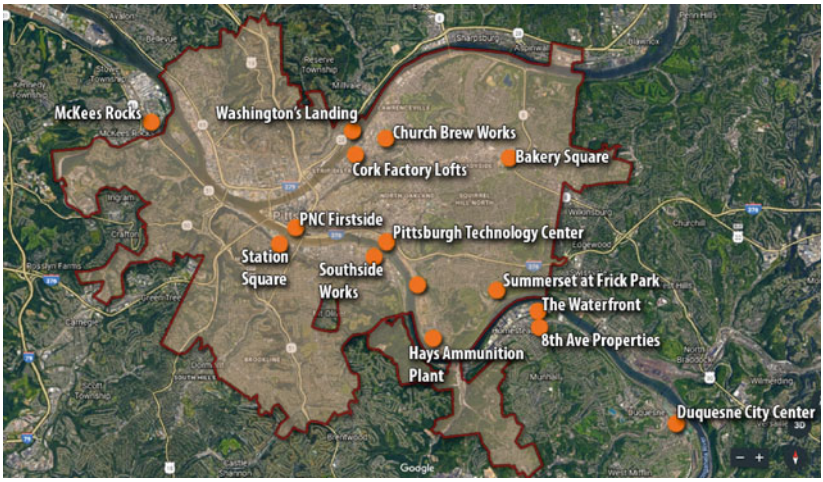
Practice of Green Infrastructure (GI) in old industrial cities is different from traditional GI planning that focuses on preservation of open spaces and natural habitats in the urban peripheries. In a post-industrial context, urban greening has the potential for returning surplus and derelict lands to productive uses, reduce surplus lands, and stabilize real estate markets. Many municipalities in the Pittsburgh metropolitan regions are increasingly mobilizing their citizens and local organizations, and becoming more pro-active in re-using abandoned properties and transforming them into green spaces and/or integrating them in a network of GI. Community gardens, landscaped spaces and other strategies are practiced at the local levels to enhance quality-of-life and foster socio-economic and environmental sustainability, which are integral part of SC approach. We investigate the effectiveness of GI strategies focusing on regeneration of vacant properties as parks, restored habitats, vegetation, or for storm water management.

17.3.1 Planning for Economic Resiliency and Brownfield Redevelopment

Planning for economic resiliency is emerging as a popular approach in the developed regions of the world, partly as a reaction to economic decline, disasters and shocks. The mechanisms of economic resiliency planning can be challenging due to unpredictability of local and regional economy in the globalized era of 21st century, but essentially focuses on capacities of local economy to withstand vulnerabilities and cope with consequences of crises [28]. Historically, the Pittsburgh region has experienced cycles of growth and decline spanning for centuries, thus, the need to embrace the concept of resiliency is unequivocally supported by politicians, policy makers and community residents.

Pittsburgh is a typical example of a post-industrial city from the western world in the recent times. For decades, the city struggled with challenges of loss of its economic base which led to further urban problems rooted in racial conflicts, flight of white population from the city's core, attraction of suburbs and problems of brownfield sites and vacant lots. The urban future of such a declining city did not look optimistic in the 1980s–90s, and city was labelled a shrinking city with aging and poor population. To change its future, Pittsburgh had to adopt economic resiliency plans since the mid-1980s. In between, 1985 and 1995, the city established a region-wide economic agenda. The plan focused on strategies to diversify the city's economy and transform its economic base from manufacturing to advanced technology, international marketing, and communication systems. The premise of such efforts was deeply rooted in identifying and capitalizing on the region's assets, taking advantage of the emerging economic trends, and fostering growth, innovation and entrepreneurship in these growing and competitive sectors of the regional economy [29].

One of the core elements of Pittsburgh's economic resiliency plans since the 1980s was a strong focus on clean-up and redevelopment of old brownfield sites (Fig. 17.10). Successful redevelopment of brownfield sites, which were idled and abandoned with closures of steel mills in the region, is considered one of the key factors that contributed to successful post-industrial economic restructuring in Pittsburgh (Fig. 17.11). Large-scale brownfield sites, which mostly occupied prime lands along the riverfront, had the potential to offer land for high-tech and knowledge-based companies and institutions. However, strategies to transform former industrial sites into viable uses are often complex due to real as well as perceived risks associated with contamination [30]. Hence, brownfield redevelopment required large-scale funding in the initial stages, which led local and regional government agencies to collaborate with State and federal government and private institutions. The visions of long-term economic and urban benefits of brownfield redevelopment encouraged multiple stakeholders collaborate in numerous projects, and eventually it emerged as an appropriate tool for efficient land management in the region.



Mapping of Old Brownfield Sites in Pittsburgh Region (Source: Google Earth, 2017; Western Pennsylvania Brownfields Center, 2017)

Fig. 17.10 Map of brownfield sites in Pittsburgh

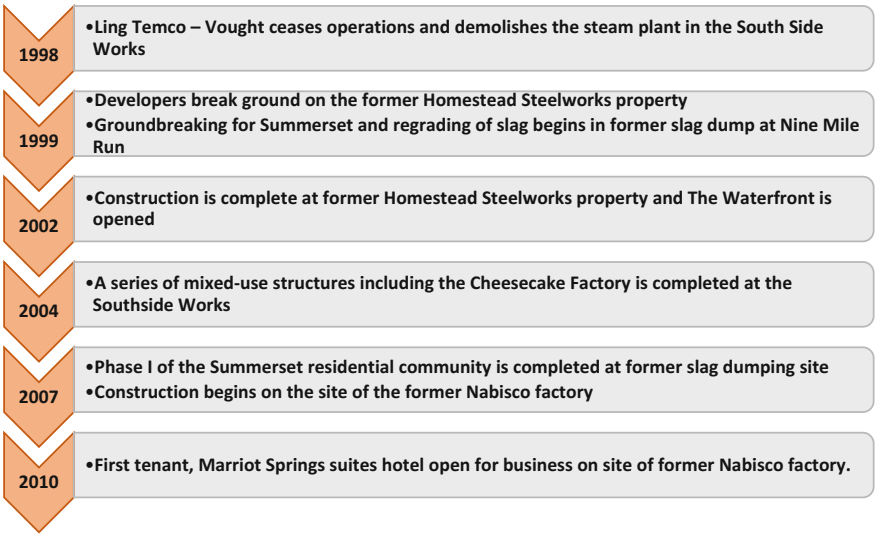
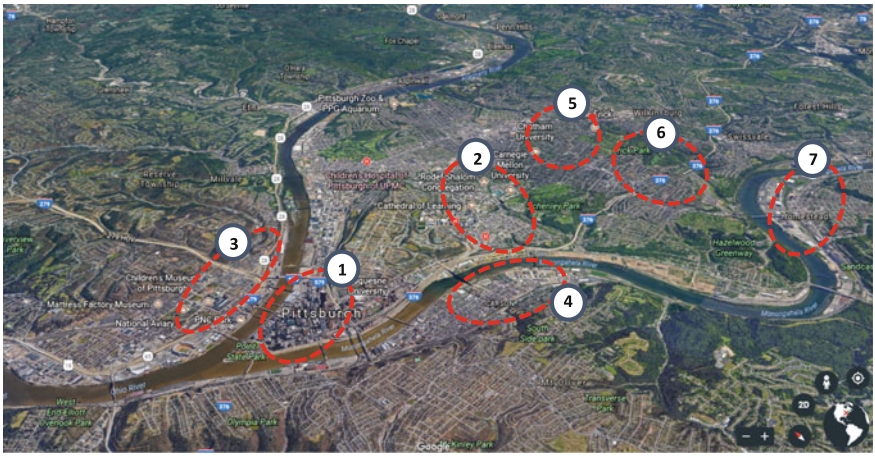


Fig. 17.11 Historic timeline of brownfield redevelopments in Pittsburgh

The Pittsburgh metropolitan region offers opportunities to explore degrees of successes and challenges in many of the successful cases of brownfield redevelopment along the Allegheny, Monongahela and Ohio riverfronts, where former industrial sites were transformed into research institutes, office spaces, mixed use developments (Fig. 17.12). We explore the effective plans and policies that led to successful examples of brownfield redevelopment at a regional scale. However, there are still vast amounts of brownfield sites in the broader region that are in abandoned and derelict state, which needs to be integrated with the changing urban fabric of Pittsburgh.

Along with economic transformation and brownfield redevelopment, Pittsburgh's planning approach in the 1980s–90s was also witnessing a radical change from the early 20th century. While the post-World War planning approaches in Pittsburgh witnessed a dominant top-down approach that led to social and economic disintegration, the planning practices since the 1980s witnessed an increasing trend of bottom-up approach with many volunteer groups and non-governmental organizations beginning to pop up throughout the city. The energy created by mobilization and engagement of community interest groups, and the low cost of housing, rental market, and living also encouraged young adults, referred to as "boomerangers," to start new businesses and create more jobs that stimulated the local economy. Over time, Pittsburgh was gradually being referred to as a "comeback" city in the context of planning and development. Thus, Pittsburgh's transformation from an industrial city to a shrinking city to a comeback



1. Downtown District **2. Oakland District** **3. North Shore** **4. South Side**
5. East Liberty/ Bakery Square **6. Summerset at Frick Park** **7. Homestead**

Pittsburgh's Innovation Districts and Revitalized Neighborhoods located in Old Brownfield Sites (Source: Google Earth, 2017)

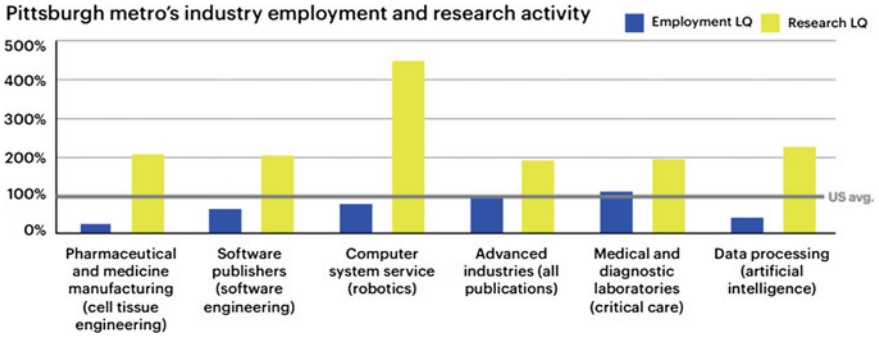
Fig. 17.12 Spatial distribution of successful economic and brownfield redevelopments

city resulted from realistic assessment of the regions assets and challenges, innovative and bold long-range economic planning, successful partnerships among various private and public stakeholders, and effective participation of local community groups and residents [29]. Since the 2000s, Pittsburgh started witnessing emergence of high-tech and research jobs in Science, Technology, Engineering and Medical (STEM) areas as the driving economic base of the region. The Locational Quotient of these jobs in Pittsburgh, as reported by the Brooking report of September 2017, are almost 200 to 400% of the national average (Fig. 17.13) [31].

In the following part, we discuss the specific examples of brownfield redevelopment and the strategies adopted to ensure economic transformation and environmental cleaning of the sites.

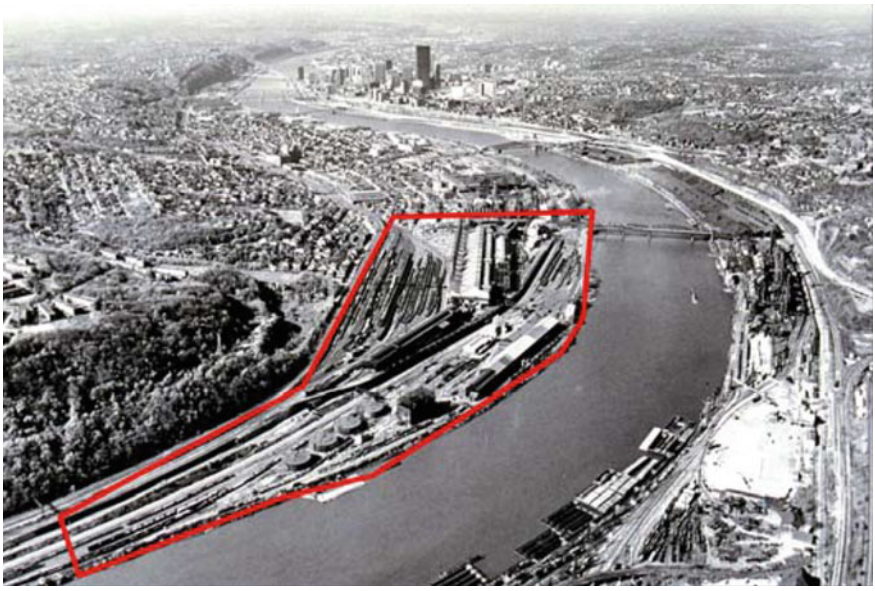
17.3.1.1 Example of South Side: East Carson Street Commercial Corridor Revitalization

East Carson Street is the commercial backbone of a once flourishing residential neighborhood of steel workers. With the decline of the steel industry during the 1970s, homes and storefronts were abandoned leaving a deserted and dilapidated neighborhood (Fig. 17.14). In 1982, the South Side Local Development Company (SSLDC) was created to encourage investment in the corridor. When the company was founded, property values in the neighborhood were 66.66% of the city's median value. In 2008–09, those values rose up to 170% of the city's median value. About 60% of the retail space along East Carson Street was vacant in 1982, and that rate went down to about 4.5% by 2010 [32]. Over 23 years, the SSLDC has leveraged $16 million in funding for businesses and housing redevelopment. By 2010, 225 older Victorian structures were rehabilitated, largely between 10th and 24th street using matching state funds. Feeling it had accomplished its mission, the SSLDC phased out in 2012.



Pittsburgh metropolitan area's Industry, employment and research activity. (source: Andes et. al., 2017).

Fig. 17.13 Research location quotient in Pittsburgh Metro Region



Southside Works, Former Brownfield Site. (source: Rivers of Steel National Heritage Area)

Fig. 17.14 Former brownfield sites at south side

Partnering with the Pittsburgh URA and using state funds, CBDG grants, and mortgage revenue bonds over 100 market rate housing units were developed between 1995 and 2010. Private developers added 330 lofts and condominiums. In all the public invested $119 million since 1985, generating $368 million in private investment. The SSLDC estimates 3500 jobs have been created.

Just to the east of the commercial district was the 123-acre LTV Steel South Sides Works. In 1993, the URA purchased this parcel of land and began a redevelopment effort. Located in the South Side Fats and running from 25th to 33rd Streets, the project has invested $128 million in public funds to generate a total investment of $450 million. The once moribund site is now home to residential, retail, commercial/office, light industrial, hotel, public parks, sports training facilities; specific uses, among many others, include Cheesecake Factory, REI, Hofbrauhaus, national, McCormick and Schmick's restaurants, national corporate headquarters for American Eagle Outfitters, Maya Design, UPMC Orthopedic Clinic led by Dr. Freddie Fu, football training facility for Pittsburgh Steelers and University of Pittsburgh. Recreational amenities open to the public include a trail and public park along the Monongahela River, a public park over a railroad tunnel and numerous plazas featuring art and other public amenities. Up to 352 residential rental units have been constructed and 5400 jobs created. Once generating zero property tax for the city, the URA estimates that the area now generates $6.03 million a year. Property values increased between 160% and 250% between 2000 and 2007 [33].

Southside Works, Redeveloped Site. (source: Google Earth, 2017).

Fig. 17.15 Contemporary image of south side

Redevelopment and livability are two cornerstones of smart growth. Here the two have combined to revitalize a decaying neighborhood and an abandoned industrial zone (Fig. 17.15). As Beth Marcello, a former SSLDC director, puts it: "Carson Street was one of those neighborhoods where there was no reason to be there…but now it has a wonderful walkable business district with almost everything you could want, a high rate of ownership, and a lot of pride" [26] (Table 17.2).

17.3.1.2 Example of Oakland District: Pittsburgh Technology Center and Establishment of Eco Innovation District

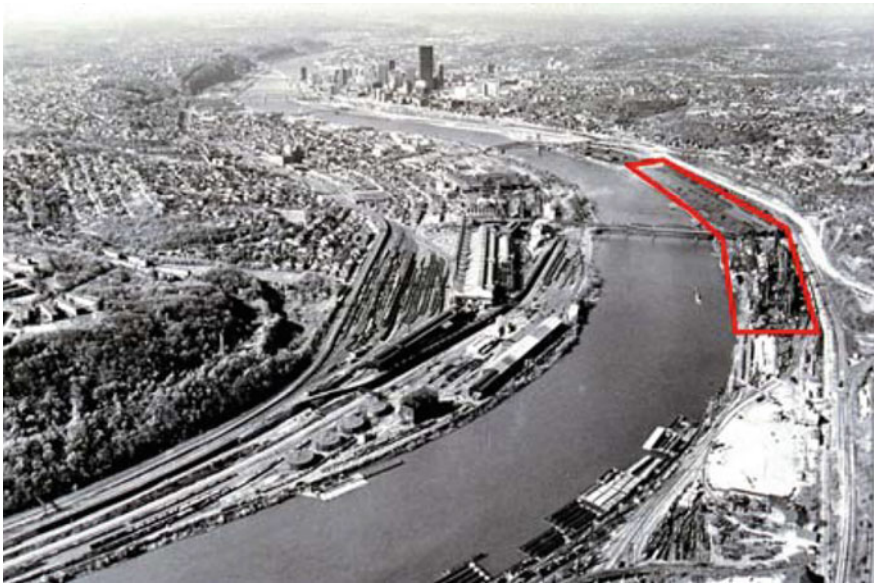
Across the Monongahela from the South Side and connected by the Hot Metal Bridges, is the Pittsburgh Technology Center. Built on the site of the former Jones & Laughlin Hot Mill this forty-eight-acre site has been converted into riverfront office park and regional research center. J&L was, by far, the major competitor to the Carnegie Steel, the top steel producer at the time. At its peak it produced almost 3.4 million tons of pig iron, steel and other products, while employing almost 22,000 people [34].

Purchased by the URA in 1983, ground breaking occurred in 1993 with project completion in 2001 (Fig. 17.16). This site was the first use of Tax Increment Financing (TIF) in Pennsylvania to fund the completion of the $104 million development. Because of its almost immediate success, the $7.5 million taken from TIF was repaid 12 years ahead of schedule. Total public investment has been $54,200,000. The public investment has largely been spent on environmental cleanup (tar pits, waste oil, and ferrous cyanide), site remediation, and open space. The URA has created a suburban-like environment with tree covered walkways and a greensward along the river. Two miles from the city center, the location was chosen because of its proximity to the University of Pittsburgh and Carnegie

Table 17.2 Economic indicators of Downtown, Oakland, East Liberty, Southside, and city of Pittsburgh

	Total Population			% Employment in Professional, Scientific, Educational, and Health Services		
	1990	2000	2010	1990	2000	2010
Downtown District (CBD)	3,785	5,222	5,325	35.1	43.1	43.7
Oakland District	21,548	20,417	19,328	52.7	50.9	50.7
East Liberty District	7,973	6,871	6,088	39.4	40.9	46.4
Southside District	11,849	10,733	11,421	30.7	36.5	34.5
City of Pittsburgh	369,879	334,563	308,003	36.0	41.0	44.5
	Average Household Income*			Per Capita Income*		
	1990	2000	2010	1990	2000	2010
Downtown District (CBD)	$76,720	$90,243	$81,870	$33,391	$33,259	$30,153
Oakland District	$47,326	$47,584	$46,442	$19,825	$19,714	$18,584
East Liberty District	$35,198	$42,507	$36,263	$18,713	$23,021	$19,575
Southside District	$41,773	$51,939	$63,564	$20,176	$26,898	$34,113
City of Pittsburgh	$55,316	$60,888	$59,963	$23,519	$27,113	$27,346

*All dollar values have been adjusted for inflation to 2016 values
Source U.S. Census Bureau, 1990, 2000, 2010, data accessed from https://www.socialexplorer.com



Location of Pittsburgh Technology Center, Former Brownfield Site.
(source: Rivers of Steel National Heritage Area)

Fig. 17.16 Former brownfield site at the South Oakland District

Pittsburgh Technology Center, Redeveloped Site. (source: Google Earth, 2017)

Fig. 17.17 Pittsburgh technology center at the South Oakland District

Mellon University's Oakland campuses, the research component has been a cooperative effort between two nationally ranked universities and the business community. Other tenants include Union Switch and Signal, Aristech, and the Oakland Consortium (Fig. 17.17) [19, 34]. Private investment has been $140 million. The Center generates $1 million in property tax revenue and employs 1000 people in high tech jobs. The URA is considering the development of an additional 1 million square feet because of the success of the site.

Another initiative focusing on supporting clean technology development and infrastructure projects includes setting up the Uptown Eco Innovation District which focuses on identifying ways in which redevelopment can improve the environment, support the needs of current residents and expand entrepreneurship and job growth and positively transform communities. The Eco Innovation district is an urban plan that intends to revitalize Uptown Pittsburgh and transform it into an innovative urban ecosystem where it will enhance equitable land use, attract and guide new investment, expand the local economy, reduce the city's environmental footprint, and ensure equity and access to local opportunities. This plan is being developed by a series of local and regional stakeholders. This is with collaboration among several agencies including the Uptown Partners of Pittsburgh, Oakland Planning and Development Corporation, City of Pittsburgh, Sustainable Pittsburgh, Urban Redevelopment Authority of Pittsburgh, Port Authority of Allegheny County, and Allegheny County Economic Development, neighborhood residents and groups, universities, and other partners (Fig. 17.18) [31, 34].

Oakland District (Source: Google Earth, 2017)

Fig. 17.18 Oakland Innovation District

17.3.1.3 Example of East Liberty/Bakery Square

East Liberty is perhaps one of the clearest examples of the failure of the early urban renewal efforts and the smart growth strategies of today. Boasting movie houses, department stores, a roller skating rink, and many retail shops, home to the National Biscuit Company (Nabisco), East Liberty was a booming regional business district until 1958. At that time faced with the first commercial vacancies in decades, congestion, poor parking, and flight to the suburbs, East Liberties business leaders began to call for change [35]. Turning to Pittsburgh's Urban Redevelopment Authority for help, East Liberty began a process of massive urban renewal. The URA proposed creating an outdoor pedestrian mall on Penn Avenue, to be surrounded by parking lots that could mimic automobile driven suburban shopping malls. The plan required the demolition of roughly half of the communities on 254 acres. Ultimately the URA demolished 1200 homes, reduced the size of the shopping district by 1 million square feet and closed the middle of East Liberty to traffic. The neighborhood lost hundreds of small businesses and in the 40 years that followed [11]. In 1959, East Liberty had 575 businesses, by 1970 it was 292, and by 1979 only 98. During the four decades that followed East Liberty lost 4500 people.

At the same time, the Pittsburgh housing authority planners noted that the African-American families displaced by the URA's earlier decision to demolish the lower hill district to make way for the Civic Arena were crowded into Homewood. Their solution was to build three 20-storey housing projects along the new Penn Circle Roads. Viewing the East Mall Apartments, a 17 storey, low income housing project that the Post-Gazette describes as "a host to drug dealers, crime and vandalism," The director of the URA in the 1950s and 1960s Bob Pease, is quoted as saying: "Right or wrong, I don't know" [11].

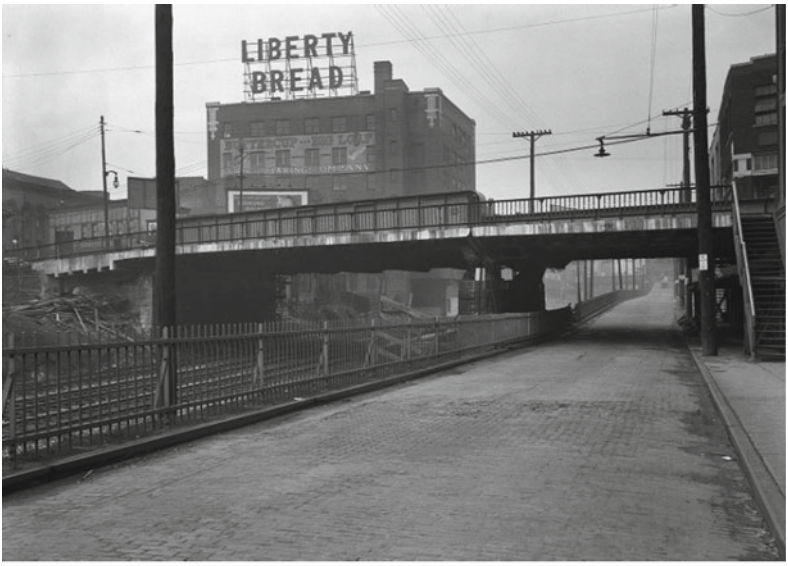
The story of East Liberty today is very different. In 1979, the East Liberty Quarter Chamber of Commerce formed the non-profit East Liberty Development Inc. (ELDI). Focusing on reopening Penn Avenue, Highland Avenue, and Broad Street to traffic, the non-profit also worked to restore and redevelop property along Penn Avenue [35]. The efforts faltered making slow progress, but under new leadership between 1996 and 2006, ELDI and the Urban Redevelopment Authority (URA) worked to attract new "big box" retailers to East Liberty and to remove the 20-storey housing projects that surrounded the neighborhood. First, ELDI and the URA used tax increment financing (TIF) to lure two national retailers to the neighborhood: Home Depot and Whole Foods. Both of these stores thrived, and their success convinced small local merchants and other national retailers to invest in the neighborhood. Second, after a complex and time-consuming set of transactions, two of the three housing projects that visually barricaded the neighborhood were demolished in 2005, and the third was demolished in May 2009. The 1400 high-rise public housing units were replaced by 450 mixed income units [36].

Working with the ELDI and URA, Mosites Company brought Whole Foods to East Liberty in 2002 with a $7.6 million along a stretch of Center Avenue. Eastside II a $32.5 million project houses Borders and Walgreens. The projects have used Federal tax credits, a $10 million Housing and Urban Development (HUD) loan and $2 million grants, and tax increment financing (TIF) [36].

In 2007, Walnut Capital purchased the old Nabisco plant and began the Bakery Square project for $5.4 million. The site received $1 million Environmental Protection Agency (EPA) grant for remediation to clean up asbestos and PCBs. The total cost of the project was $135 million. The rerouting of Penn Circle to two-way traffic was done at a total cost of $5.6 million. Of that $2.59 million was financed with TIF. An additional $7.41 million in TIF was used for traffic easing and property tax abatement. Bakery Square offers 932 public parking spaces, the 110 room Marriot Spring Hill Suites. The ground floor has 121,060 square feet of retail space hosting an Anthropologie, Coffee Tree Roasters, Jimmy Johns, Panera Bread, and 41,550 square feet of fitness center. The biggest client is Google which ultimately occupied 115,000 square feet and employs 500 people. The expectation is that Bakery Square will create 1600 jobs [34].

In 2012, East Liberty got another boost, a $15 million U.S. Department of Transportation TIGER IV grant which supplement the $34 million construction of a new transit center. The center will be a hub for 1000 bus arrivals and departures each day and have a pedestrian link to the Shadyside neighborhood. Mosites Co. is planning on Eastside III and IV development additions on surrounding land [37].

With apartments renting from $1300 for a 500-square foot studio to $4000 for a 1500 square foot two-bedroom apartment, East Liberty is returning to its glory days of the 1950s. A vibrant upscale shopping neighborhood with businesses and apartments, directly connected to public transit, it serves as an example of the difference between urban renewal and smart city growth (Fig. 17.19).



Old image of Brownfield Site at Bakery Square
(Source: Pittsburgh City Photographer Collection, University of Pittsburgh)

Historic shot of the Nabisco Factory, Bakery Square, Current Google Office.
(Source: Historical Society of Western Pennsylvania)

Fig. 17.19 East liberty/bakery square

Redeveloped Site at East Liberty / Bakery Square (Source: Google Earth, 2017)

Fig. 17.19 (continued)

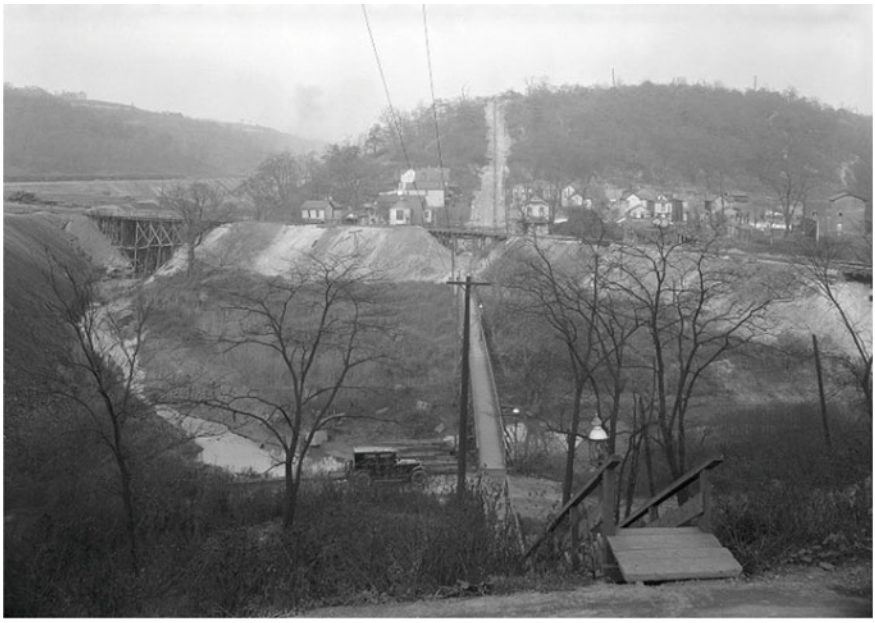
17.3.1.4 Example of Summerset at Frick Park

Summerset at Frick Park is one of the largest residential redevelopment projects since WWII. A traditional neighborhood development project, the site will ultimately comprise 710 new residential units and 105 acres deeded as an extension of Frick Park [38, 39].

Located approximately 5.9 miles from downtown Pittsburgh and adjacent to Squirrel Hill, Summerset lies along Nine Mile Run, one of the city's largest streams entering the Monongahela. In 1910, Frederick Law Olmstead saw it as one of the best opportunities for a large urban park, however its proximity to the industrial Pittsburgh lent it a different fate. In 1922, it was purchased by the Duquesne Slag Company who for 50 years used it to dump slag. By 1972, there was 17 million cubic yards of slag along the river piled as high as 120 feet [34]. In 1996, the 238-acre site was purchased by Pittsburgh Urban Redevelopment Authority for $38 million. Initial environmental assessment found two major problems. High levels of chromium remained in the slag and Nine Mile Run was seriously polluted.

State and Federal funds of $7.7 million were put into stream remediation, stemming direct sewage contamination as well as several non-point source problems. The slag heap itself was not removed, rather, it was graded and covered with three feet of topsoil. Roads and other infrastructure were also publicly funded bringing total local, state, and federal dollars to $89,554,000.

The residential development was done by a private partnership: Summerset Land Development Associates. The private investment so far has been $151,900,000. Property taxes are estimated at $5.7 million a year on full build out. Home values in adjacent neighborhoods have risen between 44 and 132% during the period 2000 and 2007 compared to 18% for the city [40] (Fig. 17.20).



Summerset at Frick Park, Nine Mile run Browns Road, October 31,1927 (Source: Pittsburgh City Photographer Collection. University of Pittsburgh)

Redeveloped Site, Summerset at Frick Park (Source: Google Earth, 2017).

Fig. 17.20 Summerset at frick park

17.3.2 Planning for Urban Greening and Green Infrastructure

Practice of Green Infrastructure (GI) in old industrial cities is different from traditional GI planning that focuses on preservation of open spaces and natural habitats in the urban peripheries. Randolph [41] defines GI as "an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations." While this is a popular approach in GI planning, industrial cities rarely possess open spaces in natural conditions, rather they boast a legacy of abandoned and derelict properties. In this section, we describe some of the GI strategies focusing on regeneration of vacant properties as parks and gardens, vegetation, or for storm water management [41].

17.3.2.1 Vacant Land Development Through Adopt-a-Lot Program

Like many rust-belt cities, Pittsburgh has considerably large number of vacant, distressed, or undeveloped properties. In a post-industrial context, urban greening has the potential for returning surplus and derelict lands to productive uses, reduce surplus lands, and stabilize real estate markets [42]. These lots are a legacy of Pittsburgh's economic shift which resulted in a large amount of vacant and distressed lots which create several issues such as a decreased tax-base, public health issues, social isolation, environmental hazards and overall a lower quality of life for the surrounding neighborhood. Consequently, 12% of all properties in Pittsburgh were vacant in 2000, 36% of which were abandoned or blighted [43]. These distressed sites include parcels that are currently vacant, condemned, or tax-delinquent. These properties that have become public responsibility places an enormous burden on the City resources and do not contribute taxes to pay for public services. In 2015, it was estimated that there were over 28,000 vacant lots could have cost the city about $20 million to maintain, of which the city-owns about 19% by area. An Adopt-A-Lot program is being implemented since last year which aims to convert these lots from blight to asset [44] (Fig. 17.21).

Most of the city-owned vacant lots have liens against them which could take several years to clear for sale and enable redevelopment. Ignoring these vacant lots would result in accumulation of trash and overgrowth, degrading public safety and giving the impression of blight. Many municipalities in the Pittsburgh metropolitan region are increasingly mobilizing their citizens and local organizations, and becoming more pro-active in re-using abandoned properties and transforming them into green spaces and/or integrating them in a network of GI. Pittsburgh's *Open Space Plan* analyzed suitable uses for these vacant lots, and determined the feasibility of turning them into formal parks and open spaces. Concurrently, the Land Recycling Task Force also evaluates vacant lands. Community gardens, landscaped spaces and other strategies are practiced at the local levels to enhance quality of life

Fig. 17.21 Map showing vacant lots in Pittsburgh. *Source* Pittsburgh Vacant Lot Toolkit Policy Guide, City of Pittsburgh 2015

and foster socio-economic and environmental sustainability, which are integral part of SC approach.

Adopt-A-Lot is a low-cost smart city initiative to fight blight, since maintaining each one of those vacant lots would cost the city almost $600/year, amounting to over $5.6 million for maintenance of only the city-owned lots. As an interim measure, the city has enabled residents to start gardens in the 7286 vacant lots it directly owns (and other government owned lots, approximately 9500 lots) through the Adopt-A-Lot program which allows them to plant flower, edible, or rain gardens on vacant lots. The Vacant Lot Toolkit policy and resource guides help residents and community groups to convert city-owned lots into community assets and clarify city processes [44, 45]. It identifies specific vacant land management strategies such as: developing a unified and coordinated vision with city departments, clarifying and developing processes for short-, medium-, and long-term reuse of vacant lots, including creating a single point of contact, an Adopt-A-Lot license for short-term temporary projects, a longer Adopt-A-Lot lease for 1-year leases (renewable for 3 years), and permission for commercial farm or tree farm or other uses [46]. Financial sustainability can be achieved thought the "market garden" model, where community organizations operating small scale community gardens or urban farms can sell unprocessed produce from growing sites on vacant lots in a farmstand-style

manner. However, in Pittsburgh, there is a prohibition on selling items produced on city-owned vacant lots due to concerns about lease fees, liability, and the difference between these community uses, in contrast with truly "commercial" uses that should pay higher fees. Commercial uses such as urban farms, commercial farmers markets, larger scale agricultural and nursery enterprises, are some of the most intensive uses that can generate employment, but need to be properly scrutinized. Another short-term proposal includes creating a vacant lot public arts program where artwork can be selected and displayed. Longer term plans for city-owned vacant land redevelopment include a "highest and best use" analysis, and implementation of green infrastructure particularly in floodplains and wetlands, and on properties adjacent to waterways. Lots along retail corridors in core development areas are likely to be more suitable for redevelopment. This year, the city created an online database of over 3000 city properties, most of them vacant lots, which provides potential buyers with information on properties available for sale [47].

17.3.2.2 Planning for County-Wide Stormwater Management

The city of Pittsburgh and other cities in the Pittsburgh metropolitan region face multiple challenges as their aging infrastructure is unable to meet the current water-quality requirements. While a majority of the rain events in Pittsburgh are not extreme, due to impermeable surfaces and clay soil there is not much absorption, and because of the steep topography in many areas (Fig. 17.22), water tends to flow fast and accumulate in low-lying and valley areas.

Like many other cities, Pittsburg's stormwater and sewage infrastructure built before 1940s relies on a Combined Sewer System (both sewage and stormwater is designed to be carried in the same pipes), so when stormwater exceeds the capacity of the pipes, untreated sewage mixed with stormwater overwhelms the system and overflows at several points before it reaches treatment plant. This results in increased flooding, water quality degradation, stream erosion, reduced groundwater recharge, and loss of aquatic life. Therefore, there is a need for more resilient infrastructure to handle the environmental problems due to untreated sewage and stormwater. Older infrastructure with combined sewer and stormwater system is not only inadequate to handle current needs, but even more ill-equipped to meet future demand due to changes in the climate, land use, and rainfall patterns. Green infrastructure (GI) techniques such as rain gardens, riparian buffers, and porous pavements have been proven to be effective for reducing the volume, the rate, as well as pollutants of stormwater runoff.

In response to EPA's citation for sewage overflows which are in violation of the Clean Water Act, a local non-profit environmental organization, *3 Rivers Wet Weather* (3RWW) was created in 1998 in a unique partnership by Allegheny County Sanitary Authority (ALCOSAN) and the Allegheny County Health Department (ACHD) to support 82 municipalities and the City of Pittsburgh to deal with the regional wet weather overflow problem. In 2008 ALCOSAN entered a consent decree with EPA that required a reduction of 85% overflow, and each of the

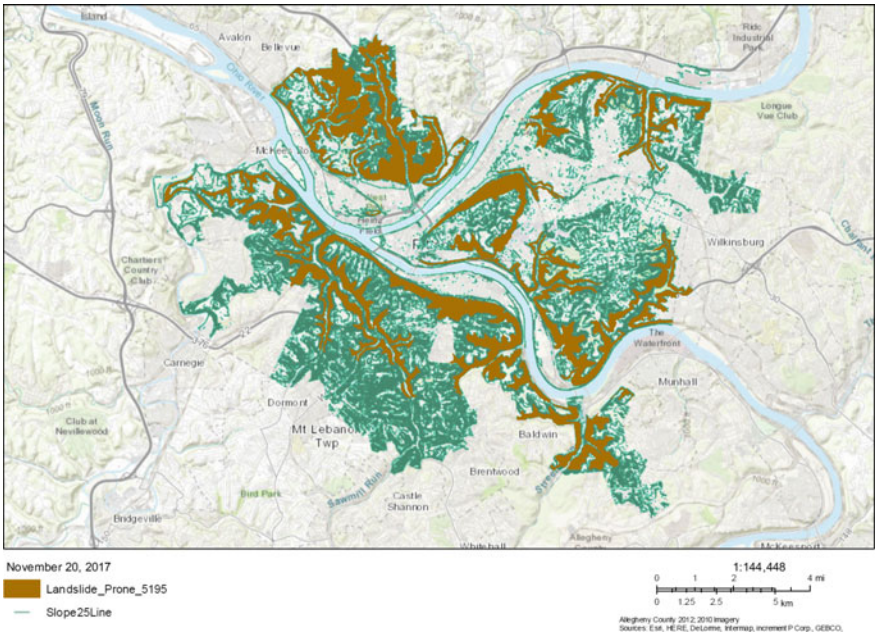


Fig. 17.22 Map showing areas with steep slopes and landslide prone areas. *Source* City of Pittsburgh GIS, http://gis.pittsburghpa.gov/zoning/

municipalities within the service area had a similar consent decree. In 2013, ALCOSAN came up with their *Wet Weather Plan,* expected to cost $3.6 Billion, which would eliminate sanitary sewer overflows and reduce overflow from combined sewers by 2026 [48]. However, ALCOSAN plan focused exclusively on massive capital-intensive gray infrastructure projects such as expanding treatment facilities and a new treatment plant, massive underground storage tunnels, and new and larger capacity drains [49]. The plan ignored GI solutions such as rain gardens, bioswales, green roofs, and tree plantation, all of which have the potential to reduce overflows in combined systems by reduction at source [50]. In any case, EPA deemed ALCOSAN's plan deficient, and incapable of complying with the consent decree [51]. Pittsburgh and Alleghany County debated benefits, feasibility and cost-effectiveness of GI solutions such as rain gardens, porous pavement and other environmentally friendly methods. In 2012, Allegheny County Sanitary Authority conducted a feasibility study for using GI as a cost-effective, long-term sustainable solution for Pittsburgh's wet weather problems with the help of 3RWW for which they used an EPA tool to identify 'best management practices' and suitable locations for different types of low-impact development/GI techniques, such as bioretention—rain garden; constructed wetlands—wet pond; grassed swale—bioswale; infiltration basin—trench; porous pavement; and vegetated filter strip—grass buffer [52]. In 2015, EPA granted a 1.5 year extension to produce a sewer plan that would

include GI such as green roofs, rain barrels, permeable pavement, bioswales and stormwater planters.

At the end of 2016, the City of Pittsburgh and PWSA introduced their *Green First* approach, based on analysis of 13,700 acres and proposed runoff management of 1835 acres over the next 20 years which will reduce CSOs through stormwater management. This plan prioritizes source reduction and the implementation of enhanced green best management practices over large scale traditional conveyance and storage structural alternatives. It has established a set of guiding principles for developing stormwater management plans for selected six sewer-sheds. Pittsburgh adopted the *Clean and Green Plan* and a storm water management plan to address problems of poor water quality, CSOs/SSOs, illegal discharge of sewage in storm sewers, local surface flooding, basement sewage flooding, and problems with 80–100 years old sewers [53, 54]. Over the next 20 years ALCOSAN plans to spend $2 billion to implement the plan, mixing both gray and green infrastructures (such as porus pavement, bioswales, green alleyways, etc.), and aims to reduce about 9 billion gallons of sewage flowing into regional waterways during heavy rainfalls. To demonstrate effectiveness of GI techniques, demonstration projects are underway in the city of Pittsburgh city in three locations—one of them is redesign of two city-owned Centre/Herron lots that flood frequently with stone pavers, bioswales, water storage under soil and pea gravel, which will reduce CSO by 750,000 gallons a year; and another is an extensive stormwater park on two vacant lots that will reduce CSO by 800,000 gallons and reduce local flooding [55–57]. One rain garden in the East Liberty neighborhood was able to capture all stormwater runoff in 2016, and ably handled a "once-in-167-year-storm," absorbing three inches of rain in two hours [58].

It is interesting to note that Pittsburg has moved to implementing smarter, cost-effective, GI techniques to reduce the overflow of sewage into its rivers during wet weather events, moving away from the traditional, strictly gray infrastructure approach. This is expected to keep one billion gallons out of the combined sewer system annually, dealing with approximately 10% of the stormwater problem in Allegheny County under current conditions. Other benefits of GI include cost-effective public realm investment, re-establish riverfront connections; complete streets design approach fostering healthy, walkable communities and; creation of resilient infrastructure. But as the climate changes, larger storms and increased rainfall are expected in the area, there is a need for a more dynamic plan with resilient infrastructure [59].

17.3.2.3 Planning for Climate Protection and Resiliency

Pittsburgh has demonstrated a commitment to renewable energy and wants to use cleaner sources of energy because it is vital to creating a more sustainable city. Each year the City of Pittsburgh purchases 25% of its energy from renewable sources, which is enough to power 3500 homes per year. Renewable energy is generated from resources that are indefinitely replenished naturally: sunlight, wind, water,

hydrogen, biomass, and geothermal heat. In 2007, Pittsburgh signed the U.S. Mayors Climate Protection Agreement, committing to implementing local climate protection solutions which will result in reduced taxpayer dollars and energy use. Pittsburgh's first greenhouse gas inventory was undertaken to measures the amount of GHG emitted from various sources, which is useful to target actions having the most impact. Pittsburgh is already experiencing climate change effects with colder winters, and Pennsylvania can expect longer and hotter summers, decreased winter snowpack and increased rainfall. Pittsburgh will face local climate threats such as increased severe weather events and flooding, higher prices and shortage of basic goods, increased rate of illnesses and other heat-related health problems. Currently, Pittsburgh is in the process of developing its third climate action plan (PCAP 3.0) to create policies and projects to reduce greenhouse gas emissions within city limits to reduce the severity of regional impacts and move towards a low carbon economy [60]. Further, the city of Pittsburgh, affiliated agencies, and the Green Building Alliance have been working through their Green Garage Initiative to retrofit lighting to LED technology in city owned buildings. After retrofitting the city garages buildings in January, city garage buildings saw a reduction of approx. 60% cut in energy consumption and costs. Also, the city and partners are working towards developing a lighting infrastructure fund for other municipal and privately-owned garages. The city also encourages developers to use clean technology in their building designs through workshops and trainings code enhancements and design standards [61]. The draft of Pittsburgh's Climate Action Plan Version 3.0 was created to align with the Mayor's climate goal commitments in line with the Paris Accords, pledging to meet the 1.5 °C target [62]. This plan builds synergies and overlaps across the 6 key areas: energy generation & distribution, buildings & end use efficiency, transportation & land use, waste & resource recovery, food & agriculture, and urban ecosystems. Many actions relate to energy sources and usage are included in the first 3 key areas listed above, focusing on improved energy efficiency and increased fuel shift. Other 3 key areas focus more on waste reduction and proper resource management.

17.3.2.4 Citizen's Participation and E-governance

The city witnessed proliferation of volunteer groups and non-profit organizations throughout the region, representing strengthening of bottom up approaches in planning. A nonprofit business named Growth through Energy and Community Health (GTECH) spun off from Carnegie Mellon University, is planting sunflowers, switchgrass, and other vegetation on vacant lots throughout Pittsburgh for biofuel production [43].

17.4 Existing Challenges

Several challenges can be outlined in the Pittsburgh's efforts of economic transformation and brownfield redevelopment. One of them is related to the large-scale brownfield sites that still dominate the urban landscape of the region, and requires an enormous amount of financial resources for economic transformation. A city's tax base can never to sufficient to address these issues in a short span of time, and Pittsburgh needs to continuously re-invent and re-innovate it's strategies for brownfield redevelopment at the metropolitan scale. A majority of success stories are concentrated within the Center City that are in close proximity to the Universities, Research Centers, and Interstates; while the locations in the broader region farther away from the center-city are still struggling to comeback. Municipalities, such as Braddock, which are still struggling with issues of brownfields and vacant lots along with aging population and infrastructure, are adopting more right-sizing strategies and planning for shrinkage by converting abandoned properties into open and green spaces that can reduce the cost of maintenance and create a better living environment. However, this will remain a challenge for these communities to attract jobs and human capital in the short-term.

There are several challenges that Pittsburgh faces in urban greening and redevelopment of vacant land. These include funding, maintenance costs, accessibility, and poor design and site programming. In Pittsburgh, a greening forum identified legal issues such as liability, liens, and zoning, as well as a confusing system for the acquisition and reuse of vacant lots, as challenges to urban greening activities [43]. Most of the city-owned vacant lots have liens against them which could take several years to clear for sale and enable redevelopment of these sites. Therefore, Pittsburgh needs to rely more on interim measures such as Adopt-A-Lot to maintain and put them to productive use. Constraints in redeveloping these vacant properties include the dispersed nature of these properties, their variation in size, their title status, and that some of them have historic resource value or a historic designation. These sites also present a problem in land use planning and determining their future land use, but present opportunities and potential of shaping Pittsburgh's future urban form. Another barrier specific to Adopt-A-Lot program implementation is that since the program is often on derelict sites, the applicant must check for possible soil contamination, which requires a soil test. In case if lead content is higher than 1000 PPM, a new site must be selected by the applicant. Pittsburgh faces multiple challenges and constraints in implementing GI practices such as sites with steep slopes, clay soil, high-intensity rainfall, and space constraints. EPA has developed fact sheets and white papers to address these concerns and provide guidance on constrained sites: (1) *Challenges regarding space constraints*: Significant portion of future development in Pittsburgh is expected to be on previously developed sites (redevelopment) or within urban areas (infill), which presents opportunity to incorporate GI into urban areas [63]. However, incorporating green infrastructure into these areas on limited space may be challenging due to existence of buried utilities, mature trees, basements, buildings, and roads pose obstacles;

(2) *Challenges regarding steep slope*: The Pittsburgh area has a dramatic landscape dominated by steep hills and valleys [64]. Since many GI practices enhance infiltration of water into the soil, care must be taken when designing green infrastructure for the Pittsburgh area. Development is restricted on steep slopes, and according to most ordinances, lands with slope greater than 25% should be left undisturbed and roads are typically built with slopes of less than 5%. Many strategies are adopted to manage storm water at its source for slopes of up to 25%; (3) *Challenges with abundant and frequent rainfall*: Pittsburgh area receives 37–45 inches of rainfall per year, and combined with humid climate and frequent rain events, GI is sometimes considered inappropriate for the region. However, it receives most of its annual precipitation as small rain events of one inch or less, which implies that GI works very well with Pittsburgh's climate and rainfall pattern [65]; and (4) *Challenges regarding clay soils*: The region has clay soil which poses a challenge to GI practices, since clay allows little to no infiltration of water to the groundwater table [66]. This becomes even more challenging is when soil has been disturbed and compacted by construction as compacted soil results in very little infiltration and results in ponding [63–66]. However, in spite of these physical constraints, appropriate GI practices are working well in the Pittsburgh region.

In summary, the big challenges still confronted by many municipalities in Pittsburgh region are:

- Abandoned industrial sites
- Declining and aging population base
- Lack of skills and diversity among population base
- Lack of economic diversity
- Lack of advanced service sector jobs
- Urban dereliction and abandonment.

A few municipalities are witnessing economic and population growth with success in attracting Information Communications and Technology (ICT) firms, and other advanced service sector jobs, such as Cranberry, Wexford and others. However, the challenges are to distribute such growth at a regional scale, and to recognize the need for a region-wide planning effort that calls for co-operation and resource-sharing among the fragmented landscape of local governance within the region.

17.5 Future Visions and Conclusions

Rust belt cities such as Pittsburgh have particularly high rates of vacant industrial and residential lots, and thus need effective strategies to repurpose urban spaces and address the insidious nature of blight and abandonment [43]. Such strategies define Pittsburgh's smart city initiatives. Effective application of green infrastructure, and economic redevelopment strategies for vacant lands and brownfields demonstrates a

"right-sizing" model that is suitable for other similar shrinking cities in the American rust belt. However, there is a lack of strong regional-scale comprehensive strategies for smart management and monitoring of blight and abandoned, both for residential and industrial sites. While addressing challenges of small-scale abandoned and vacant lots require less financial and human resources, dealing with large-scale abandoned and vacant sites require stimulation of co-operation and planning efforts at the regional, state or even federal level.

The smart city strategy in Pittsburgh constitutes replacing vacant and abandoned properties both at large and small scales. The large-scale efforts involve public funding and multiple government agencies working with community organizations to transform brownfield sites into places of innovation district. The small-scale efforts involve strategies of urban greening and green infrastructure planning to convert surplus, blighted land into green space that costs less for the city to maintain. A green infrastructure network for shrinking cities involves the regeneration of vacant properties for new parks, community gardens, restored habitat, flood mitigation and storm water treatment sites, and urban agriculture plots linked with existing green spaces; and strongly emphasizes on community group participation and a bottom up approach of planning. Green infrastructure can be deployed to address a major economic and social consequences of a shrinking city, which is the decay and blight caused by vacant and abandoned properties. Pittsburgh is demonstrating that green infrastructure has the potential to strengthen the resiliency of the built environment while it transforms to adapt to the modern post-industrial context.

Nevertheless, Pittsburgh still needs to continue such efforts of right-sizing as a strategy to become smart and competitive in the New Economy. In doing so, the region should also place emphasis on the differential effects of smart city benefits across various racial and ethnic groups, gender and age groups, and educational levels of its population. Thus, the regional scale metropolitan planning in Pittsburgh needs to focus on the aspects of smart governance, which should be able to harness the collective efforts of public agencies, private organizations as well as local community groups. This transformation towards smart governance can ensure a common vision across municipalities, foster leadership in local communities, and lead towards more equitable access to resources and a sustainable future.

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