Berwyn Stormwater Management Plan Vulnerability Assessment

Introduction

Climate vulnerability refers to the degree to which a community is exposed to climate change, is sensitive to its impacts, and is able to adapt to those impacts.[1] This assessment explores climate-related hazards affecting stormwater issues in the City of Berwyn, as well as the community's projected future exposure to hazards and its adaptive capacity. Because of climate change's anticipated effect on precipitation, it is a highly relevant consideration in stormwater planning. The vulnerabilities identified in this report will help inform the Berwyn Stormwater Management Plan, which will identify a wide range of strategies for local implementers. This assessment focuses primarily on stormwater vulnerabilities, but provides information on other climate-related hazards as well.

This assessment was developed in partnership with the National Oceanic and Atmospheric Administration (NOAA), the American Planning Association (APA), and Illinois-Indiana Sea Grant, with the goal of identifying new ways to integrate climate science into the local planning process. The methodology and data sources used to develop this analysis will be compiled by the American Planning Association and integrated into a guidebook for local planners. The finding of the assessment will inform the recommendations of the Berwyn Stormwater Management Plan.

Key Findings

1. The Chicago region has been experiencing increases in annual precipitation and the number of very large storms. Climate models suggest that the region will see greater variation in annual precipitation, with wetter wet years and drier dry years. These models also suggest that a larger proportion of precipitation will fall during a small number of very large storms, rather than being distributed evenly throughout the year.

2. Urban flooding is a significant concern for Berwyn residents. Basement flooding—including sewer backups and groundwater seepage—is the most common form of flooding experienced by homeowners and renters across the City. Projected increases in precipitation and storm intensity will place increased strain on the combined sewer

[1] Intergovernmental Panel on Climate Change, 2007, "Synthesis Report," https://www.ipcc.ch/publications_and_data/ar4/syr/en/mains5-2.html.

system and continue to put vulnerable residents, businesses, and infrastructure at risk of flooding.

3. Because Berwyn is located far from a river or stream, many new residents are not aware of the risk for flooding in their community. Flood insurance policies do not always cover urban flooding. Homeowner rider policies can be purchased to cover sewer backups which are not covered by the National Flood Insurance Program (NFIP). Neither policy protect homeowners from damage caused by seepage.

4. Many Berwyn neighborhoods have high concentrations of households that are more vulnerable to economic and environmental hazards. Areas with high concentrations of low-income households and minority or limited English proficiency populations are often at a greater risk of experiencing serious social, economic, and environmental impacts from natural hazards.

Community Profile

Berwyn, Illinois is located in Cook County, within ten miles of downtown Chicago. It is known for its affordable Chicago-style bungalow homes, multi-modal transportation infrastructure, and a diversity of stores and restaurants. The City is home to a stretch of Historic Route 66, well-maintained parks, good schools, and an assortment of recreational and cultural institutions. Neighboring communities include Oak Park, Cicero, Stickney, Riverside, North Riverside, and Forest Park.

As of 2015, Berwyn has a growing population of 56,706. The City is a diverse, mixed-income community. Berwyn has a large Latino community that makes up 61.6 percent of its total population, a higher percentage of the population than in Cook County (24.7 percent) or the Chicago region (22.4 percent) as a whole. The City's median household income is $57,355, which is similar to that of Cook County ($55,251) and the region ($63,441). Berwyn's population is of a similar age to that of the county and the region, with a median age of 34.5 years, compared to 35.9 in Cook County and 36.5 in the region. More than one-third of Berwyn residents work in the City of Chicago.

From the early 1900s, Berwyn's appeal as a residential community has fueled its development. The numerous bungalows built in the first decades of the 20th century gave rise to Berwyn's nickname, the "City of Homes." Today, Berwyn is a dense, developed community that supports a variety of residential, commercial, industrial, and institutional land uses, served by three Metra stations, several Pace bus lines, and two nearby expressways. The City has undertaken several planning efforts in recent years, including partnerships with CMAP to develop a new comprehensive plan (2012), a capital improvement plan (2015), parking management plan (2016), and zoning ordinance (2017). Throughout these long-range planning projects, stormwater management has emerged as a major area of focus. Unlike some nearby communities, Berwyn is at little risk of flooding from rivers and streams. However, because the

City is flat, densely developed, and has little permeable surface, it is vulnerable to flooding from stormwater runoff.

Climate and Natural Hazards

The City of Berwyn has a continental climate characterized by hot, humid summers and cold, dry winters. Summer temperatures typically peak in July, with average daytime highs of 84 degrees Fahrenheit. Winter temperatures are lowest in January, when daily lows average 18 degrees Fahrenheit. Annual precipitation in the City averages 39.09 inches.[2] The City's proximity to Lake Michigan helps to moderate temperatures during both the summer and winter, while the large amount of impervious surfaces in Berwyn and surrounding communities increases local temperatures by an average of 5 degrees Fahrenheit.[3]

Severe storms, flooding, extreme heat, drought, heavy snowfall, and ice accumulation are the most commonly experienced natural hazards in the Berwyn area. The City's most recent federally declared disaster took place in April 2013. During a two-day period, 4.86 inches of rain fell on Berwyn and surrounding communities, prompting a major disaster declaration from President Obama.

Weather vs. Climate

The terms are sometimes confused, but weather and climate are quite different.

Weather refers to temporary atmospheric conditions, typically lasting a few hours or days. Thunderstorms, cold spells, heat waves, droughts, and blizzards are all examples of weather.

Climate refers to long-term atmospheric trends, typically measured by 30-year "normals." Climate is the sum total of many weather events, occurring over a long period of time.

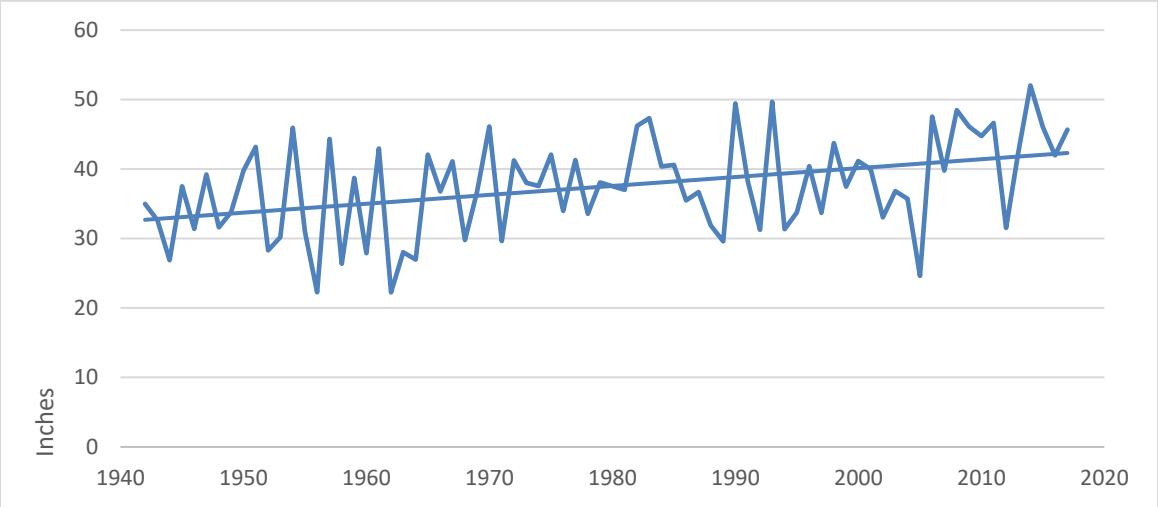
While it can be tempting to point to individual weather events as a sign that climate change is or is not happening, a single storm or heat wave is not a trend. Instead, climate scientists analyze records going back many decades to find evidence of long-term changes in weather patterns. These changing patterns may mean individual weather events are stronger, or more frequent, but individual weather events themselves do not constitute a change in climate.

Average annual temperatures in the Midwest have increased by 1.5 degrees Fahrenheit since 1900, resulting in warmer and more variable weather.[4] Because warmer air can hold more water vapor than cooler air, the temperature increase has resulted in a comparable increase in precipitation. Figure 1 shows annual precipitation at Midway International Airport (3 miles south of Berwyn), from 1942 to 2017. During this period, average annual precipitation has

[2] National Oceanic and Atmospheric Administration, Annual/Seasonal Normals, 1981-2010: Chicago Midwater Airport, IL US, https://www.ncdc.noaa.gov/cdo-web/datatools/normals.
[3] Chicago Metropolitan Agency for Planning, 2016, Climate Resilience Strategy Paper, http://www.cmap.illinois.gov/documents/10180/517388/Climate+Resilience+Strategy+Paper.pdf/dd610883-d00f-407d-808b-484f9800a3f6.
[4] National Climate Assessment, "Chapter 18: Midwest," https://nca2014.globalchange.gov/report/regions/midwest

steadily increased. Region-wide, northeastern Illinois has also seen an increase in the number of very large storms—those producing more than one inch of precipitation. This trend has been most noticeable during the last 30 years, which saw a 40 percent increase in storms producing one inch of precipitation compared to the previous 30-year period.[5]

Figure 1: Annual precipitation at Midway International Airport, 1942-2017



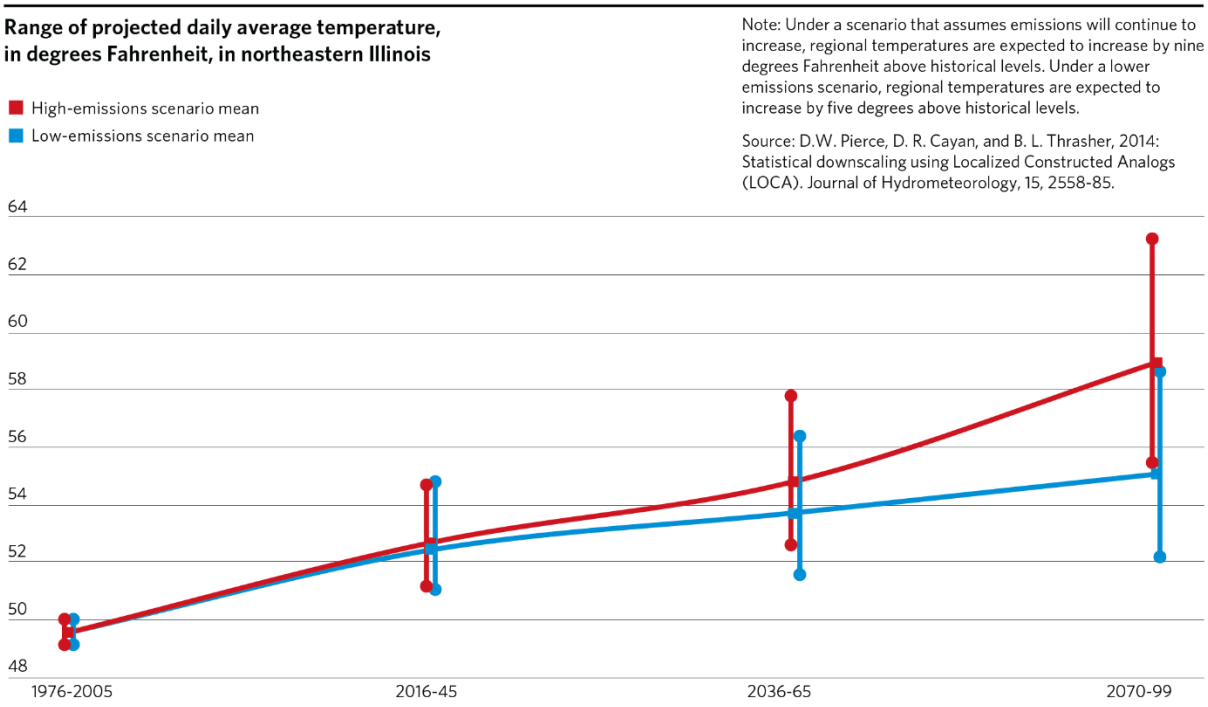
Source: National Centers for Environmental Information, "Global Summary of the Year Station Details," National Oceanic and Atmospheric Administration, https://www.ncdc.noaa.gov/cdo-web/datasets.

During the years to come, the region's warming trend is expected to continue and intensify. This warming trend is primarily due to increasing concentrations of greenhouse gases in the Earth's atmosphere.[6] To determine future climate conditions, scientists create models using greenhouse gas emissions scenarios. Generally, these models include a low-emissions scenario that assumes drastic reductions in global greenhouse gas emissions, and a high-emissions scenario that assumes emissions will continue to increase. These climate models predict the Chicago region could see temperature increases of between three and thirteen degrees Fahrenheit by the year 2100. Figure 2 shows the range of temperature change for high and low-emissions scenarios in the Chicago region.

[5] Illinois Department of Natural Resources, 2015, "Urban Flooding Awareness Act," https://www.dnr.illinois.gov/WaterResources/Documents/Final_UFAA_Report.pdf.

[6] Intergovernmental Panel on Climate Change, "Climate Change 2014: Synthesis Report," https://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full_wcover.pdf.

Figure 2: Temperature projections for the Chicago region, 1976-2099



These models also suggest the Chicago region—including Berwyn—will see greater variation in annual precipitation, with wetter wet years and drier dry years. By 2100, climate scientists project annual precipitation increases of between four to fourteen inches under a high-emissions scenario, and three to nine inches under a low-emissions scenario, with a considerable amount of variation between dry and wet years. These models also suggest that a larger proportion of precipitation will fall during a small number of very large storms, rather than being distributed evenly throughout the year.[7][8]

Flooding

The City of Berwyn is not located near a major waterway, and the entire City is outside of the 100-year regulatory floodplain.[9] Nonetheless, urban flooding is a major issue for residents, business owners, and other stakeholders. Urban flooding in Berwyn is generally caused by the City's dense development patterns and limited combined sewer capacity to manage the runoff generated during large or intense storms. Impervious surfaces created by rooftops, parking lots,

[7] Pierce, D. W., D. R. Cayan, and B. L. Thrasher, 2014: Statistical downscaling using Localized Constructed Analogs (LOCA). Journal of Hydrometeorology, 15, 2558-2585.

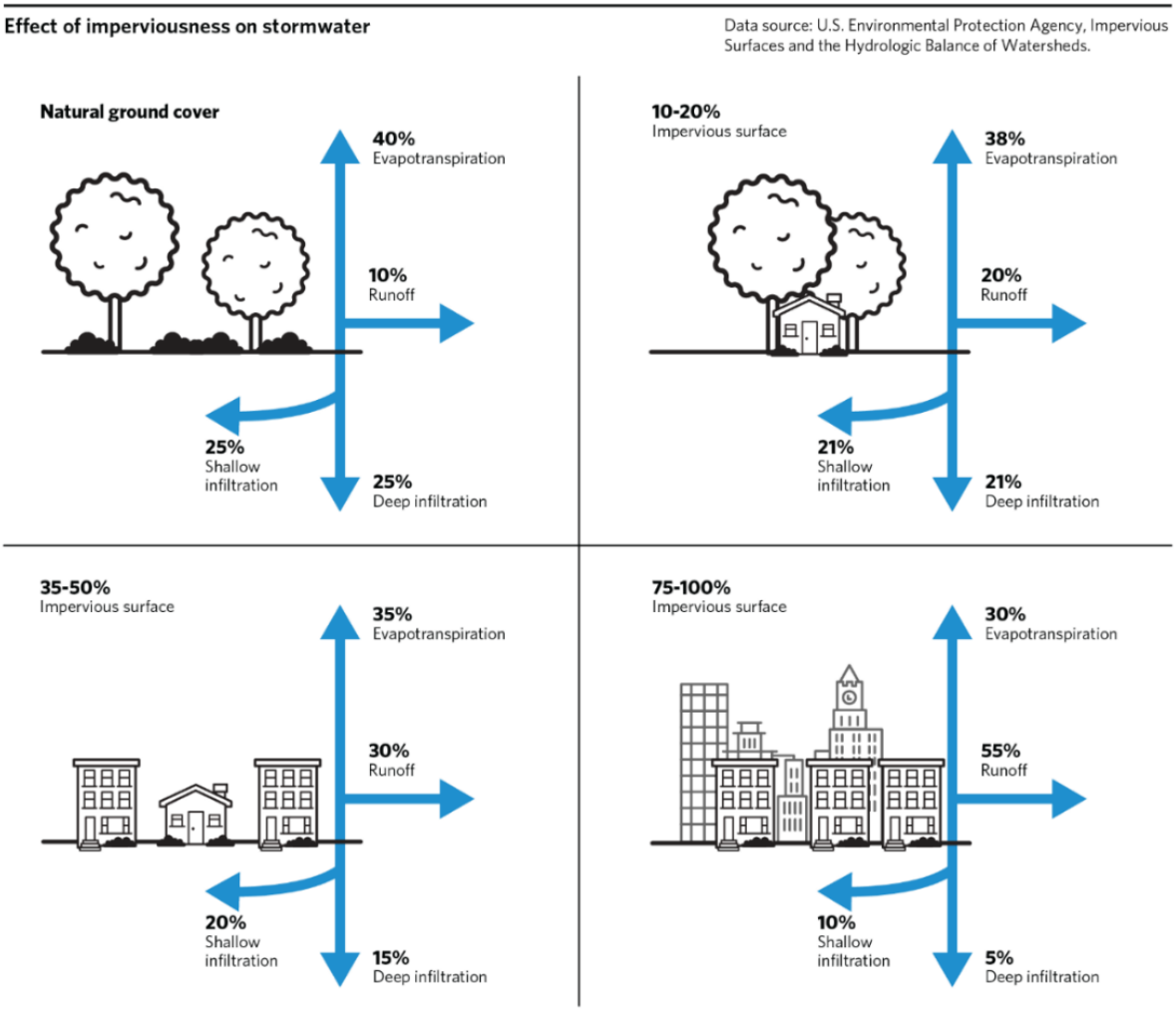
[8] Localized Constructed Analogs, U.S. Global Change Research Program, 2017: Localized Constructed Analogs (LOCA) designated scenarios for the Fourth National Climate Assessment. https://scenarios.globalchange.gov/

[9] The 100-year regulatory floodplain refers to areas near a river, stream, lake, or other waterway that have a one percent chance of experiencing a riverine or costal flood during a given year. These areas are identified by the Federal Emergency Management Agency (FEMA).

and streets increase the risk of urban flooding by preventing water from being absorbed into the soil and generating stormwater runoff (Figure 3). Basement seepage is a concern due to both high groundwater and poor drainage that causes runoff to pond against building foundations.

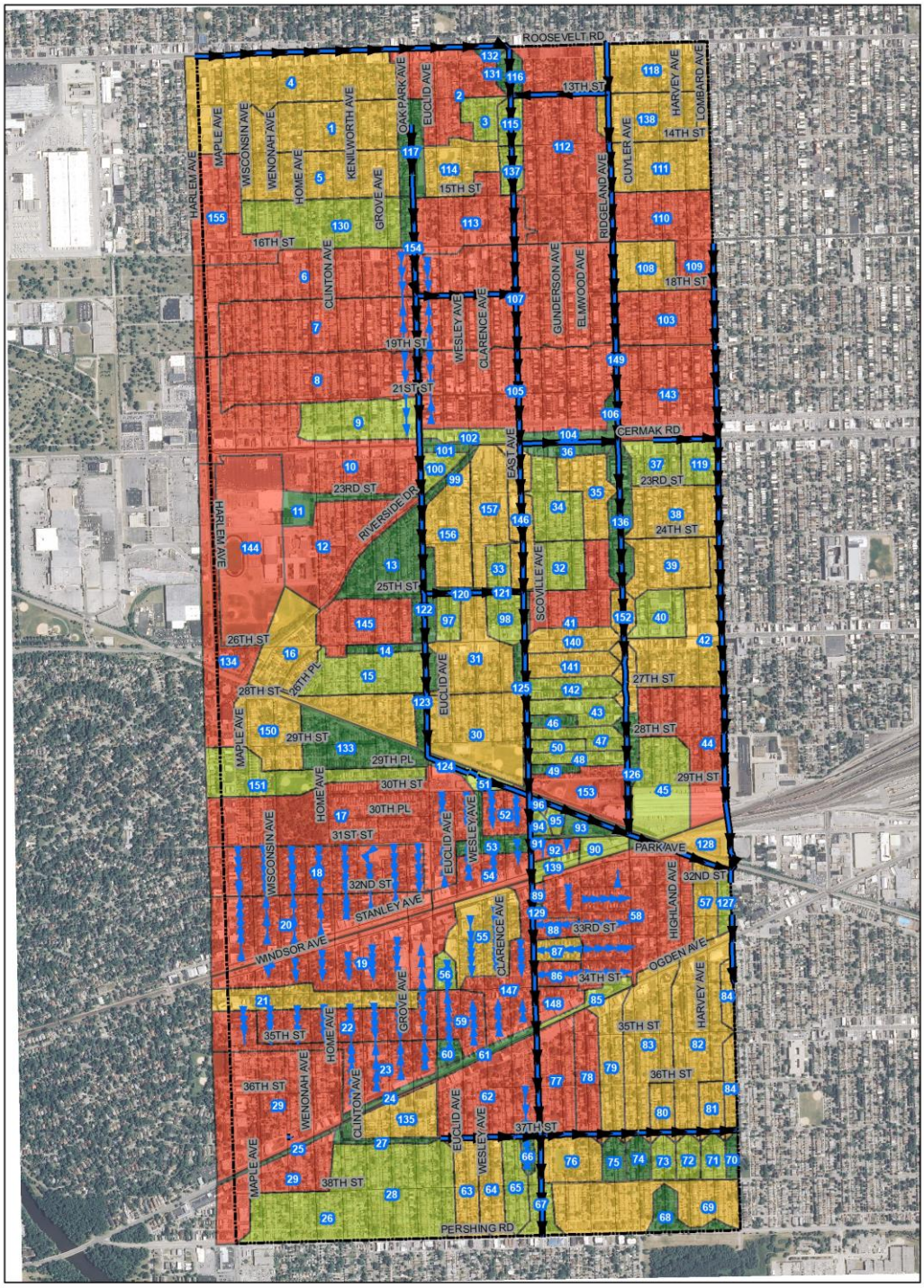
Berwyn is served by a combined sewer system that carries stormwater and sanitary sewage in a single pipe. Because of this dual function, the capacity of combined sewers can easily be exceeded during rainstorms, causing sewage and stormwater runoff to back up into basements and streets, and water to pond in low-lying areas, such as streets, parking lots, and yards. Another factor contributing to flooding in the community is the City's location at the downstream end of the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) interceptor system, which transports stormwater and wastewater from Berwyn and the surrounding communities to the MWRDGC Stickney Water Reclamation Plant. Due to the City's downstream location, the interceptor system often has limited capacity to convey runoff generated in Berwyn, which contributes to backups in the community. MWRDGCs' Tunnel and Reservoir Plan (TARP), which includes the McCook Reservoir, was designed to reduce the number of combined sewer overflows and reduce flooding in the MWRDGC service area. However, the limited capacity of local sewers and interceptors in Berwyn can limit the effectiveness of the TARP system to relieve flooding in the City.

Figure 3: Effect of impervious surfaces on stormwater runoff



To identify areas in Berwyn with the greatest exposure to flooding, CMAP worked with a consulting team to conduct a sewershed analysis. A sewershed refers to the area of land that drains into a particular sewer pipe. The team calculated the sewer pipe capacity for each sewershed to identify areas where the system has a greater likelihood of restricting flow during larger storms, resulting in sewer backups. The analysis also evaluated sewersheds based on whether they are served by small, shallow sewers in alleys that are prone to backups. The analysis combined the evaluation of these two flood risk factors to determine the sewersheds with the highest risk for flooding. Figure 4 illustrates the result of the analysis.

Figure 4: Results of flood risk analysis, by sewershed, in Berwyn



Scale: 0 500 1,000 Feet

Orientation:

Legend:
- Collector Sewer
- Alley Sewers
- Berwyn Limits
- 26 Sewershed ID

Sewershed Boundaries

Sewershed Flooding Risk
- 1 Lower Risk
- 2
- 3
- 4 Higher Risk

Project Name: Berwyn Stormwater Analysis

Prepared for: CMAP

Information about exhibit:

Exhibit Title: **Flood Risk Ranking** Figure: **3**

Project Number: 17-0256 Latest Revision: 6/4/2018

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Severe Storms

Severe storms, some capable of producing hail and strong winds, are common in Berwyn and the Greater Chicago area. The Cook County Hazard Mitigation Plan lists severe storms (excluding snow/ice) as the most significant hazard in the community, a reflection of the high probability and high impact of these events. Specific impacts of severe storms include flooding, blackouts due to downed power lines, damage and potential loss of life from lightning strikes, and transportation delays due to unsafe driving conditions.

In recent years, strong winds have caused damage to trees and structures in Berwyn on several occasions. In 2010, a microburst was responsible for downing approximately 50 trees, primarily in the public parkway. Replacing these trees—and those lost to the emerald ash borer—is an ongoing project.[10]

Other Hazards

Flooding and severe storms are the hazards most likely to have significant impacts on the City of Berwyn, and are the natural events that are most likely to influence stormwater planning. However, local business and residents also face a range of other climate-related hazards, including extreme heat, winter weather, and drought.

Extreme Heat

Due to the prevalence of impervious surfaces in the City of Berwyn and surrounding communities, the area experiences a significant urban heat island effect. This phenomenon occurs when impervious surfaces—including streets, parking lots, rooftops, and other paved surfaces—heat up during the day, and remain warm long into the night. In northeastern Illinois, areas with greater than 50 percent impervious coverage have been found to be five to six degrees warmer than the regional average.[11] In Berwyn, the effect is seen in the form of elevated temperatures on streets and sidewalks. During periods of persistent, extreme heat, as climate models project for the region's future, an increase of just a few degrees Fahrenheit significantly increases the risk of dehydration, heat stroke, and other health effects.

During the years to come, the Berwyn area is expected to see increases in both average annual temperatures and the number of very hot days—those over 90 degrees Fahrenheit. These changes will not only increase the risk of health impacts to sensitive populations, but may also affect local businesses that rely on pedestrian traffic, especially in areas with high amounts of imperviousness and little vegetation.

[10] Stakeholder interview, December 5, 2017.

[11] CMAP, "Climate Resilience Strategy Paper," http://www.cmap.illinois.gov/documents/10180/470714/Climate%20Resilience%20Strategy%20Paper/dd610883-d00f-407d-808b-484f9800a3f6.

Winter Weather
Snow, freezing rain, and extreme cold are all common in the Berwyn area. Recent climate models suggest the Chicago region will see higher average winter temperatures, causing more precipitation to fall as rain, rather than snow. However, these models also suggest the winter months will see an overall increase in precipitation, which will likely cause total snowfall levels to remain relatively constant during the decades to come.

As the climate continues to change, warmer winter temperatures may lead to more freeze-thaw events, which occur when the temperature of roadways and other infrastructure fluctuate between several degrees above to several degrees below the freezing point. Because materials expand and contract as temperatures change, the freeze-thaw cycle can cause stress on infrastructure and increase the likelihood of cracks, potholes, and fractures. Similarly, the area could see an increase in freezing rain, which is particularly damaging to transportation and energy transmission systems.

Drought
Although droughts are relatively common in Illinois (occurring roughly once every 16 years in Cook County), the City of Berwyn has only limited exposure the impacts of drought.[12] The City's access to Lake Michigan for drinking water insulates it from the impact of droughts on the water supply, and the lack of agriculture and natural spaces in the area means that its demand for water during drought conditions does not increase as dramatically. Nonetheless, drought and drought-like conditions are expected to become more frequent during the years to come, especially during the summer and fall.

Vulnerability and Risk Assessment

The City of Berwyn faces a range of natural hazards, including several that are expected to become more frequent and more powerful during the years to come. Understanding the community's vulnerability to these hazards—in addition to the level of exposure—is a crucial step for preparing a comprehensive approach to reducing the impact of climate change.

The following section of this report assesses the vulnerability of Berwyn residents, businesses, and infrastructure to observed and projected hazards. The assessment considers both the likelihood of an event and the severity of the impacts caused by the event to gain a better understanding of the area's true vulnerability.

In many cases, the community can address these vulnerabilities through proactive planning and incremental investments. In some cases, collaborative approaches involving neighboring municipalities and several levels of government may be necessary.

[12] Cook County Multi-Hazar Mitigation Plan, Cook County, September 10, 2015, https://www.cookcountyhomelandsecurity.org/sites/default/files/Cook_County_HMP.pdf.

Critical Infrastructure

Streets, railroads, sidewalks, power lines, trees, and other vegetation are critical for sustaining a high quality of life in the City of Berwyn. Because of their prominent role in the function of the City, these assets have a high level of exposure to natural hazards, and will face significant challenges as the climate continues to change.

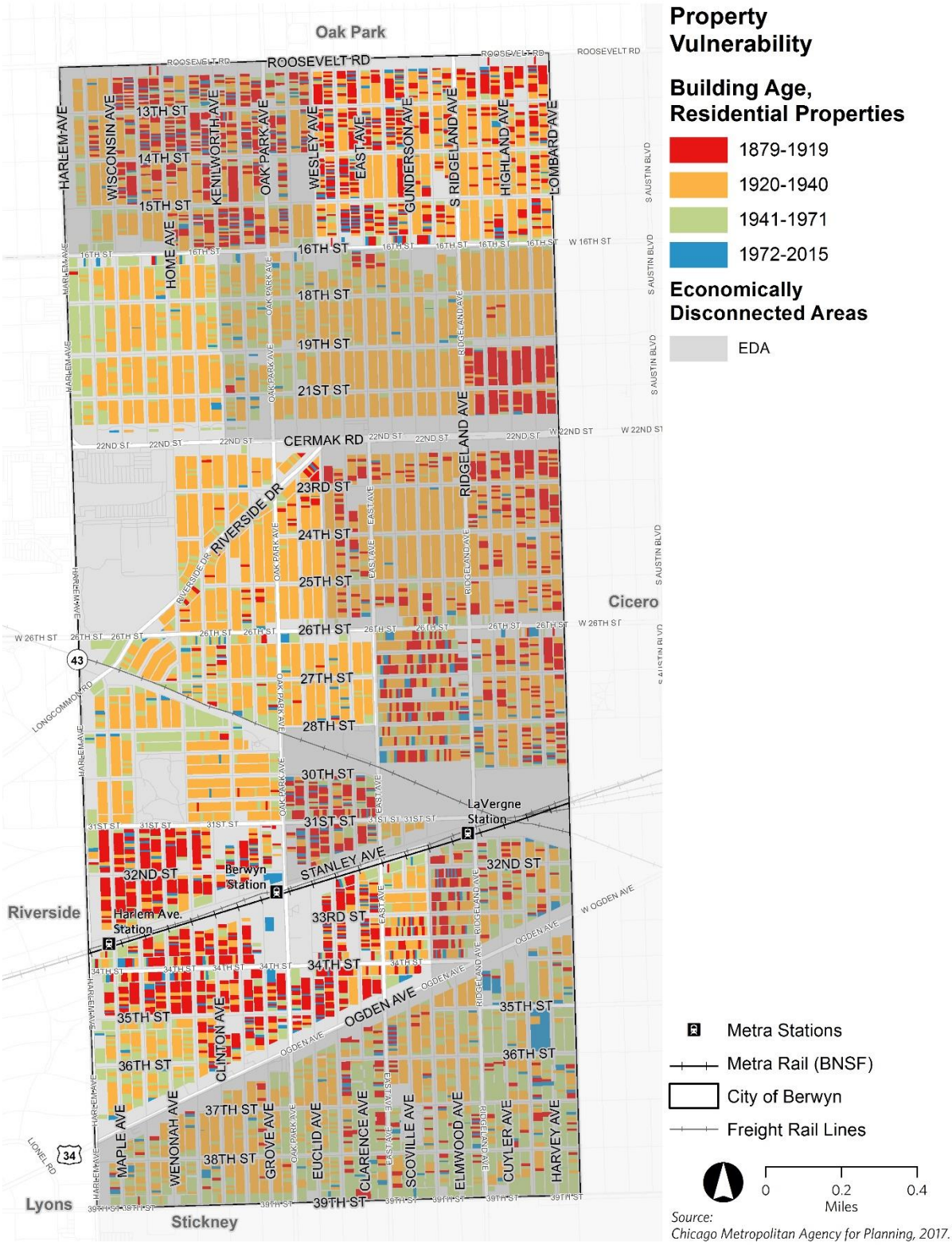
Private property

Homes, businesses, and automobiles are all susceptible to damage from flooding and other natural hazards. Due to the prevalence of sewer backups and groundwater seepage, buildings with a basement are the most vulnerable to damages during periods of heavy rain or snowmelt. Basement backups and seepage occur based on a variety of property, building, and sewer system conditions and can vary from block to block and house to house. Basement backups are less likely to occur in buildings with overhead sewers or a flood control device, such as backflow prevention. Buildings with disconnected downspouts also have a reduced risk of experiencing a backup, due to their ability to divert rainwater away from the sewer and into lawns, flowerbeds, and rain gardens, thereby reducing rainwater volume within the sewer system.

While location is a key indicator of flood risk, there are several general risk factors including building age and land use that can be used to identify higher-risk properties. Figure 5 illustrates residential building age in Berwyn classified into four ranges. Newer buildings, especially those built after 1972, are more likely to feature flood-mitigating features, such as overhead sewers and watertight foundations. Older buildings, on the other hand, are less likely to have these improvements, and often feature porous limestone foundations, rather than cement foundations, which are more common today. This is especially true for buildings built before 1920.

Socioeconomic factors also play a large role in a household's vulnerability to flooding. To identify residents who may have a higher vulnerability to environmental, social, and economic hardships, CMAP has mapped Economically Disconnected Areas, or EDAs (Figure 5). Generally, these areas have high concentrations of residents living in poverty and minority or low-English proficiency households. While these factors do not make an area more likely to flood, they are key indicators for a household's ability to prepare for and recover from a natural hazard, which has important implication for the vulnerability of private property. Economically Disconnected Areas are discussed at greater length on page 19: Social Vulnerability.

Figure 5: Building age in Berwyn



While all basement flooding is disruptive, the effects of flooding are felt most acutely when the basement is used as a living space, rather than storage or recreation. Figure 6 shows the current, registered use of basements in the City of Berwyn and EDAs. When reviewing this data, it is important to note that, while it is the most current and accurate information available, it likely undercounts the number of basement dwelling units. As shown in this map, basement apartments are found throughout Berwyn, but have the greatest concentrations in the north central and south central parts of the City. Most basement apartments are located in buildings built before 1972, though some may have been retrofitted with overhead sewers or other flood control devices.

Figure 6: Basement use in Berwyn

Because Berwyn is located far from a river or stream, many new residents are not aware of the risk for flooding in their community and may not have an insurance policy that covers damages. Flood damages are not covered by most homeowners and renters insurance policies. Instead, residents must purchase insurance through the National Flood Insurance Program (for overland flooding), or as a rider on an existing policy (to cover sewer backups). Neither policy protect homeowners from damage caused by seepage, which is considered to be a maintenance issue. As a result, homeowners, property owners, and renters often have to cover the cost of flood damages themselves. One exception is during federally declared disasters, such as the April 2013 flood. During these types of events, residents may be eligible for grants and loans from the federal government, but this aid is only available under very specific conditions.

Streets, roads, rail, and sidewalks

Streets, roads, rails, sidewalks, and other forms of transportation infrastructure are vulnerable to flooding, extreme heat, extreme cold, and winter weather. In the Berwyn area, transportation infrastructure—especially roads and parking lots—also contribute to flooding and the urban heat island effect because of their large concentrations of impervious surfaces. Pavement and railways are susceptible to buckling during periods of extreme heat, although the occurrence is rare. More commonly, streets, parking lots, and other paved surfaces develop cracks and potholes due to freeze-thaw events, which are expected to become more frequent as winters become warmer.

In addition to higher maintenance costs, natural hazards affect transportation systems by increasing travel times. Nearly 84 percent of Berwyn residents commute to work by car (alone or carpool). When inclement weather forces road closures, or merely increases travel time, these residents may have difficulty accessing work. While data covering other personal trips is not available, it is likely that a similar percentage of the community relies on automobiles for meeting day-to-day needs, such as grocery shopping, accessing childcare, and medical visits.

Street flooding and ponding is most common on Oak Park Avenue and East Avenue, where the streets pass under the railroad viaduct. During heavy rains, these low-lying underpasses sometimes accumulate water that could make the streets impassible. Physical damage from ponding in these areas is rare, but it does disrupt the flow of traffic and increase travel times.

Critical Facilities and Emergency Services

Critical facilities are physical assets that provide services or functions that are essential to a community, especially during and after a natural hazard.[13] Such facilities include fires stations, hospitals, nursing homes, and wastewater treatment plants. Schools, libraries, and community centers also serve critical roles. Often these facilities require uninterrupted access to basic

[13] Federal Emergency Management Agency, "Critical Facilities and Higher Standards Fact Sheet" https://www.fema.gov/media-library-data/1436818953164-4f8f6fc191d26a924f67911c5eaa6848/FPM_1_Page_CriticalFacilities.pdf

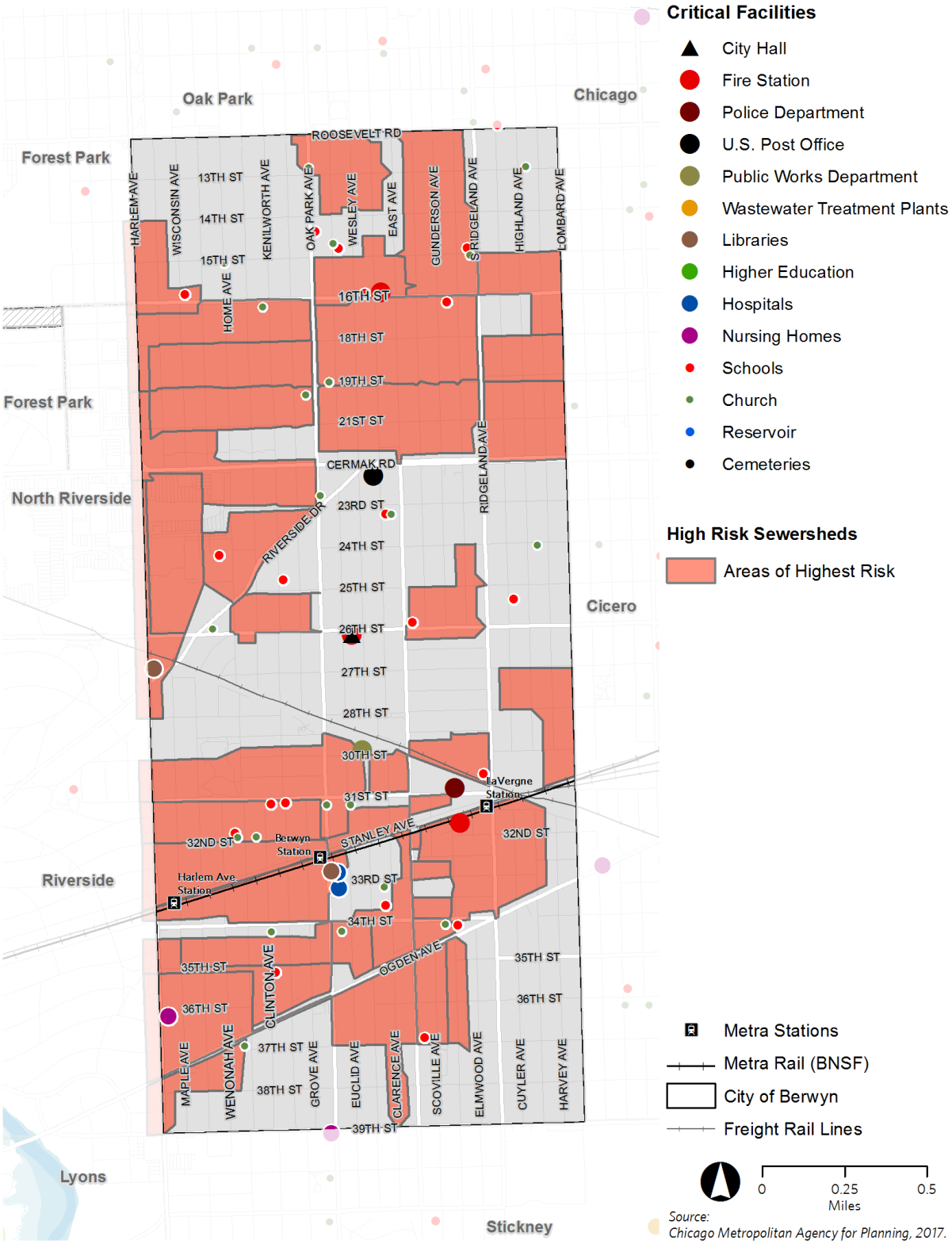
utilities—power, water, communications, etc.—to ensure supporting systems and equipment remain in operation. A comprehensive understanding of a community's critical facilities and local assets can help the community assess infrastructural and social vulnerabilities as well as prioritize which assets are in greatest need of protection.

The City of Berwyn has a wide range of critical facilities, which are vulnerable to natural hazards to varying degrees. Figure 7 identifies the location of critical facilities in the City of Berwyn in relation to sewersheds with a high risk for flooding (see Figure 4). Several of these facilities are at risk for impacts from stormwater and other hazards. These facilities include two fire stations, a nursing home, and several schools. The age of the City's schools make them particularly vulnerable to urban flooding. Many of these buildings are older with basements that are susceptible to seepage, and some of which are used as classrooms. In recent years, sump pump, detention systems, and other flood control improvements have been successfully used to mitigate flood risk, but as climate change intensifies, these challenges may return.

The City of Berwyn operates three fire stations, each covering approximately one third of the community. In total, the department employs 80 professional firefighters, 30 paramedics, and 3 EMTS. The City also participates in the Mutual Aid Box Alarm System (Division 11), which ensures help will arrive from surrounding communities if Berwyn-based emergency first responders are unavailable or require additional assistance.

The even distribution of emergency services in the City, as well as Berwyn's street grid and participation in mutual aid agreements, mean that residents are unlikely to be isolated from emergency services, even during and after severe weather events. The only significant interruption in the City's street grid is caused by the two railroads that cross through town. In some areas, the railroad has grade crossing that block auto and pedestrian traffic, especially during rush hour. In other areas, the train right of way blocks the street entirely, creating a dead end. Nonetheless, the City's proximity to numerous hospitals and medical centers further ensures that first responders will have quick access to emergency health care.

Figure 7: Critical facilities and sewershed flooding risk in Berwyn



Water supply

The City of Berwyn receives its water from Lake Michigan, via the City of Chicago. Because of the large size of Lake Michigan, and careful regulations under a United States Supreme Court Decree, communities with access to water supply drawn from the lake water are relatively resilient to the effects of seasonal and annual droughts. Nonetheless, as groundwater supplies in the region experience more pressure, competition for Lake Michigan water may become more intense, leading to higher rates for customers, and creating a greater urgency for infrastructure projects aimed at reducing water loss through leaking pipes.

Energy

Electricity in the City of Berwyn is provided by Commonwealth Edison (ComEd), and is transmitted by overhead and underground wires. In areas with overhead wires, strong winds and freezing rain can knock down transmission lines, leading to local power outages. This is a particularly serious concern in areas that have concentrations of dead trees. To reduce the risk of outages from downed trees, the City has been proactive in removing ash tress affected by the emerald ash borer. The City's power transmission system is also vulnerable to flood damages. During the April 2013 floods, a ComEd substation in neighboring Forest Park was inundated, resulting in service disruptions in Berwyn.

Power outages, even those lasting just a few hours, may seriously affect sensitive populations, including senior citizens, infants, and residents with disabilities. The risk of adverse health effects during blackouts is greatest during extreme heat and extreme cold. To mitigate the risk of health-related impacts from extreme temperatures, the City of Berwyn operates five warming and cooling centers, including two—the Berwyn Police Department and the Fire Department on 16th Street—that are open 24 hours a day, 7 days a week.[14]

Nicor Gas provides natural gas for residents and business in the City of Berwyn. Because most natural gas infrastructure is underground, it is generally more resilient to the effects of extreme weather than electricity. In many cases, natural gas can also provide backup electricity during a power outage through natural gas generators that automatically activate when the primary electricity source interrupted.[15] Individual natural gas systems may, however, be vulnerable to damage during floods, especially if a home's gas meter or gas-powered appliances are submerged. If this occurs, Nicor Gas may shut off service to the affected area until Nicor personnel are able to inspect the site and confirm it is safe to resume service.[16]

Green infrastructure and open space

The City of Berwyn is home to a number of parks that provide important recreational opportunities. These open spaces, in combination with the City's larger urban forest, also

[14] Berwyn Police Department, Cooling/Warming Centers," http://www.berwynpd.com/general_information/cooling__warming_centers.

[15] Nicor Gas, "Generators," https://www.nicorgas.com/residential/appliances/generators.

[16] Nicor Gas, "Flood Fact Sheet," https://nicorgas.com/-/media/Files/NicorGas/PDF/16400_NG_Flood_factsheet.pdf.

provide important ecosystem services, including stormwater management, heat and noise reduction, and air purification.

Natural hazards, such as flooding and extreme heat, and long-term changes in the local climate, such as warmer winters and more variable weather, can reduce the ability of these natural amenities to provide ecosystem services. The arrival of the emerald ash borer in 2008 greatly reduced the City's tree canopy, and continued climate changes may allow new invasive (and non-invasive) species to establish themselves in Berwyn and the surrounding area.

Replacing trees lost to the emerald ash borer is a top priority for many communities in the Chicago region, but in some cases, residents may oppose the installation of new trees in their front yard or parkway due to concerns about roots clogging sewer pipes. Generally, tree roots do not directly damage pipes, but if a pipe is already damaged (due to age, faulty connections, or other causes) roots may enter the pipes, causing a clog. Often, this threat can be mitigated by ensuring all pipes are in good condition, that the tree is well mulched and has ample room for healthy roots near the surface, and by avoiding certain fast-growing wetland species. At the neighborhood and city level, a healthy urban canopy is a critically important asset for reducing the risk of flooding and alleviating the urban heat island effect.

Flooding is currently an issue in Proska Park, and it is likely that additional open spaces will experience comparable challenges during the coming years. Park space is particularly scarce in northern Berwyn, and if new parks are added, through land acquisitions or redevelopment projects, designing these spaces to provide stormwater management functions, in additional to recreational space, may be crucial.

Social vulnerability

Natural hazards do not affect everyone in the same way or to the same degree. The capacity of a community or an individual to prepare for and recover from a natural hazard is often correlated with key social, demographic, and economic factors. Identifying these groups is critical for development an inclusive strategy for addressing natural hazards.

Community and health

Climate change and related natural hazards typically have the most severe impacts in areas already experience economic, social, and environmental challenges. Often these communities not only have limited capacity to prepare for and recover from natural hazards, but also have the highest level of exposure to their effects. In Cook County, low-income neighborhoods account for a higher portion of reported flood damages than more affluent areas,[17] and region

[17] Center for Neighborhood Technology, "The Prevalence and Cost of Urban Flooding: A Case Study of Cook County, IL. https://www.cnt.org/sites/default/files/publications/CNT_PrevalenceAndCostOfUrbanFlooding2014.pdf.

wide, the top 10% hottest census tracts by land surface temperature tend to be disproportionately low-income, minority, and limited-English speaking.[18]

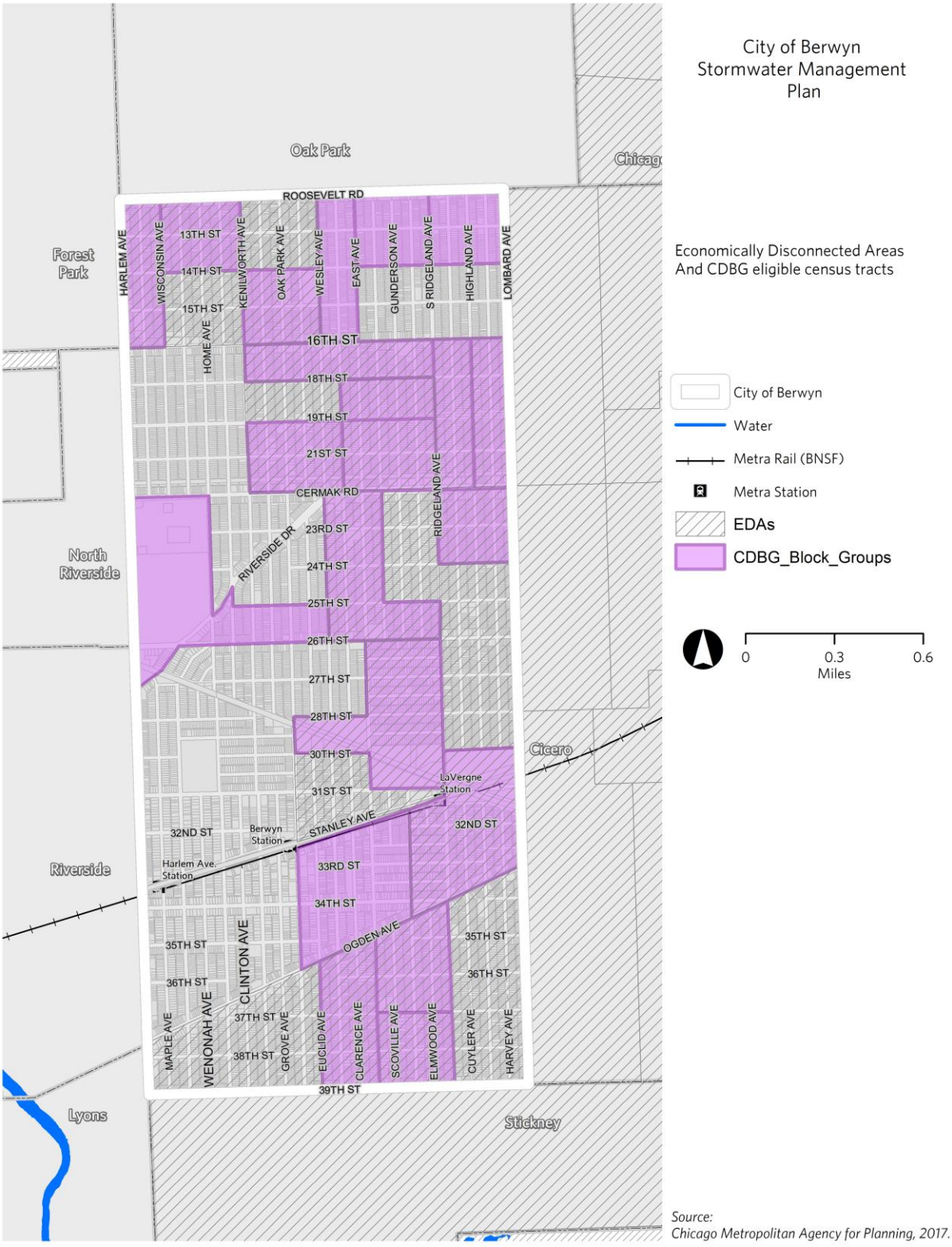
To help plan for these areas, CMAP has created a map of Economically Disconnected Areas (EDAs) that identifies census tracts with large concentrations of low-income and minority or limited English proficiency households in the Chicago region. Figure 8 shows CMAP-identified Economically Disconnected Areas and Community Development Block Grant (CDBG) eligible census tracts in the City of Berwyn. The EDAs layer is an important input for a range of local planning activities, including hazard mitigation and disaster recovery plans. The CDBG program provides federal funding for affordable housing, economic development, infrastructure, and other anti-poverty programs. These funds may be an important tool for addressing the unique challenges facing Economically Disconnected Areas.

Over half of the City of Berwyn is located in an area identified as an EDA, including several areas that are at high risk of flooding and have clusters of older buildings or basement apartments (Figures 5 and 6). Because these areas are statistically more likely to be severely affected by flooding and other natural hazards, they should be given additional consideration for stormwater management projects, including green infrastructure interventions. Elderly, disabled, and very young residents also have an elevated risk of being disproportionately affected by natural hazards, but the Economically Disconnected Areas map does not identify these population groups.

People living in basement apartments have a significantly higher level of exposure to urban flooding than those who live in ground floor apartments. This high level of exposure can be exacerbated by other socioeconomic factors, such as those highlighted in Figure 8. Low-income residents may have a hard time paying for flood improvements and after experiencing a flood, may have a harder time replacing damaged property. Minority and limited-English speaking residents, especially recent immigrants, may have difficulty accessing mitigation and recovery services.

[18] Chicago Metropolitan Agency for Planning, "Climate Resilience Strategy Paper," http://www.cmap.illinois.gov/documents/10180/517388/Climate+Resilience+Strategy+Paper.pdf/dd610883-d00f-407d-808b-484f9800a3f6.

Figure 8: Economically Disconnected Areas and CDBG eligible census tracts in Berwyn



Municipal capacity

The City of Berwyn has a high-functioning government that provides quality services for businesses and residents. In recent years, the City has collaborated with CMAP to conduct a number of plans, including a comprehensive plan, capital improvement plan, parking study, and zoning code update. The City has also made investments and obtained grant funding to improve stormwater management through gray and green infrastructure projects in alleys, the Depot District, and Proksa Park to name a few.

Like many communities in the Chicago region, the scale of flood-related challenges paired with the ongoing need to maintain and rehabilitate aging sewer infrastructure requires significant resources and investment from all units of government, as well as private property owners. The Stormwater Management Plan will identify future steps the City should take to further mitigate flood risk, including establishing sustainable streams of funding, continuing regional partnerships, and coordinating investments.

Economic impacts

Natural hazards are more than inconveniences. The damages, travel delays, and business closures they produce have very real effects on the local and regional economies. These impacts can be difficult to fully measure. In many cases, these impacts can be mitigated or avoided by cost effective solutions, such as green infrastructure interventions, or simply having an emergency preparedness plan.

Travel delays and disruptions

For most severe weather events, traffic delays and disruptions are the most common impact. Nationwide, up to 70 percent of all winter storm-related injuries occur in auto crashes, and 22 percent of all crashes nationwide are weather related.[19,20] Because flooding in Berwyn is caused by ponding and sewer backups rather than rivers, there is low risk of drivers being washed away when crossing flooded streets (a leading cause of flood-related deaths in the United States), but flooded streets still create dangerous driving conditions by increasing stopping distances, reducing visibility, and creating conditions that cause hydroplaning.

Road closures and travel delays reduce the ability of residents and visitors to participate in the economy. Workers may lose wages, and businesses, especially those reliant on non-local customers, may experiences revenue losses. In both of these cases, the City is affected by lost tax revenue.

[19]Will County, "County-Wide All Hazard Mitigation Plan," https://www.plainfield-il.org/pages/documents/2013WillCountyAHMP_10-19-14.pdf.

[20] Federal Highway Administration, "How Do Weather Events Impact Roads?" U.S. Department of Transportation, https://ops.fhwa.dot.gov/weather/q1_roadimpact.htm.

Business closures and lost revenue

Most commercial properties in Berwyn either do not have a basement, or do not rely on their basement for day-to-day operations. As a result, flooding in commercial areas is typically a nuisance, rather than an emergency. Nonetheless, flooding and other natural hazards can negatively impact businesses and the economy in significant ways.

Business closures, even those lasting a few hours or days, can have significant impacts on the economy. Short-term closures, typically due to snow and ice accumulation, roadway flooding, or power outages, are most common and may result in budget shortfalls for local residents. Long-term closures are most commonly associated with large storm events. According to the Federal Emergency Management Agency (FEMA) 40 to 60 percent of small businesses that are forced to close due to a flood never reopen their doors.[21] This is a problem not only for the business owner, but also for employees and residents who rely on City services supported by tax revenue.

Weakened market

For many Berwyn residents, home ownership is an important investment. Flooding, especially basement flooding, can reduce the value of a home, and ultimately, affect the finances of the household. For rental properties, including commercial buildings, recurrent flooding may have a similar impact.

These challenges are not unique to Berwyn. Flooding and other hazards affect homes and businesses throughout the region and beyond. This presents the City of Berwyn with a unique opportunity to use flood mitigation strategies, such as its successful shared cost program, to not only preserve current home values, but to provide the City and its residents with a competitive advantage for years to come. Several non-flood-related hazards such as extreme heat and severe storms may also affect life in Berwyn, but will likely not have significant impacts on local markets, as these events are less predictable and more regional in nature.

Looking forward

The analysis contained within this report will inform the recommendations presented in the Berwyn Stormwater Management Plan. Specially, the Plan will recommend strategies related to local policy and regulations, flood control assistance for residents, green and gray infrastructure improvements, system maintenance and monitoring, and education and outreach. To ensure improvements provide the greatest return on investment, the City should prioritize them in areas that have the greatest exposure to flooding and provide special consideration to those areas facing social vulnerability. Additionally, implementation of these strategies should emphasize not only the ability of green infrastructure to reduce flooding, but also the various co-benefits of these tools, including a reduction of the urban heat island effect, improved air quality, reduced noise pollution, and expanded habitat for insects, birds, and other animals.

[21] FEMA, "Make Your Business Resilient," https://www.fema.gov/media-library/assets/images/116921.