

# CITY OF DETROIT GRATIOT/HARPER DEVELOPMENT PROJECT

by

Bingqing Han, Ihsan Akhtar, Jillian Morissette, Zhongyi Zhang, Ziyi Chen

A Master's Project submitted in partial fulfillment of the requirements  
for the degrees of  
Master of Science & Master of Landscape Architecture  
University of Michigan  
School for Environment and Sustainability

**MAY 2024**

Advisor: Dr. Mark Lindquist, ASLA, PhD





# ABSTRACT

---

This project proposes a development plan framework for a Detroit project site which aims to address three main objectives. These objectives are to protect and improve community members' quality of life and health, to enhance stormwater management, city services and ecosystem health in the region, with a focus on mitigating the flooding, improving transportation, and to provide opportunities for potential economic growth. An additional content deliverable was created as well. This deliverable aims to address watershed health, providing recommendations for native plantings and other ecological components that will greatly improve the quality of the project sites' encompassing watershed and existing landscape. Several policies, programs and funding initiatives have also been identified that aim to cover climate justice, environmental justice and community revitalization efforts through green actions. In order to best mitigate issues in these focus areas, the team has compiled extensive GIS analyses, community research and data related to all three areas of focus. In addition to an in depth analysis, a well constructed literature review was completed to enhance the qualitative data previously collected. Overall, this project has created an extensive development plan that will aid the City in revitalizing and improving the chosen community area.

# ACKNOWLEDGEMENTS

---

We would like to give a special thanks to Dr. Mark Lindquist, our faculty advisor, for lending a helping hand and providing us with excellent advice, encouragement and support during our capstone experience.

We would also like to extend our gratitude to several others who have helped make this project possible:

Khalil Ligon, Lead Urban Planner for the City of Detroit  
City of Detroit's Planning and Development Department

The Detroit Water and Sewage Department & Detroit Department of Transportation  
Department of Neighborhoods, City Council 3rd District, Friends of the City Airport, Detroit Economic Growth Corporation, Detroit Eastside  
Community Collaborative, the Connor Creek Greenway, Keep Growing Detroit

Faculty members from the University of Michigan's School for Environment & Sustainability:  
Prof. Runzi Wang & Prof. Andrew Gronewold  
University of Michigan PhD candidates: Chen Zuo & Shuying Liu

Lastly, we would like to thank our friends and family members for their continued support and encouragement throughout this capstone process. We also extend gratitude to the many plant and animal species that reside within our project site and surrounding community.

# CONTENTS

<b>1</b>	<b>INTRODUCTION</b>	1	<b>5</b>	<b>COMMUNITY ENGAGEMENT</b>	99
<b>2</b>	<b>CONTEXT &amp; ANALYSIS</b> Site & Social Context Spatial Analysis	3	<b>6</b>	<b>CONCLUSION</b>	105
<b>3</b>	<b>CASE STUDIES</b>	47		<b>APPENDICES</b> Watershed & Native Plantings Stormwater Infrastructure Capacity	
<b>4</b>	<b>DESIGN &amp; RECOMMENDATIONS</b> Stormwater Management Transportation & Streetscape Commercial & Mixed-Use Development Policy Recommendations Funding Sources	50		<b>BIBLIOGRAPHY</b>	

# 1

# INTRODUCTION

Detroit was once synonymous with American innovation and manufacturing prowess, particularly in the automotive sector. The “Motor City” witnessed prosperity during the early 20th century that was driven by the rapid expansion of the auto industry, which attracted workers from across the nation and the world, contributing to a peak population of over 1.8 million in the 1950s.

However, starting in the 1960s, Detroit began to experience a decline precipitated by a confluence of factors. The consolidation and relocation of manufacturing plants, increased automation replacing human labor, and competition from foreign automakers led to significant job losses. Racial tensions and the subsequent 1967 riots further exacerbated outmigration, and the city’s population declined through the second half of the twentieth century, reducing its tax base and limiting the funds available for investment in infrastructure and services which in turn spurred. This decline continued into the 21st century, culminating in Detroit filing for bankruptcy in 2013, the largest U.S. city ever to do so.

Despite these challenges, the 21st century has seen pockets of resurgence within Detroit, particularly in the Downtown, Midtown, and New Center neighborhoods. These areas have benefited from concentrated investments, attracting businesses, entertainment venues, and residential development. Unfortunately, this revitalization has not been evenly spread throughout the city. Many districts, especially those distant from these hubs of activity, remain neglected, with residents facing the enduring realities of blight and lack of services.

Adding to these socio-economic challenges are environmental concerns, particularly the city’s capacity for stormwater management. Detroit’s legacy infrastructure, designed primarily for an industrial past, struggles to cope with the combined sewer overflows (CSOs), where stormwater and domestic wastewater share the same pipes. During heavy rainfalls, this system can become overwhelmed, leading to flooding and potential public health risks as untreated sewage is discharged into waterways.

Our project site is situated adjacent to the Coleman A. Young International Airport and encompasses the area within Gratiot and Harper Avenues. The majority of the site consists of residential zones, including the Wade, Ravendale, and Airport Sub neighborhoods. In the vicinity of the Gratiot and Harper Avenue intersection, there are commercial spaces, some of which are currently abandoned and overgrown, or otherwise vacant concrete surfaces. In partnership with the UM SEAS Sustainability Clinic and the City of Detroit Planning and Development Department, we will focus on the 672-acre Gratiot and Harper Area, to develop a feasible, sustainable plan to guide future development of the region for the benefit of the community and the environment.

Taking Detroit’s Strategic Neighborhood Framework Plans as a guidance we will focus on the City’s three most urgent concerns regarding the region: stormwater management, neighborhood revitalization, transportation and streetscape. We plan to incorporate the concept of 20-minute neighborhoods and integrated management to approach the issues and provide solutions in a systematic, sustainable way that builds and can be maintained on social and cultural capital within the area. By proposing a development plan, we want to provide a strategy that addresses these objectives:

- To protect and improve community members’ quality of life and health.
- To enhance stormwater management, city services and ecosystem health in the region, with a focus on mitigating the flooding at the intersection of Harper and Barrett.
- To provide opportunities for potential economic growth.

We would like to have a comprehensive understanding of the site, current issues, notably flooding issues, community needs and wants through site visit, secondary research, surveys and stakeholder engagement. Then we will analyze the data and conduct case studies to guide design. In each step of preliminary design and master planning, continued engagement efforts will seek involvement and feedback from the community, organizations and the City through focus group meetings or interviews. The deliverables will be presented in an easily understandable form to the community.

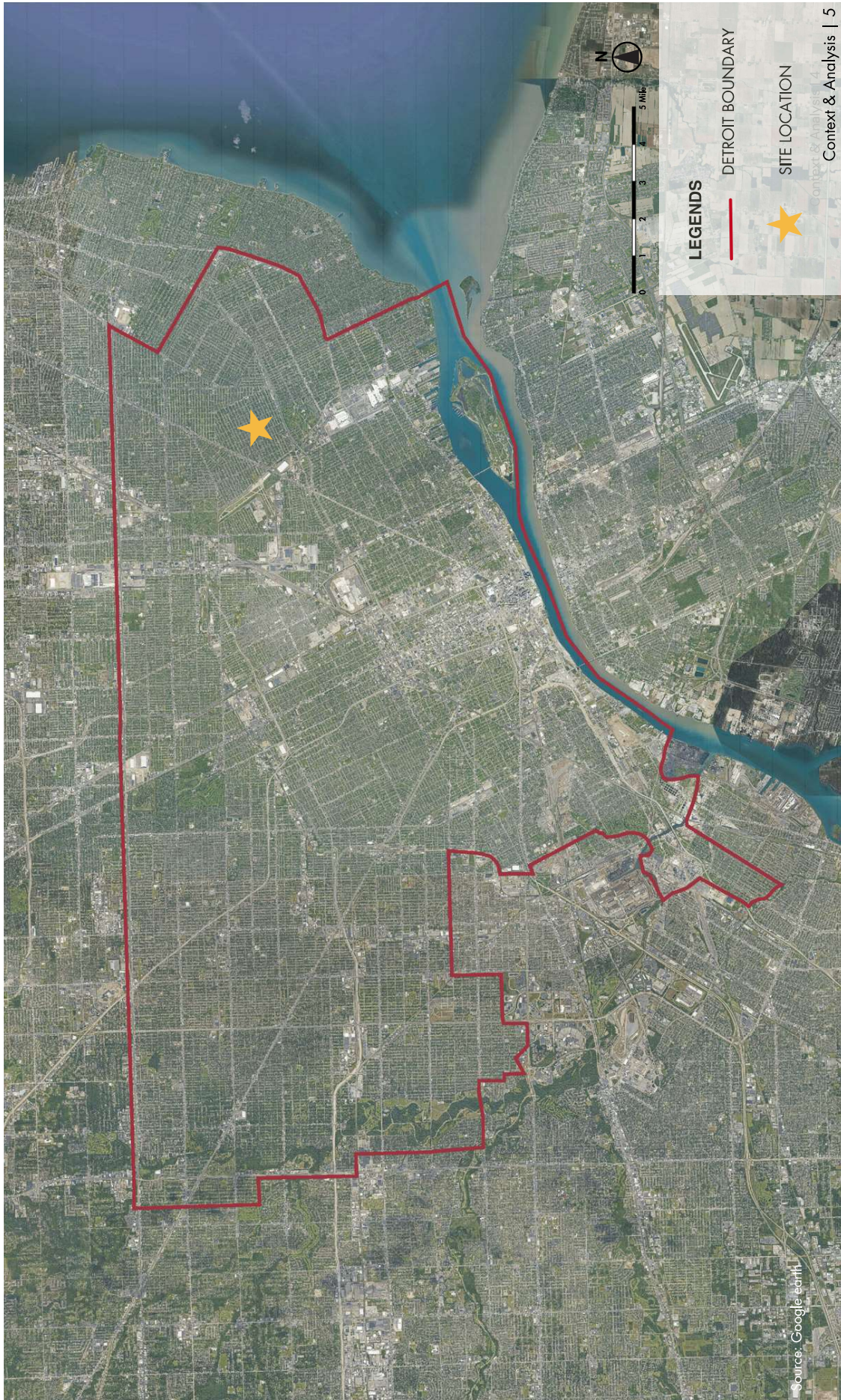
# 2

## CONTEXT & ANALYSIS

SITE CONTEXT | SOCIAL CONTEXT | STORMWATER MANAGEMENT | TRANSPORTATION & STREETSCAPE | COMMERCIAL & MIXED-USE DEVELOPMENT

# SITE CONTEXT





Source: Google Earth

**LEGENDS**

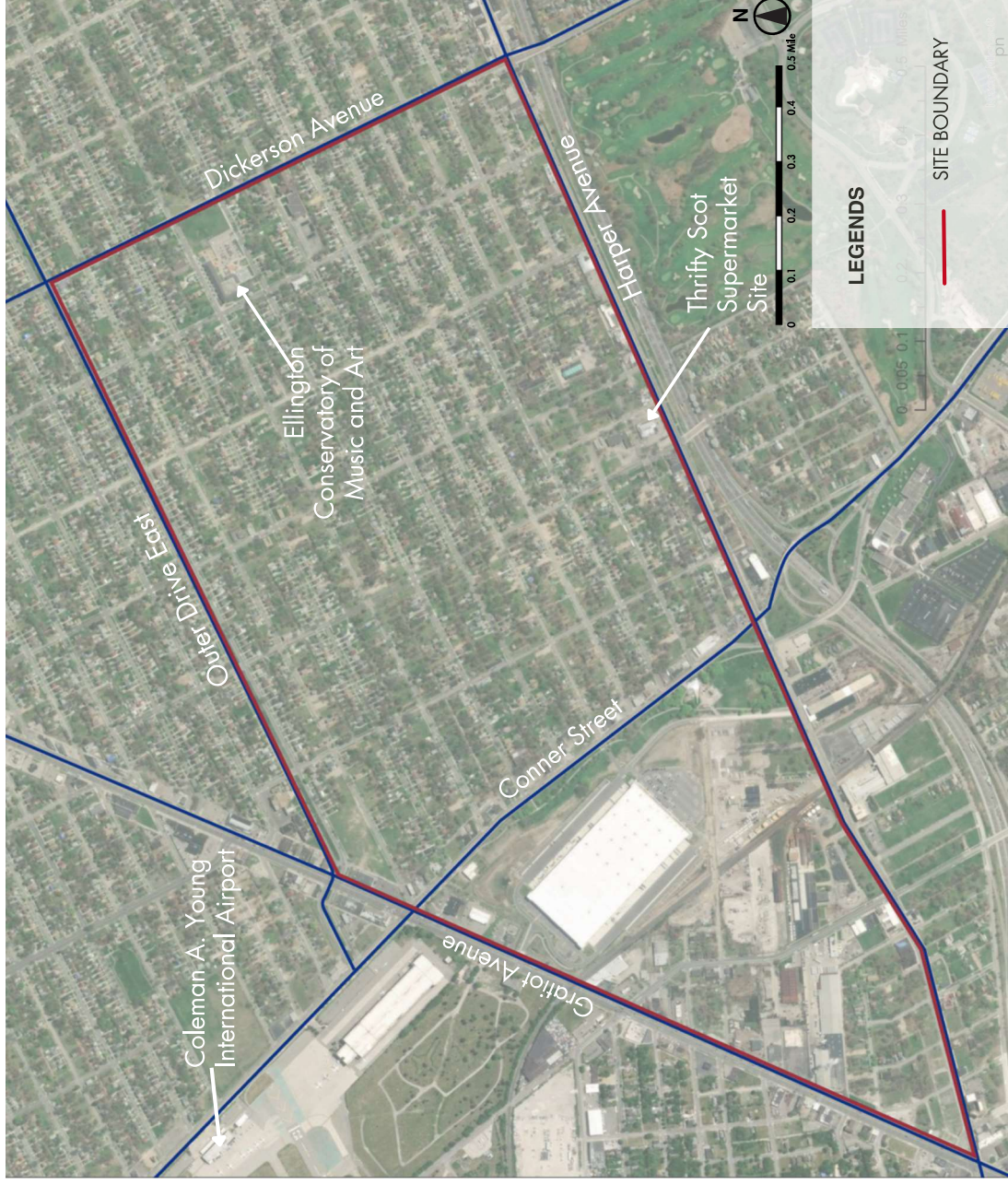
— DETROIT BOUNDARY

★ SITE LOCATION



## SITE OVERVIEW

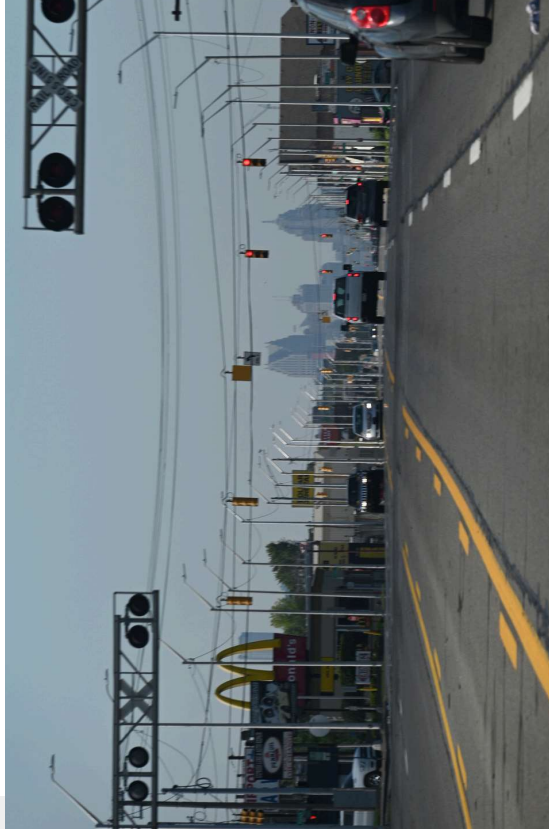
Covering a total area of 672 acres, this region predominantly comprises of residential zones, fostering communities within its boundaries. The neighborhoods within this expanse include Wade, Ravendale, and Airport Sub, each contributing to the diverse fabric of the area. It also covers commercial areas along Gratiot Avenue and Harper Avenue, as well as industrial areas at the West-East part of the site.



Source: ArcGIS Map



SITE VISUALS FROM SEPTEMBER SITE VISIT



# SOCIAL CONTEXT

## Introduction

This section details social and cultural characteristics as well as site-specific analyses. Through the use of geospatial analysis and mapping, the team was able to provide an extensive review of the site's problem areas. We also conducted a site visit in September of 2023, to get a better understanding of the project sites existing built environment and vegetation. In order to combat these issues, the team created detailed designs and renderings for specific areas within our project site.

The culture of Detroit is a rich tapestry woven from its diverse history, vibrant arts scene and resilient spirit. From the Motown sounds that revolutionized music to its legendary automotive past, Detroit embodies a blend of creativity, innovation and tenacity. The city's architecture reflects its industrial past, with iconic landmarks like the Michigan Central Station standing as symbols of both decay and renewal. Detroit's cultural institutions such as the Detroit Institute of Arts and the Charles H. Wright Museum of African American History, celebrate its cultural diversity and showcase the contributions of its residents. Beyond its historical significance, Detroit's contemporary culture thrives through its culinary scene, grassroots community initiatives and passion for sports. Overall, Detroit's culture is a dynamic fusion of tradition and reinvention continually evolving while honoring its roots.

The Ellington Conservatory of Music and Art in our project site, stands as a hub of cultural enrichment and community development in the heart of the city. Founded with the vision of fostering artistic talent and nurturing creative expression, the conservatory offers a comprehensive curriculum in music and fine arts education to students ages K-8 and backgrounds. Beyond its role as an educational institution, the conservatory serves as a catalyst for urban revitalization and neighborhood regeneration. In order to tie in this respect for the arts, we incorporated the use of public open canvas space in our reimagined Thrifty Scot Supermarket plan. Through collaboration between residents and artists, public canvas spaces become catalysts for positive change, sparking dialogue, fostering creativity, and enhancing the overall livability and vibrancy of neighborhoods.

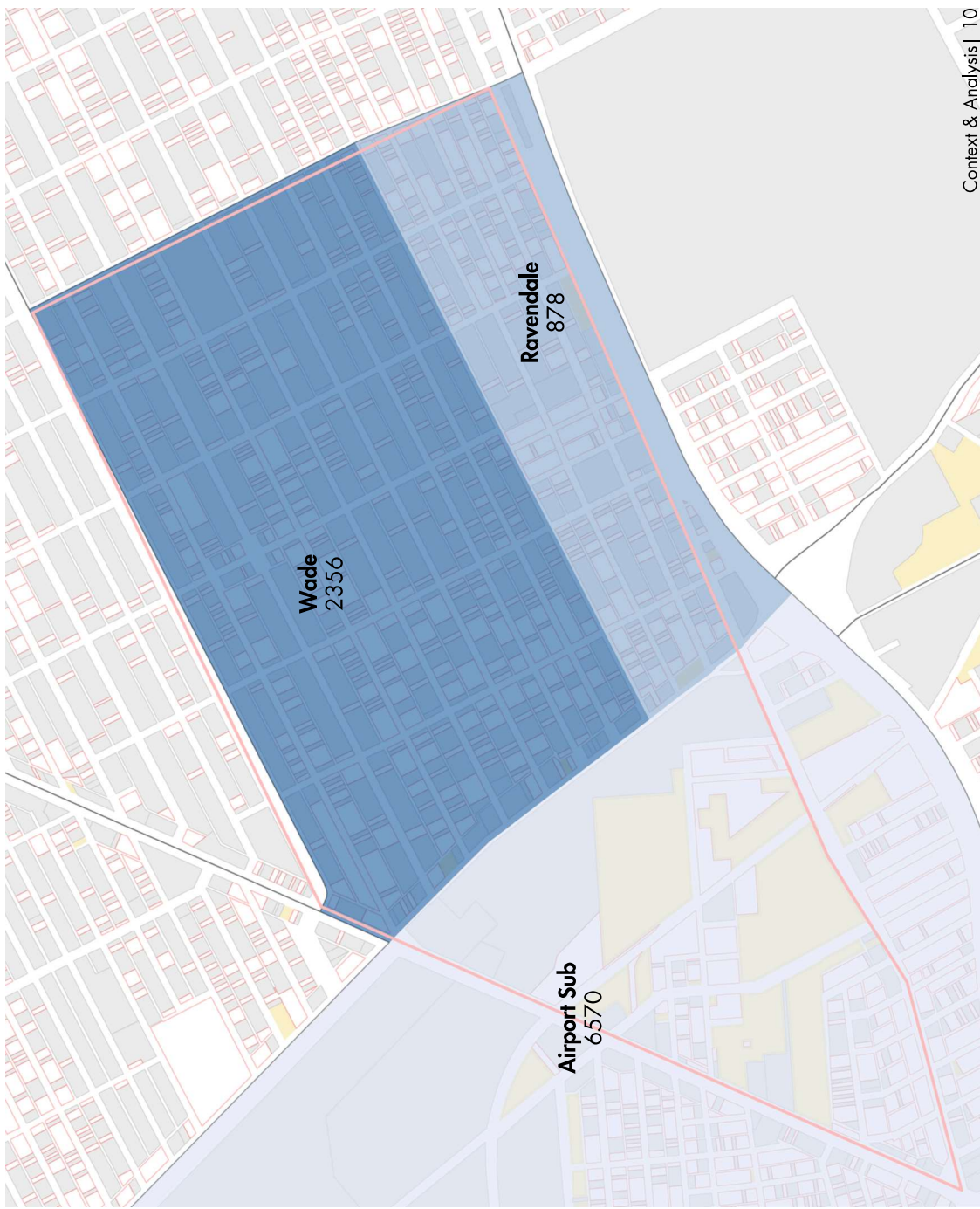
In order to gain a better understanding of the residents who live in our project site, we conducted a demographics analysis. These analyses include information related to population, age, race, income and crime.



Image Source: Detroit Historical Society

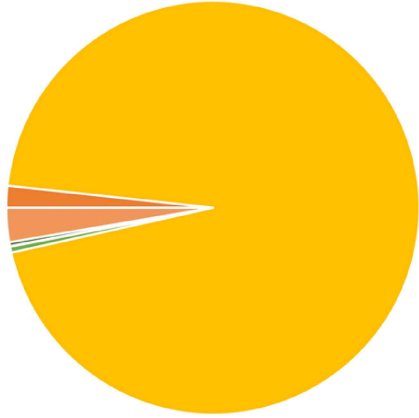


**POPULATION**

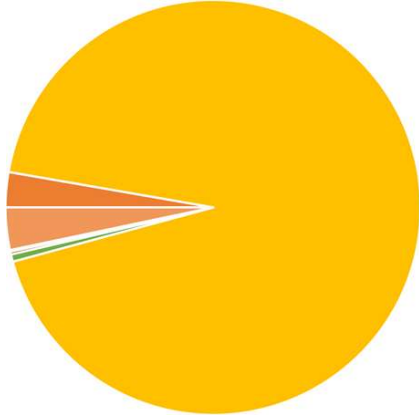


Source: SimplyAnalytics & US Census Bureau -  
American Community Survey and Puerto Rico  
Community Survey

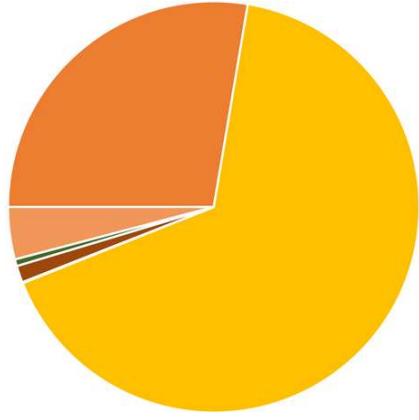
**RACE OF EACH  
NEIGHBORHOOD**



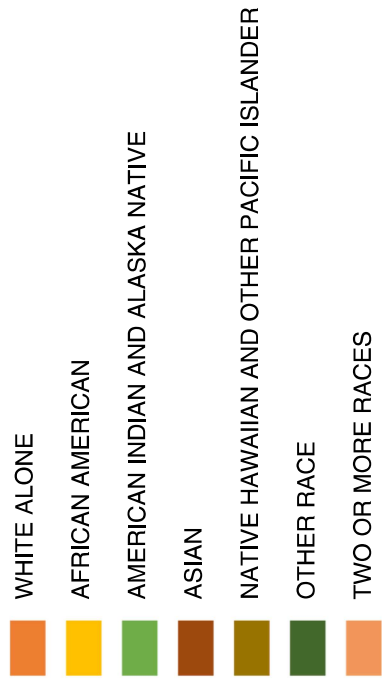
WADE



RAVENDALE

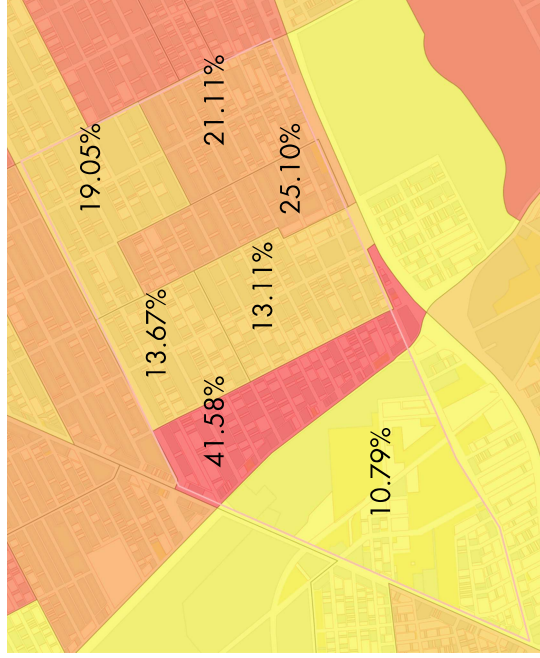


AIRPORT SUB

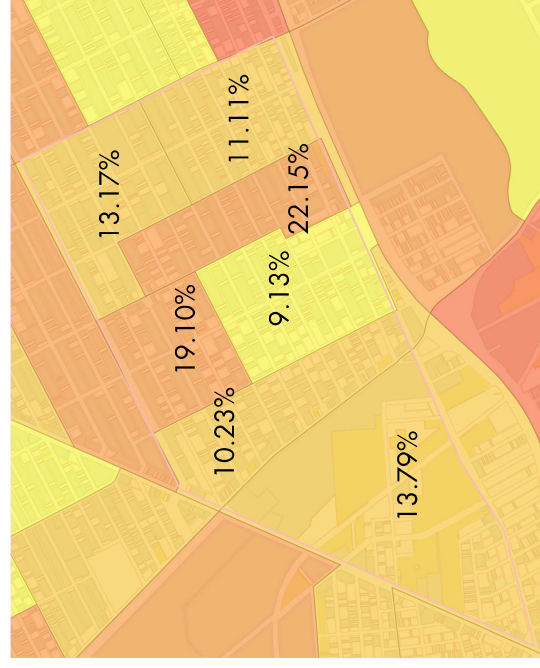


Source: SimplyAnalytics & US Census Bureau -  
American Community Survey and Puerto Rico  
Community Survey

## AGE



POPULATION UNDER 20 YEARS OLD



POPULATION OVER 65 YEARS OLD

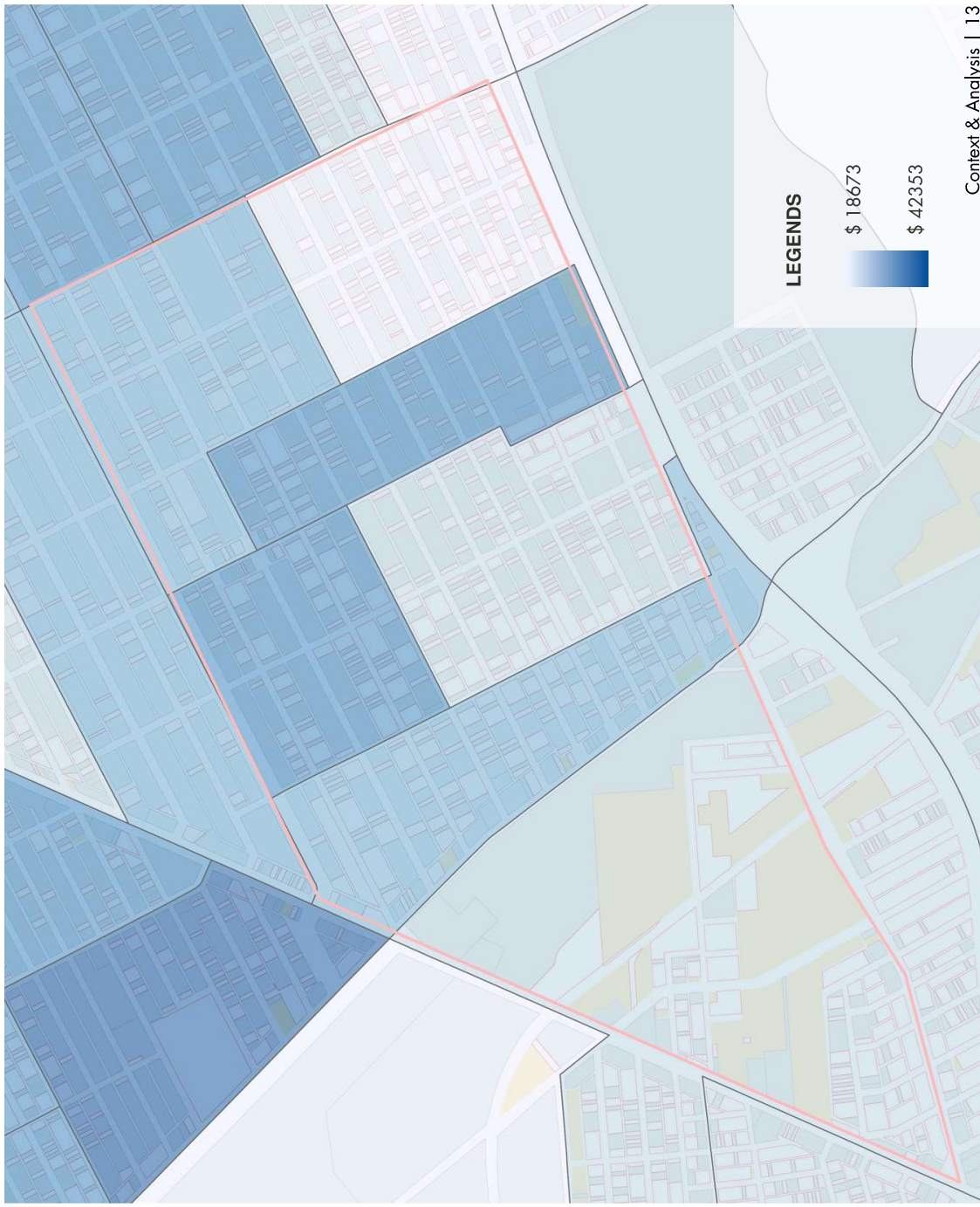
Source: SimplyAnalytics & US Census Bureau - American Community Survey and Puerto Rico Community Survey



## MEDIAN HOUSEHOLD INCOME

The median household income here is relatively low compared to other neighborhoods in Detroit, which profoundly impacts the overall development and socioeconomic health of the community. This situation also makes these neighborhood less attractive to potential investors and residents, leading to an increase of vacant land.

Source: SimplyAnalytics & US Census Bureau - American Community Survey and Puerto Rico Community Survey





## CRIME INCIDENTS

Crime is also a serious problem in these neighborhoods. Crime incidents happen almost everywhere on the project site. Over 250 crime incidents have occurred on Harper Avenue since 2017; most of them being theft and robbery. High crime rates result in a low median household income, which may contribute to an increase in crime. Our plan aims to change the situation and create a safer, more vibrant, and sustainable community.

Source: The Detroit Police Department's Records Management System (RMS)



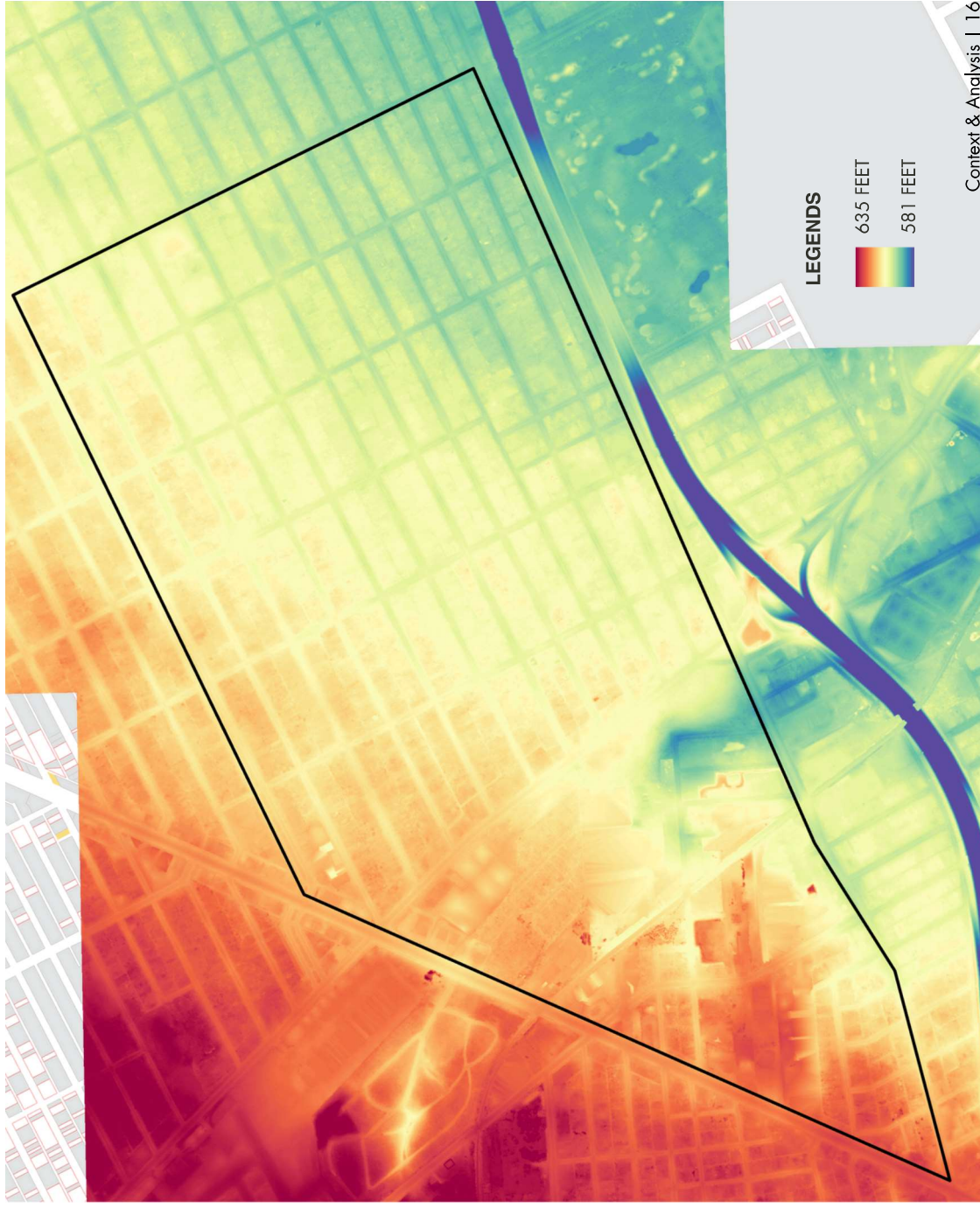
# STORMWATER MANAGEMENT

## ELEVATION

Given the flooding issues on site, it is presumed the cause is precipitation trapped on the ground, as there are no large aboveground bodies of water in the vicinity.

The elevation analysis indicates that the site is generally lower on the southeast side while the northwest side is at a higher elevation.

Source: SEMCOG





## WATERFLOW

Initial speculation suggested that flooding occurred in topographic depressions. However, hydrology analysis revealed no such depressions in the terrain, indicating that water should flow unimpeded over the ground.

The likely cause was identified as sewer overflow, a hypothesis later confirmed by our client.



### LEGENDS

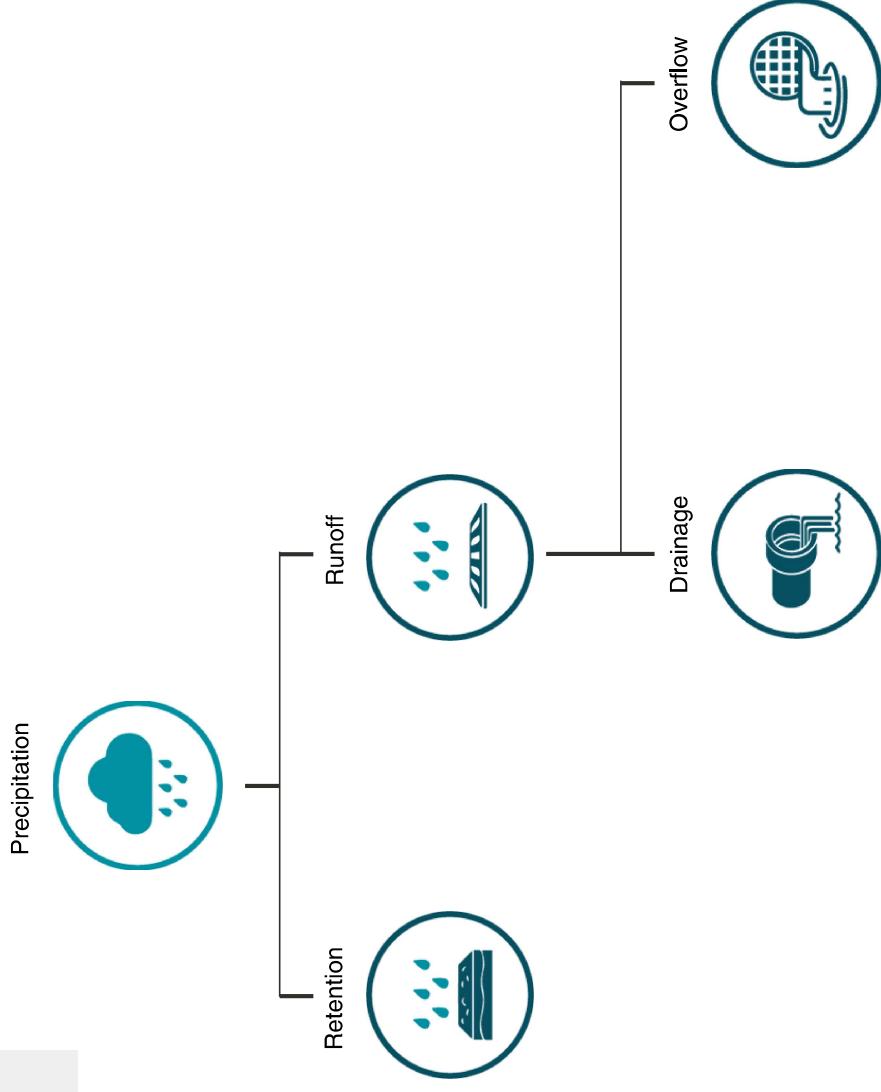
— WATERFLOW

→ FLOW DIRECTION

## OVERFLOW ANALYSIS METHODOLOGY

When precipitation falls, the land absorbs and retains water up to its infiltration capacity. Excess stormwater becomes runoff, which flows away from the area. In urban settings, this runoff is channeled into the drainage system. When runoff exceeds the sewer system's capacity, the remaining water overflows, leading to flooding (R. Wang, C. Zuo, S. Liu, personal communication, 2023, September 12; C. Zuo, personal communication, 2024, January 16).

Determining the location and quantity of overflow requires data on precipitation levels, runoff volume, and the drainage system's capacity.

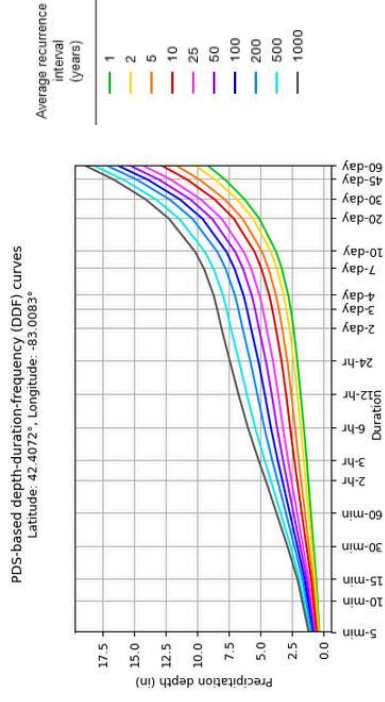


## PRECIPITATION

Fortunately, the National Oceanic and Atmospheric Administration (NOAA) operates a weather station approximately 3,000 feet from our site boundary. We will utilize the precipitation and storm event data recorded by this station.



Name: Detroit, Michigan, USA \*  
Station name: DETROIT CITY AP  
Site ID: 20-2102  
Latitude: 42.4072°  
Longitude: -83.0083°  
Elevation: 625 ft



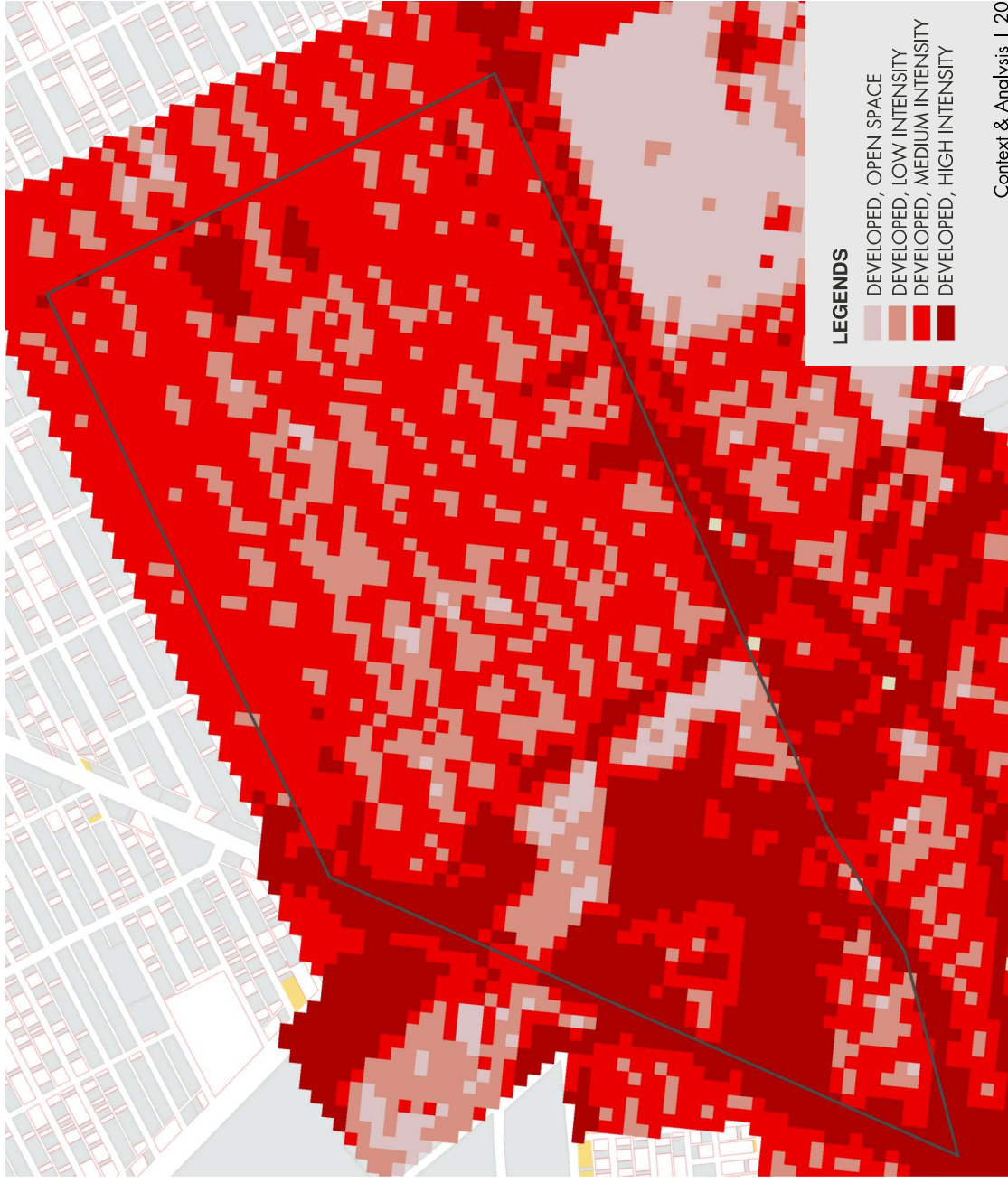
Source: US Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Office of Water Prediction (OWP)



## LAND USE LAND COVER

The Land Use Land Cover (LULC) information was retrieved from the National Land Cover Database (NLCD) 2019 edition. The site is predominantly marked with varying shades of red, indicating fully developed areas. Darkest red areas represent high-intensity development, such as factories, major roads, commercial centers, and educational institutions. Lightest red areas represent low-intensity development, such as parks and open spaces.

Source: National Land Cover Database, U.S. Geological Survey



## PARKS

Although classified as low-intensity development in the LULC classification, parks have greater water retention potential compared to plazas. Therefore, parks will be categorized as a separate LULC classification reflecting their unique characteristics.



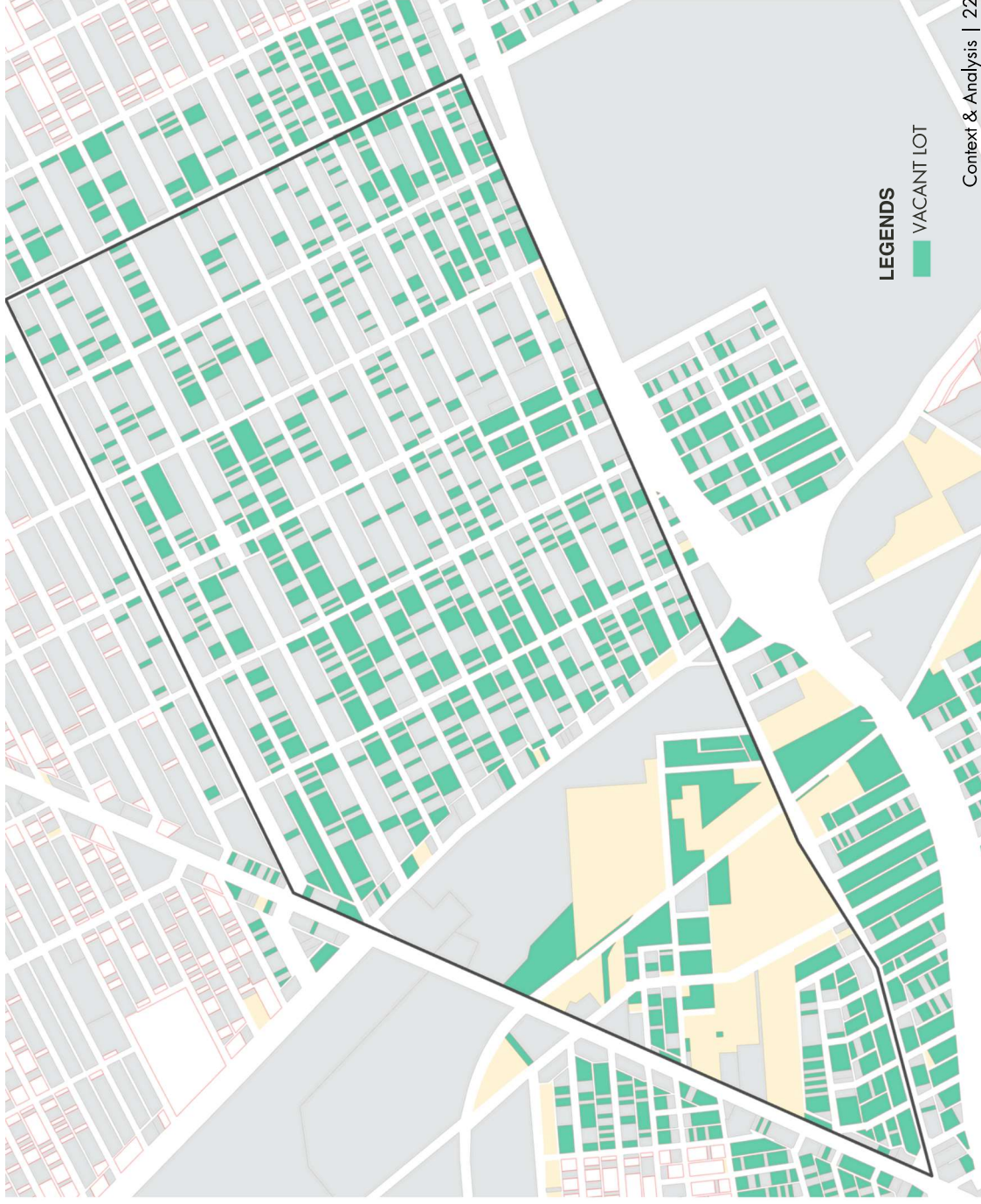
Source: City of Detroit Open Data Portal



## VACANT LAND

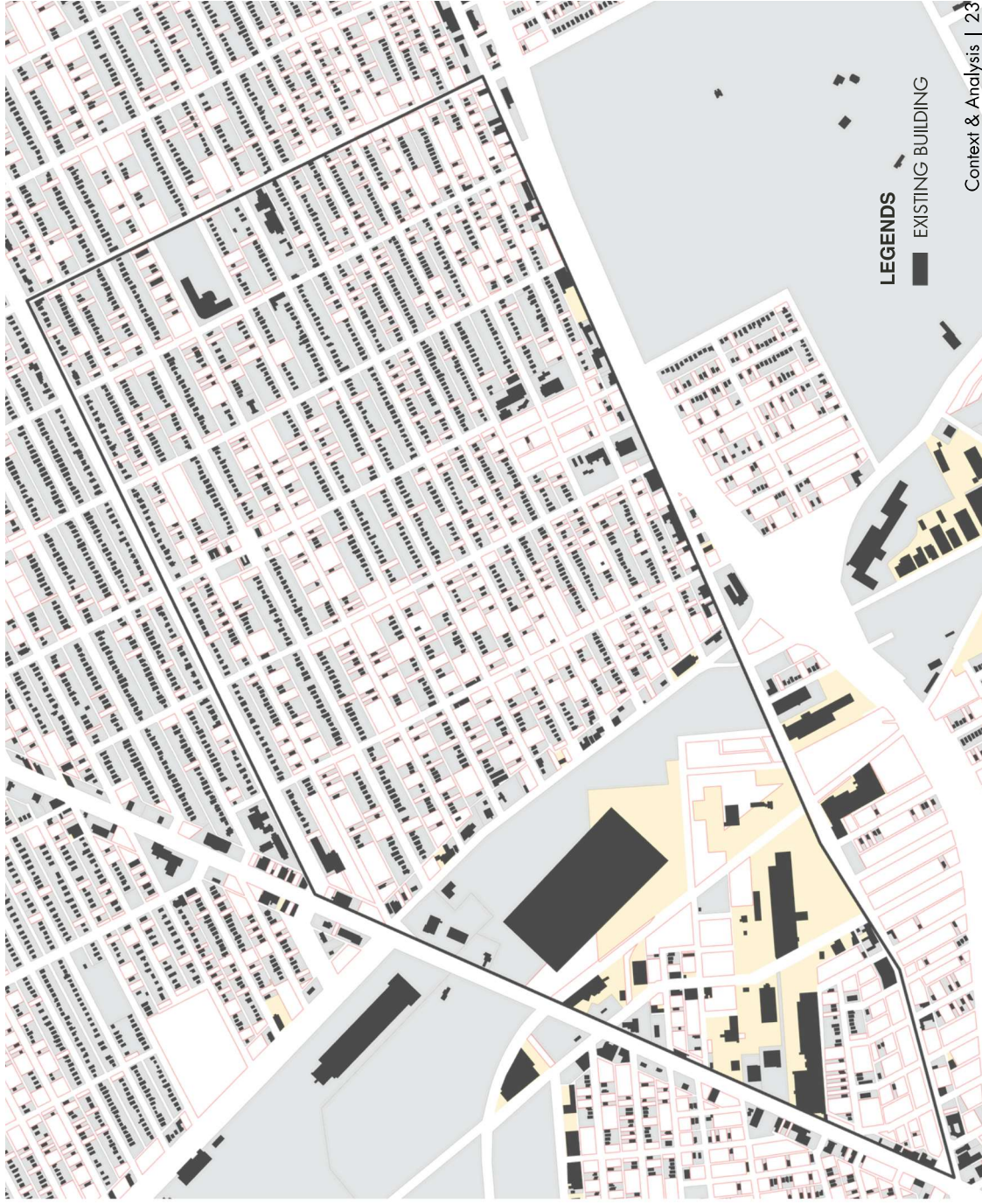
Similarly to parks, vacant lands are often vegetated and thus have a higher potential to capture stormwater. Over 20% of our site is unoccupied.

Source: SEMCOG



## EXISTING BUILDINGS

Buildings are one of the least permeable surfaces, especially without the addition of green roofs or green walls. Areas with dense building coverage have reduced water retention capacity and contribute to increased runoff.



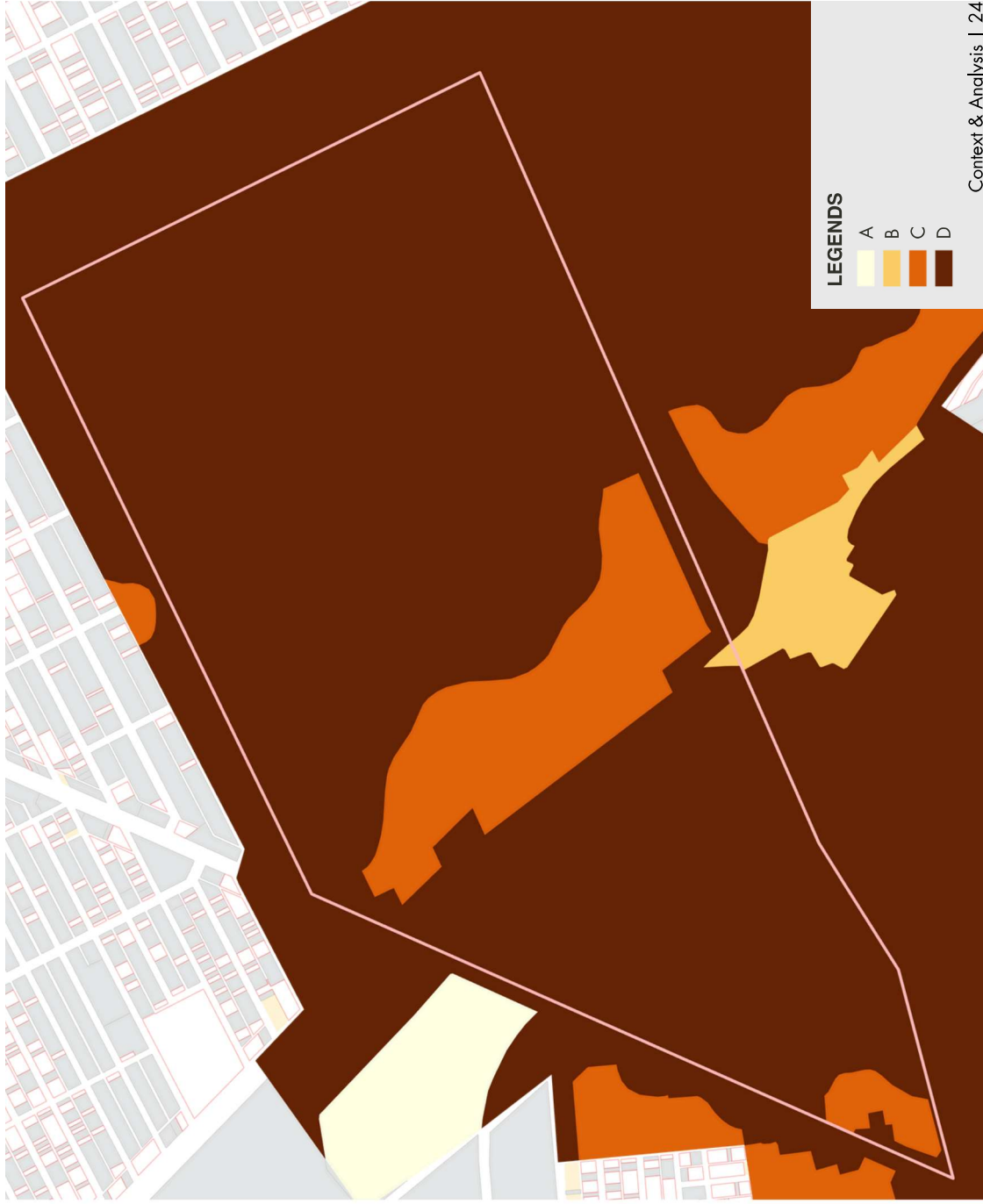
Source: SEMCOG



## SOIL HYDROLOGIC GROUPS

Soils are categorized into Hydrologic Groups A, B, C, or D, which indicate the potential for runoff when those soils become saturated. Group A soils infiltrate water quickly, resulting in minimal runoff, but such soils are not present within our site boundary. The majority of our site's soils are classified as Group D, which are poorly drained, have a high-water table, and infiltrate slowly, leading to a large volume of runoff.

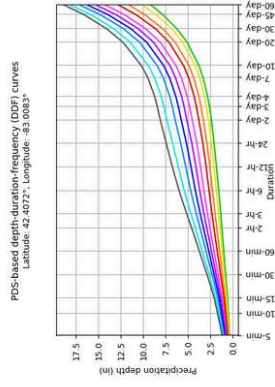
Source: United States Department of Agriculture,  
Natural Resources Conservation Service



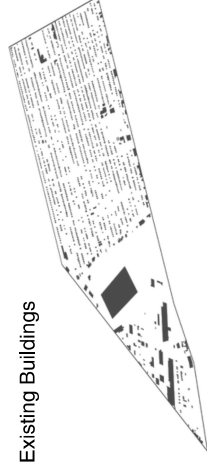
## INVEST URBAN FLOODING RISK MITIGATION MODEL

The InVEST Urban Flood Risk Mitigation Model assimilates data on LULC, Soil Hydrological Groups, building footprints, and precipitation depth to calculate runoff and retention volumes. For our simulations, we set scenarios for 2-hour and 24-hour durations during a one-hundred-year storm event.

### Precipitation



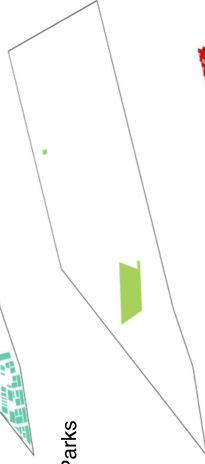
### Existing Buildings



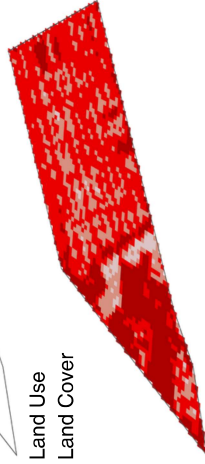
### Vacant Land



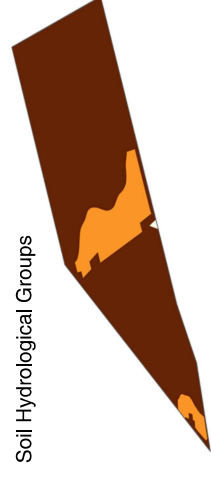
### Parks



### Land Use Land Cover



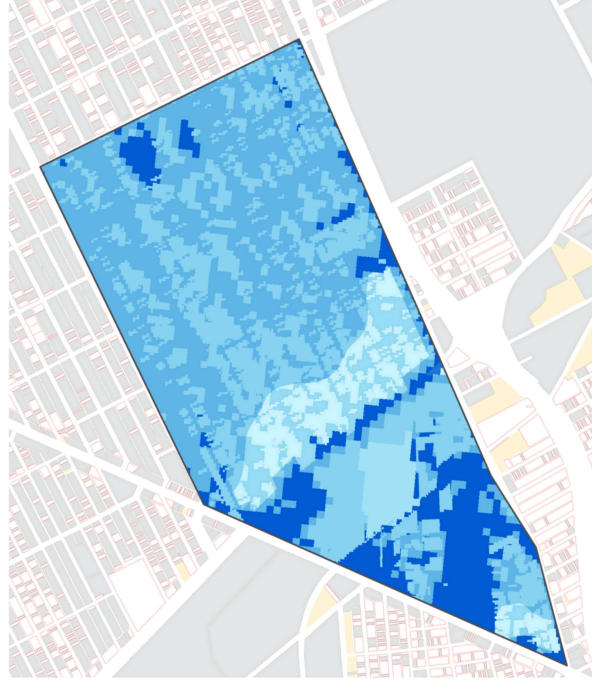
### Runoff & Retention



## RUNOFF VOLUME

The areas of high runoff are consistent within both the 2-hour and 24-hour scenarios. The industrial zones, major roadways, commercial hubs, and the school generate the most runoff during one-hundred-year storm events.

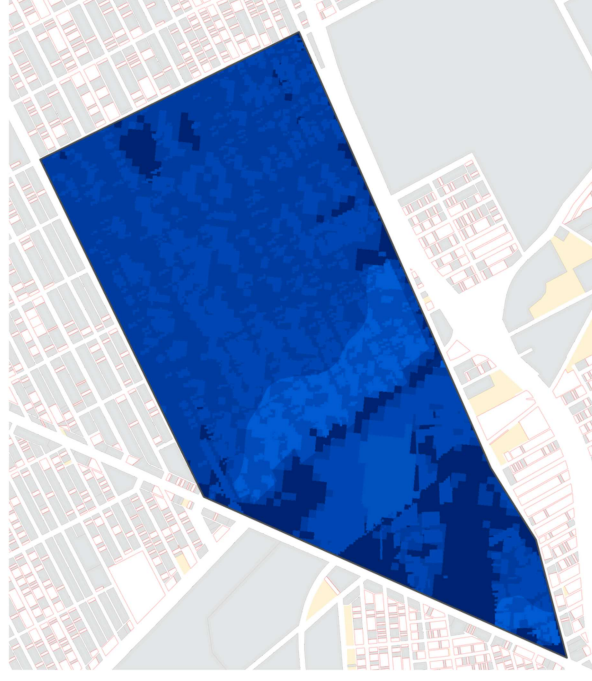
RUNOFF VOLUME IN 2 HOURS



**LEGENDS**



RUNOFF VOLUME IN 24 HOURS



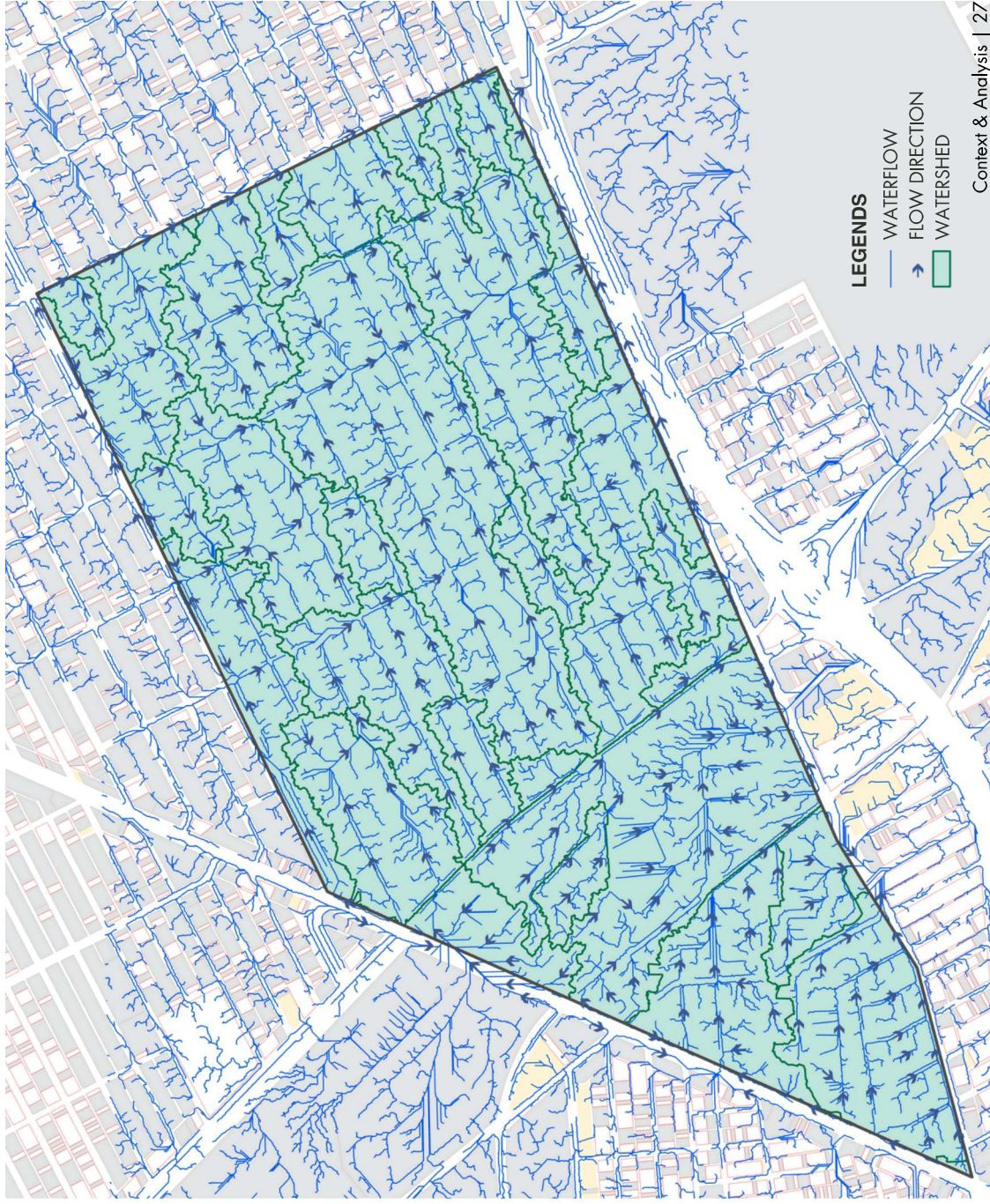
**LEGENDS**





## WATERSHED

To calculate overflow, we need to aggregate runoff and drainage capacity by sub-areas of reasonable sizes. Thus, we have divided the site into 48 'Watersheds' based on surface water flow.





## SEWER CATCHMENT

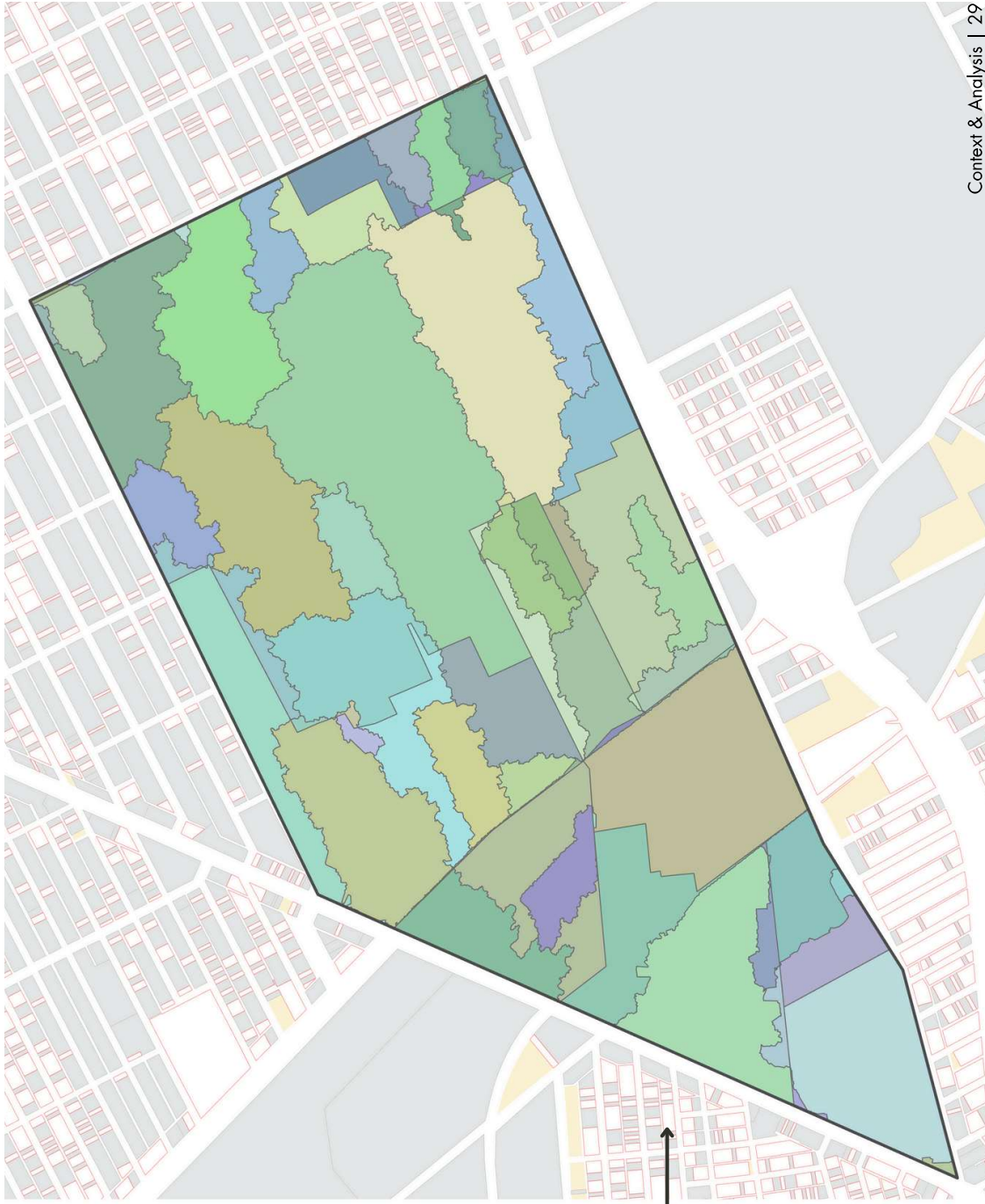
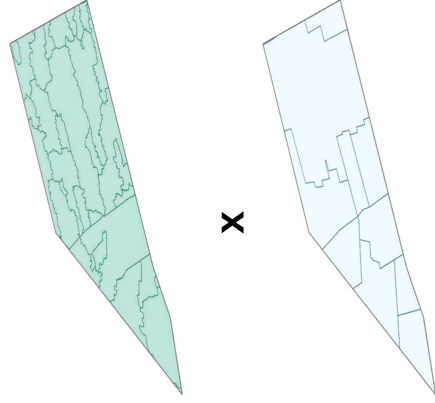
Similarly underground, the site is partitioned into 11 'Catchments' following the sewer water flow direction.



Source: Detroit Water and Sewerage Department, personal communication, 2023, December 14)

## WATERSHED X CATCHMENT

By intersecting Watersheds and Catchments, the site is segmented into 88 areas. Within each area, water flows in the same direction, both on the surface and sub-surface. These Watershed-Catchments serve as the units for overflow calculation.

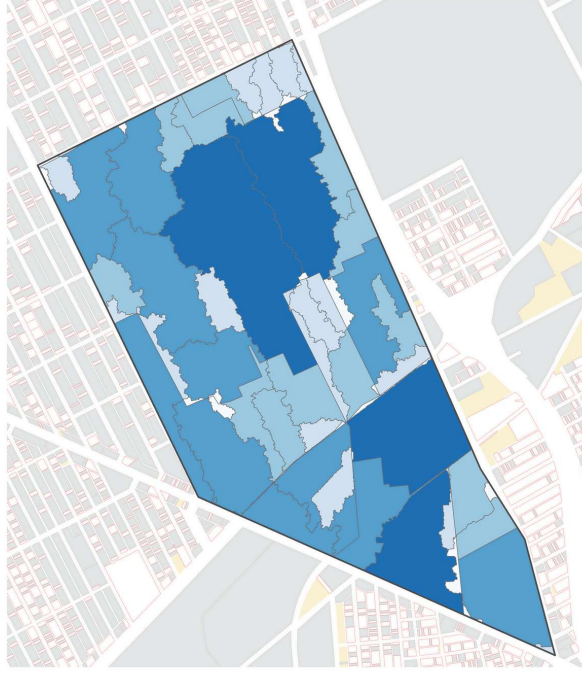




## RUNOFF VOLUME BY WATERSHED-CATCHMENT

The runoff volume is summarized within each Watershed-Catchment.

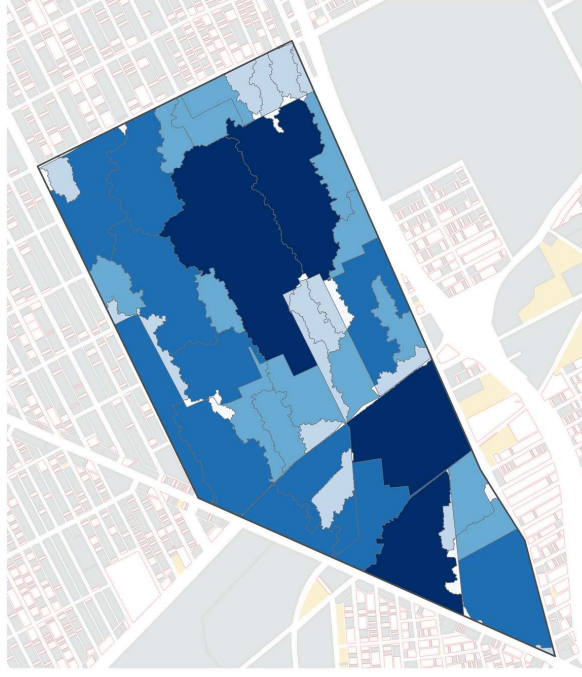
RUNOFF VOLUME IN 2 HOURS



**LEGENDS**

- 987.39 - 615,644.14 GAL.
- 615,644.14 - 1,834,866.40 GAL.
- 1,834,866.40 - 4,025,054.04 GAL.
- 4,025,054.04 - 8,890,405.68 GAL.
- 8,890,405.68 - 19,269,416.70 GAL.

RUNOFF VOLUME IN 24 HOURS



**LEGENDS**

- 641.96 - 1,182,492.54 GAL.
- 1,182,492.54 - 3,686,375.15 GAL.
- 3,686,375.15 - 7,644,820.10 GAL.
- 7,644,820.10 - 18,450,042.46 GAL.
- 18,450,042.46 - 41,729,506.29 GAL.

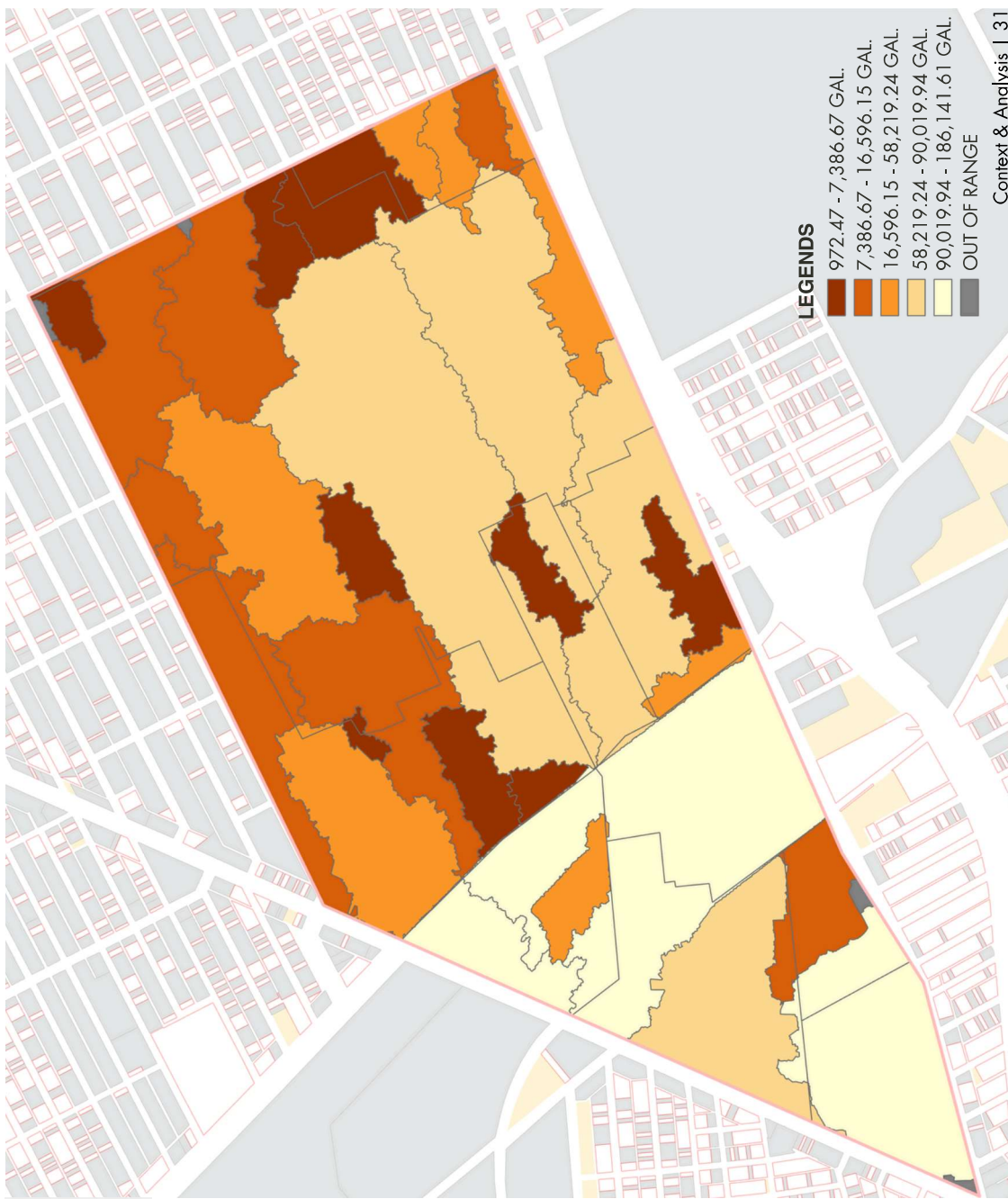
## SEWER CAPACITY PER SECOND BY WATERSHED-CATCHMENT

Sewer capacity is computed by summing the maximum flow capacity of each pipe per second, using Manning's Formula (Oregon State University, 2006):

$$Q = A \times 1.49/n \times R^{2/3} \times S^{1/2}$$

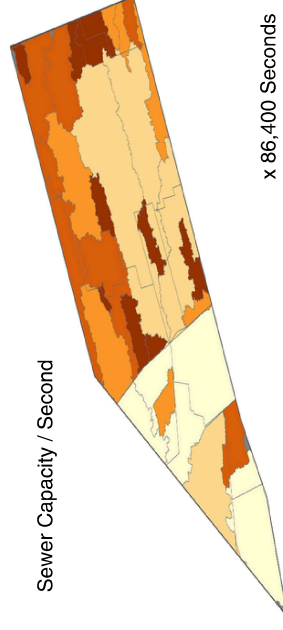
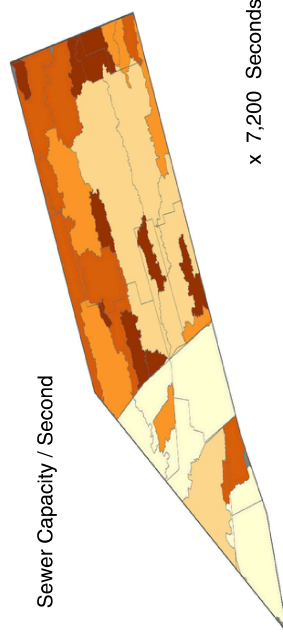
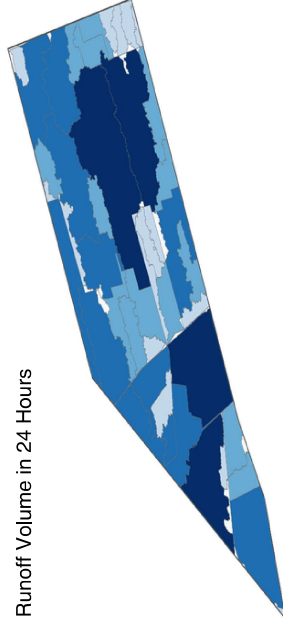
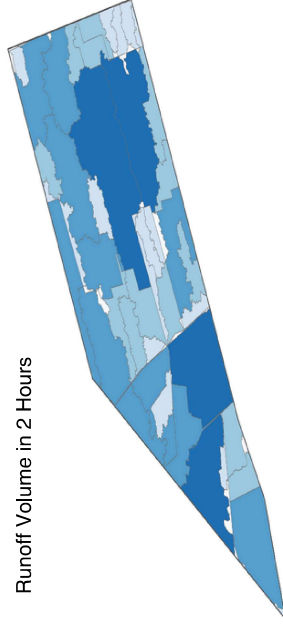
where:

- Q = Flow Rate, (cu ft/s)
- A = Flow Area, (sq ft)
- n = Manning's Roughness Coefficient
- R = Hydraulic Radius, (ft)
- S = Channel Slope, (ft/ft)



## CAPACITY DIFFERENCE CALCULATION

Within the same Watershed-Catchment, we determine the capacity difference by subtracting sewer capacity from the runoff volume. A positive difference suggests that within the Watershed-Catchment, runoff exceeds sewer capacity, potentially causing overflow under the assumed scenario.



Capacity Difference in 2 Hours



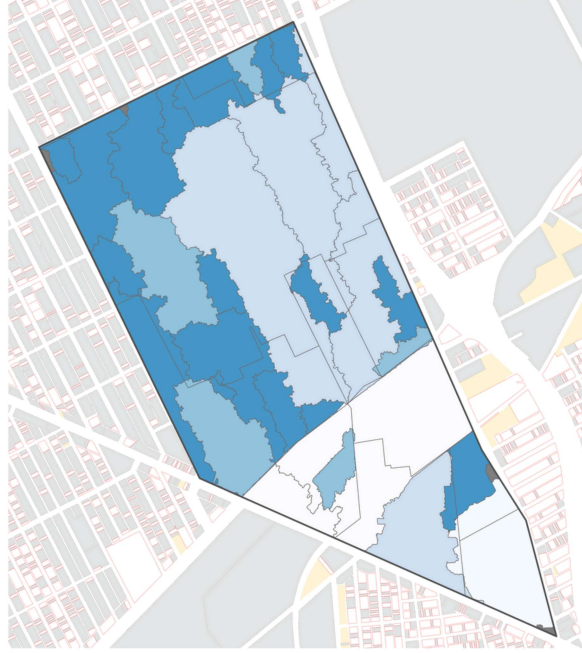
Capacity Difference in 24 Hours



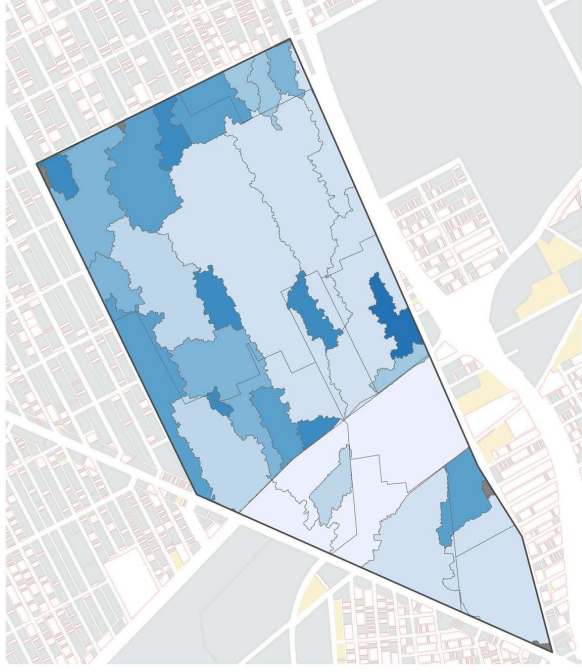
## CAPACITY DIFFERENCE AT 100% CAPACITY

Surprisingly, initial results showed all negative differences in both scenarios, which contradicts the known flooding frequency on-site. This discrepancy exists because the sum of each pipe's capacity, as calculated by Manning's formula, assumes pipes are at 100% efficiency, yet most pipe systems do not function at this ideal level [A. Gronewold, personal communication, 2024, March 13].

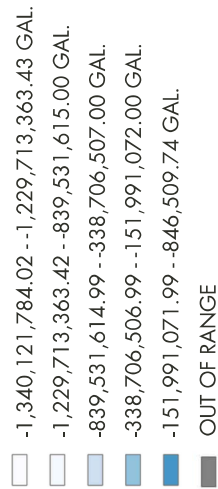
IN 2 HOURS



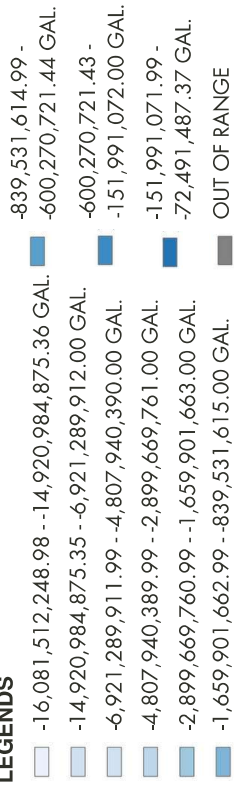
IN 24 HOURS



LEGENDS



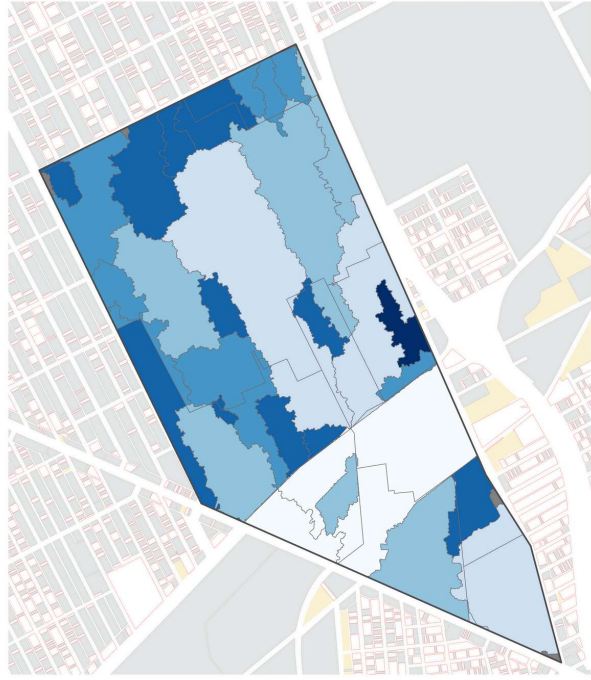
LEGENDS



## CAPACITY DIFFERENCE AT 70% CAPACITY

Typically, due to aging, cracking, or clogging, pipe systems perform around 70% of the sum of their ideal individual pipe capacities (A. Gronewold, personal communication, 2024, March 13). Under the 2-hour scenario, the Watershed-Catchment at Harper and Gunston St exhibits a positive capacity difference—indicating overflow.

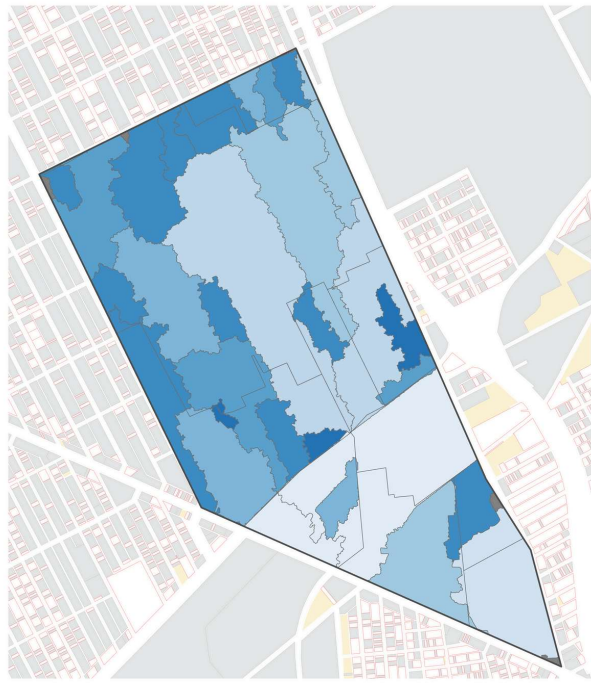
IN 2 HOURS



### LEGENDS

Lightest Blue	-938,083,823.70	--839,531,615.00 GAL.
Light Blue	-839,531,614.99	--338,706,507.00 GAL.
Medium-Light Blue	-338,706,506.99	--151,991,072.00 GAL.
Medium Blue	-151,991,071.99	--39,731,849.00 GAL.
Dark Blue	-39,731,848.99	- 0.00 GAL.
Very Dark Blue	0.01	- 1,317,692.39 GAL.
Black	OUT OF RANGE	

IN 24 HOURS



### LEGENDS

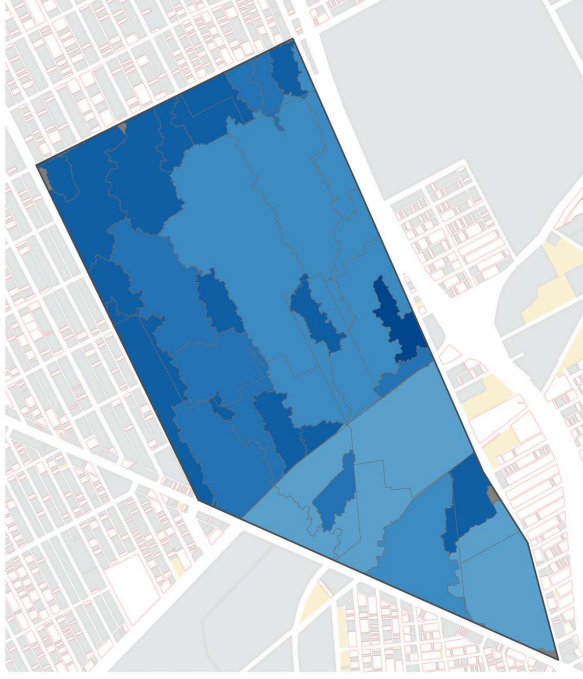
Lightest Blue	-11,257,056,725.20	--8,454,422,809.37 GAL.
Light Blue	-8,454,422,809.36	--6,921,289,912.00 GAL.
Medium-Light Blue	-6,921,289,911.99	--4,807,940,390.00 GAL.
Medium Blue	-4,807,940,389.99	--2,899,669,761.00 GAL.
Dark Blue	-2,899,669,760.99	--1,659,901,663.00 GAL.
Very Dark Blue	-1,659,901,662.99	--839,531,615.00 GAL.
Black	-839,531,614.99	--151,991,072.00 GAL.
Black	-151,991,071.99	--46,521,061.87 GAL.
Black	OUT OF RANGE	

## CAPACITY DIFFERENCE AT 50% CAPACITY

During heavy storm events, sewer capacity can further reduce to 50%, lower or even 0 since rising water tables can lead to pipe flooding. This problem occurs more quickly in poorly drained soils, which constitute the majority of our site (A. Gronewold, personal communication, 2024, March 13).

At a sewer capacity of 50%, three Watershed-Catchments are identified as vulnerable to overflow: apart from Harper and Gunston St, another is near the school, and a third is at the western section of Outer Drive E.

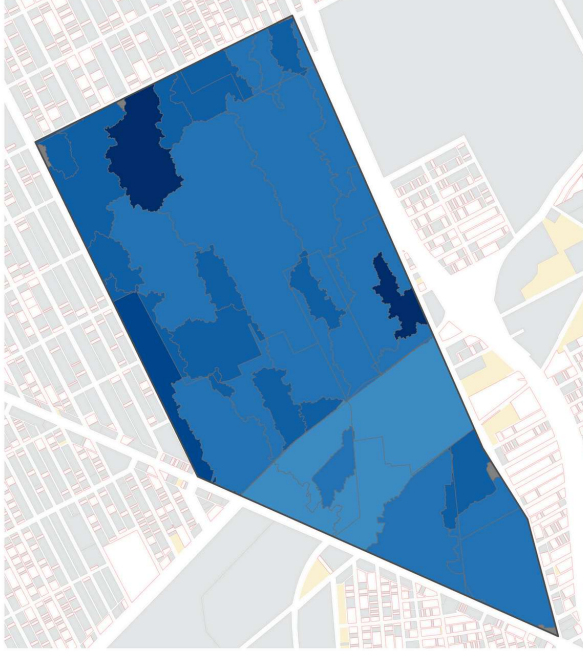
IN 2 HOURS



**LEGENDS**

- 670,058,516.82 - -338,706,507.00 GAL.
- 338,706,506.99 - -151,991,072.00 GAL.
- 151,991,071.99 - -39,731,849.00 GAL.
- 39,731,848.99 - 0.00 GAL.
- 0.01 - 2,760,493.81 GAL.
- OUT OF RANGE

IN 24 HOURS



**LEGENDS**

- 670,057,103.57 - -590,800,969.46 GAL.
- 590,800,969.45 - -39,731,849.00 GAL.
- 39,731,848.99 - 0.00 GAL.
- 0.01 - 2,760,495.00 GAL.
- 2,760,495.00 - 10,469,594.11 GAL.
- OUT OF RANGE



# TRANSPORTATION & STREETSCAPE

## SITE VISIT

The site analysis showed key issues affecting traffic and safety in the area. There is a clear lack of streetscape infrastructure on most roads, with insufficient street tree planting and neglected lawn maintenance, resulting in limited sidewalk accessibility which affects environmental quality. However, the overall vegetation coverage rate is high, and it has the ability to implement green infrastructure in combination with road design.





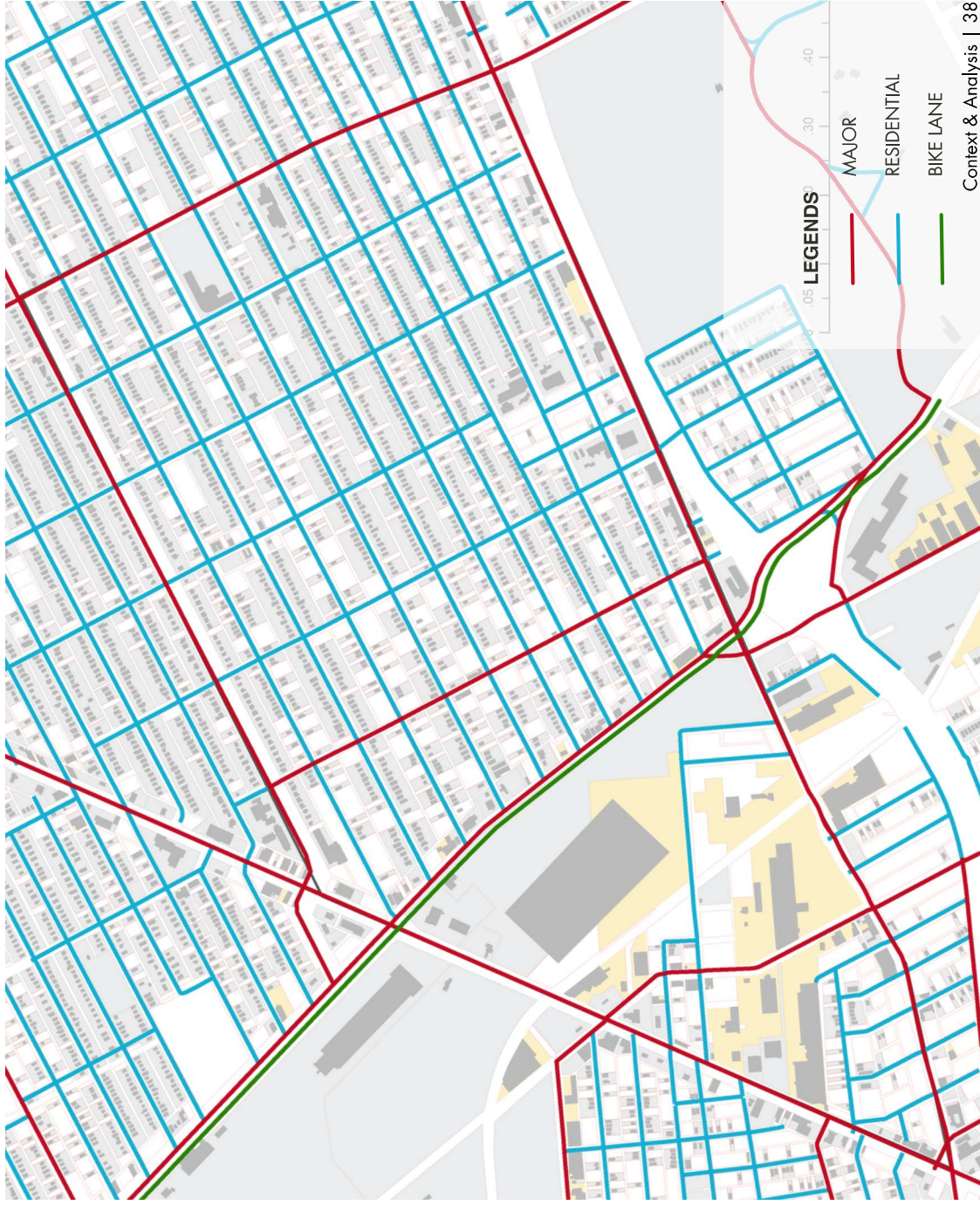
## EXISTING ROAD TYPES

According to the roads map from Southeast Michigan Council of Governments, the existing roads are divided into 3 types:

Major Road

Residential Road

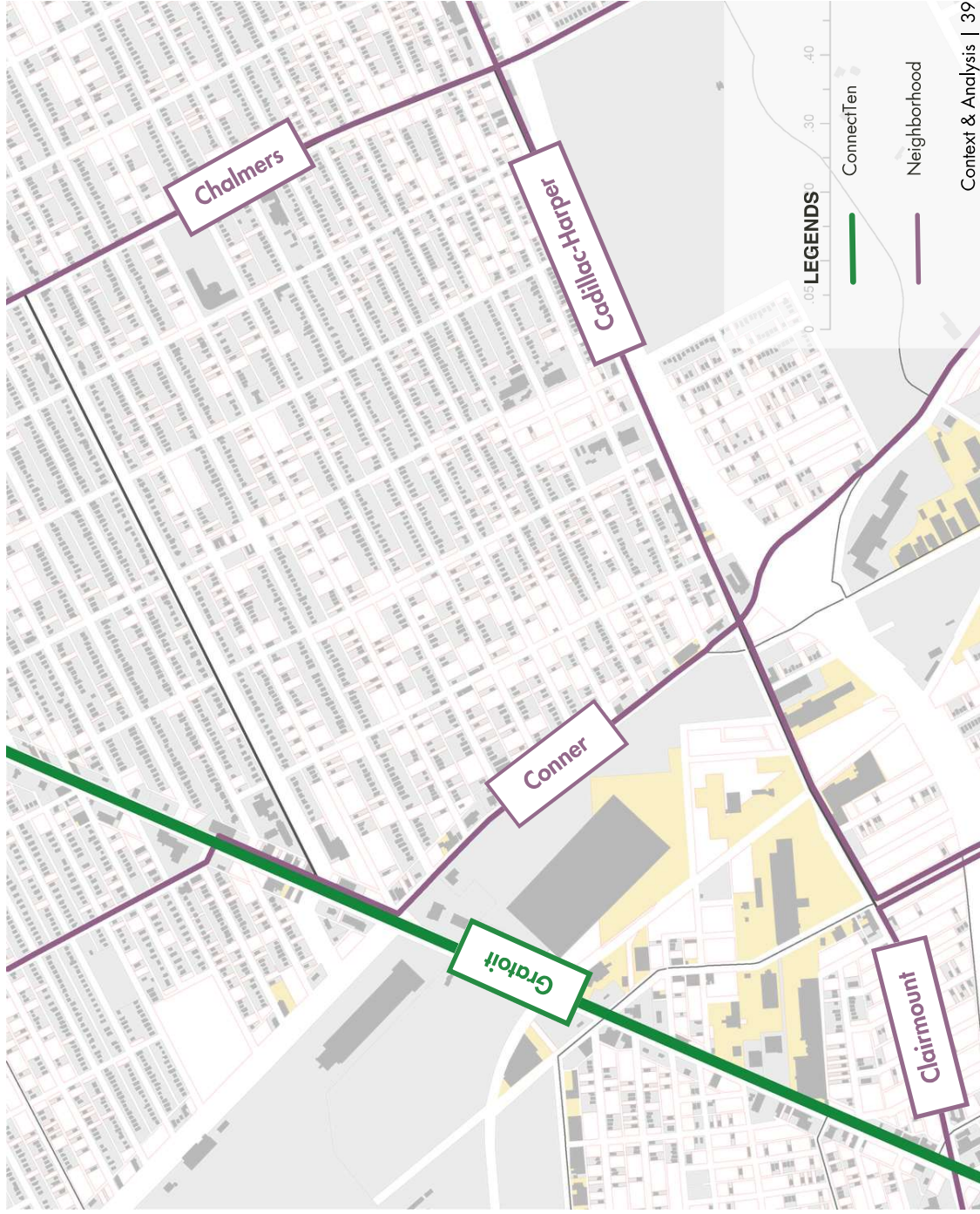
Bike Lane





## BUS ROUTE

According to the Detroit Department of Transportation, we found that there are 5 bus routes that go across our site. These are the ConnectTEN routes and neighborhood routes. ConnectTEN routes are the ten most popular routes used by 60% of the riders. They run 24h/7 days a week, with a peak hour frequency of 15 minutes. Gratiot Avenue is an example of one of these routes. Another type are neighborhood routes, which are shorter routes running every 35 to 60 minutes on weekdays. Harper, Conner and Dickerson Avenue are all examples of this type.



Source: DDOT-SystemMap  
City of Detroit Governments

## MDOT - PEL STUDY

The Michigan Department of Transportation (MDOT) is completing a study on Gratiot Avenue (M-3) within the City of Detroit. The Planning and Environmental Linkages (PEL) study for M-3 (Gratiot Avenue) from Randolph Street to M-102 (8 Mile Road) in Detroit will identify and evaluate safety, multimodal mobility, transit needs, and proposed improvements. They have provided illustrative alternatives for possible road design, which serve as a reference for the following road-type design proposal.

### WHY A PEL FOR THIS PROJECT?

#### A PEL study helps us:

##### Build from previous work

Apply designs and acceptable alternatives from previous plans

##### Get ahead on future work

Expedite future phases of improvements for Gratiot Avenue

##### Put safety first

Address disproportionate safety issues along the corridor

##### Fast-track implementation

Advance the project through environmental review, funding, engineering, and construction

3



## DETROIT STREET DESIGN GUIDE

The City of Detroit is introducing the Streets for the People (SFP) Detroit Street Design Guide to provide guidance and recommendations on all aspects of Detroit street design. The Guide integrates design flexibility to support all modes of transportation and presents minimum, maximum, and preferred criteria that vary by street type and context. The guide provides a total of eight street types based on size, land use, operation and character while introducing the overall design principles for each section, as well as the individual design elements under each theme. Our projects will be designed according to this guidance to meet the purpose and needs, creating a complete network integrated with surrounding land uses.

Source: City of Detroit Streets for the People (SFP) Detroit Street Design Guide



## CONTENTS

### 1: Introduction

Vision, Guiding Principles, & Purpose  
Designing Streets for Safety  
How to Use this Guide

### 2: Street Typologies

Typology Overview  
Street Type Design Profiles

### 3: Sidewalks

Sidewalk Zones  
Sidewalk Design Elements  
Bike Parking  
Bus Stops & Shelters  
Driveways  
Furniture  
Green Stormwater Infrastructure  
(GSW) Lighting  
Materials  
Planters  
Public Art / Street Murals  
Sidewalk Cafés / Retail  
Signage  
Trees

### 4: Roadways

Roadway Zones  
Roadway Design Elements  
Bus Lanes  
Materials  
Pedestrian Islands  
Separated Bike Lanes  
One-way  
Two-way  
Signage  
Traffic Calming  
Physical Measures  
Visual Measures  
Measures for People on Bikes  
Travel Lanes  
Rightsizing

### 5: Intersections

Design Considerations  
Design and Control Vehicles and Encroachment Intersection Design Elements  
Corners / Curb Radii  
Crosswalks  
Curb Extensions  
Curb Ramps  
Pedestrian Hybrid Beacons  
Rectangular Rapid Flashing Beacons  
Separated Bike Lanes  
One-way  
Two-way  
Signage  
Signals  
Accessible Pedestrian Signals  
Pedestrian Signal Phasing



# COMMERCIAL AND MIXED-USE DEVELOPMENT

## BUILDING TYPE

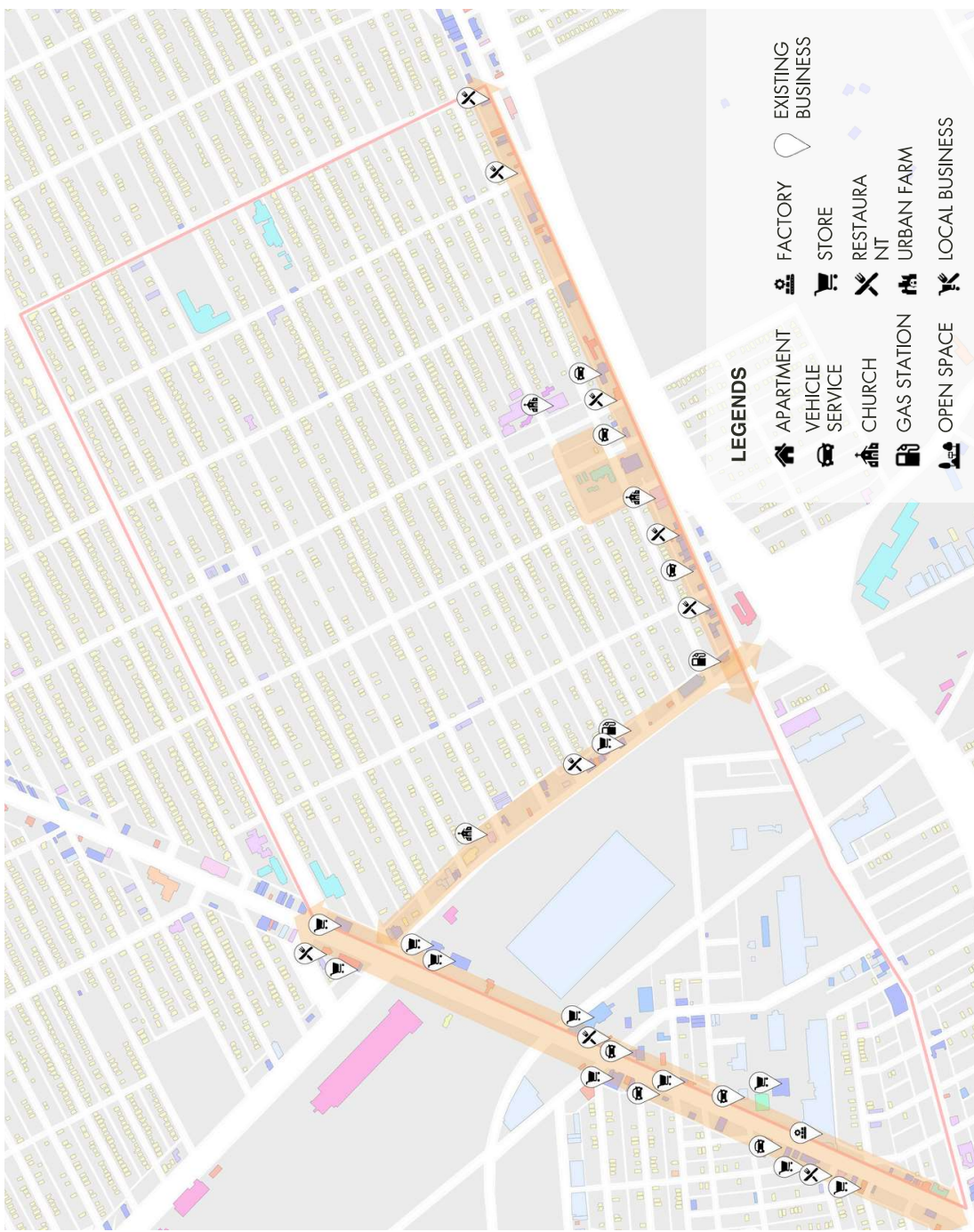
Within this neighborhood, residential buildings are the main building type. Apart from that there are also churches, factories, and schools located in the middle of the residential areas. Restaurants, hotels, and stores exist along Graitiot Avenue, Conner Street, and Harper Avenue, which are the main streets and have more traffic and people compared to other streets.



Source: Building Footprints, 2020  
Southeast Michigan Council of Governments

## BUSINESS IN RUNNING

Despite the poor economic situation here, there are some businesses still running on these streets, including gas stations, vehicle services, and other stores. However, there is still a large proportion of vacant land and abandoned buildings here that can be used for potential local business development.



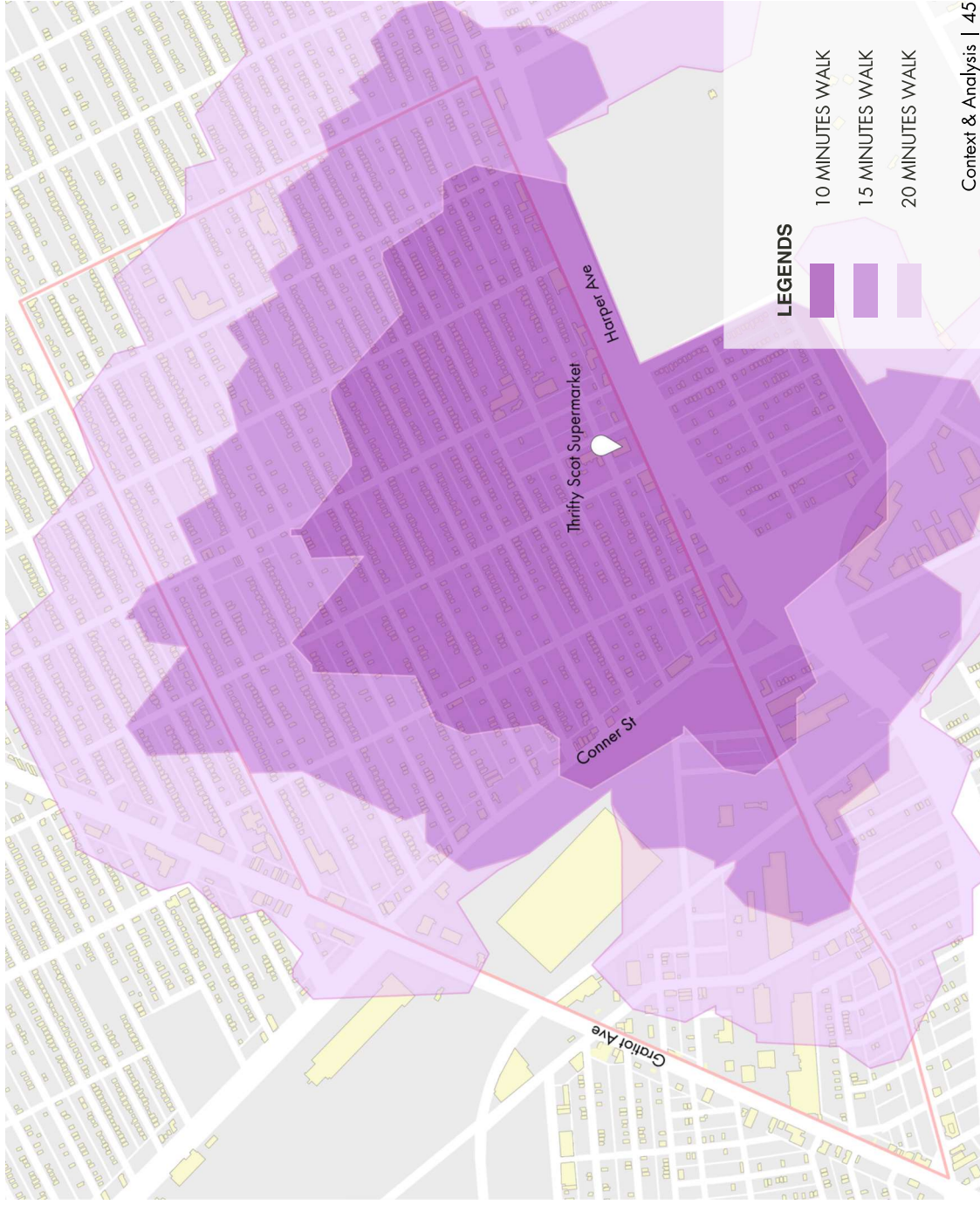
Source: Building Footprints, 2020  
Southeast Michigan Council of Governments



## 15 MINUTE CITY ANALYSIS

The 15-minute city is a concept aimed at ensuring residents can get access to the most important services and daily needs like work, shopping, and recreation within a 15-minute walk, bike, or other avenue of transportation.

This concept can be used in our project to minimize reliance on cars and enhance sustainable lifestyles in this neighborhood. In this analysis, we took the Thrifty Scot Supermarket building, as the starting point and used the darkest purple to represent a 10-minute walk range and the lightest purple to represent a 20-minute walk range. This can be the design guideline of our business plan.



## SUMMARY OF ISSUES

1

### **Stormwater Management**

- Flooding
- Combined sewer overflows
- Poor natural stormwater controls

2

### **Transportation & Streetscape**

- Lack of safe, sustainable transportation infrastructure
- Low connectivity
- Poor pedestrian safety measures
- Lack of speed control
- Lack of school bus facility near school zone

3

### **Commercial & Mixed-Use Development**

- Lack of local business and shared community spaces

# 3

## CASE STUDIES



## EASTERN MARKET NEIGHBORHOOD FRAMEWORK

### STORM WATER MANAGEMENT NETWORK PLAN

**Author:** Planning and Development

Department City of Detroit

**Location:** Detroit

**Time:** November 2019

**Area:** 123 acres

Management Network Plan (SWMNP) focuses on the Greater Eastern Market area (GEM), a 123-acre area. It adopts green stormwater infrastructures (GSIs) to mitigate flooding and reduce water pollution, in compliance with the City of Detroit's Stormwater Management Regulations. SWMNP proposes Stormwater Management Practices (SMPs) within a series of greenways which also enhances the community by providing networks of green spaces and supporting urban agriculture.

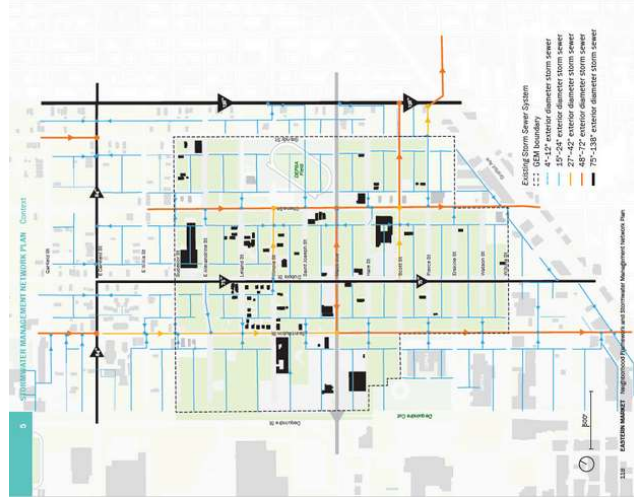
The analytical process, adoption of GSIs, and the integration with other planning layers presented in the SWMNP can be used as references for our project. However, considering the area of the SWMNP is only 17% of our site's size, achieving the same level of detailed spatial design as this case may not be feasible.

Source: City of Detroit Planning and Development Department

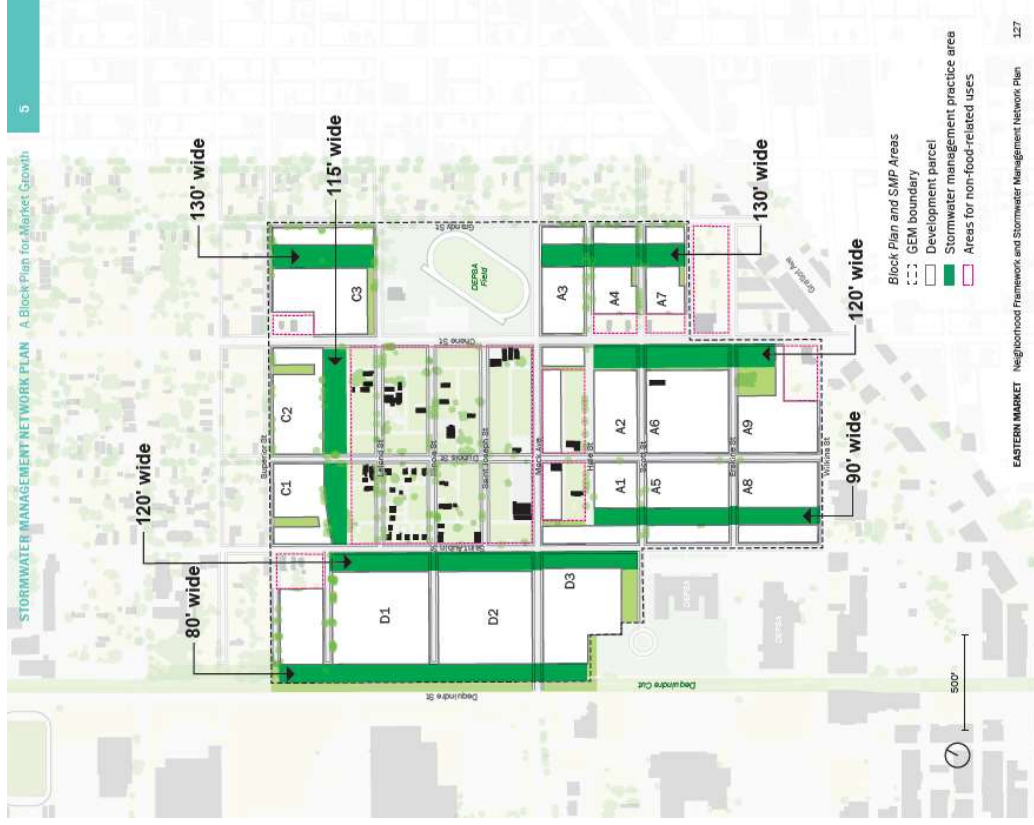
### SITE BOUNDARY



### EXISTING STORM SEWER SYSTEM



### BLOCK PLAN AND SMP AREAS



## EAST WARREN / CADIEUX

### NEIGHBORHOOD FRAMEWORK PLAN

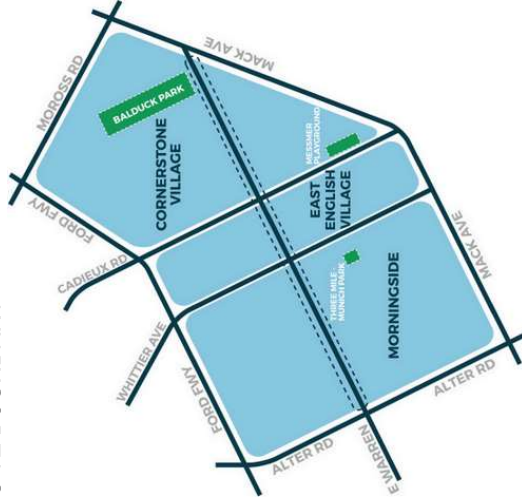
**Author:** Planning and Development  
Department City of Detroit  
**Location:** Detroit  
**Time:** April 2021

This project aims to use feasible, implementable strategies to improve residents' quality of life in this neighborhood. Their strategies are based on in-depth community engagement and include four aspects: commercial & mixed-use development, streetscape improvement, parks and open space, and neighborhood stabilization.

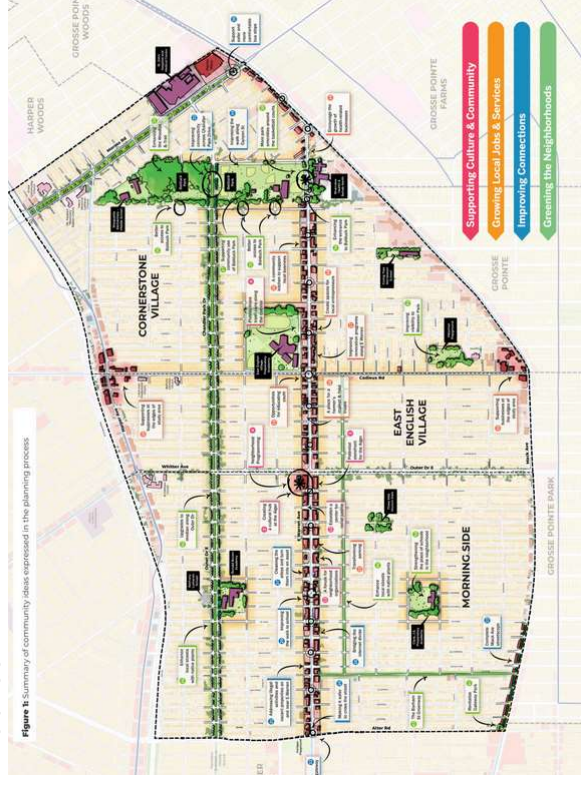
In community engagement, they held at least one formal community meeting in each planning phase. Used different tools including newsletter updates, door knocking, website, virtual and online engagements, gathering information and ideas in terms of supporting arts, culture & community, growing local jobs & services, improving connections, and greening E Warren & the neighborhoods. These informed strategies inspired the planning process for our project.

Source: City of Detroit Planning and Development Department

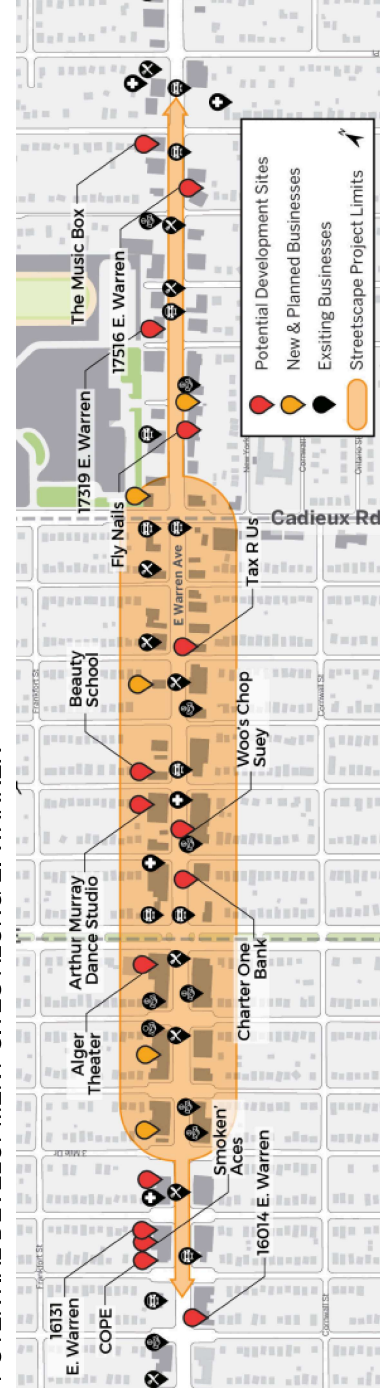
### SITE BOUNDARY



### SUMMARY OF COMMUNITY IDEAS EXPRESSED IN THE PLANNING PROCESS



### POTENTIAL DEVELOPMENT SITES ALONG E. WARREN



# 4

# DESIGNS & RECOMMENDATIONS

STORMWATER MANAGEMENT | TRANSPORTATION & STREETScape | COMMERCIAL & MIXED-USE DEVELOPMENT | POLICY | FUNDING



# STORMWATER MANAGEMENT

## DESIGN GOALS



To capture and infiltrate all runoff on the ground before entering sewer system.

1



If the capacity on the ground is not enough to achieve Goal #1, capture the runoff that exceeds sewer capacity.

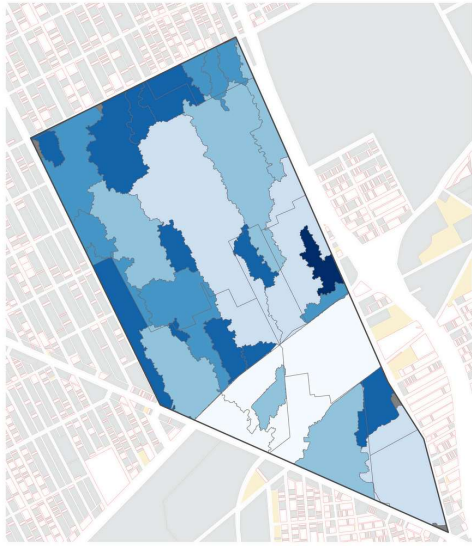
2



If the capacity on the ground is not enough to achieve Goal #2, seek grey infrastructure improvements.

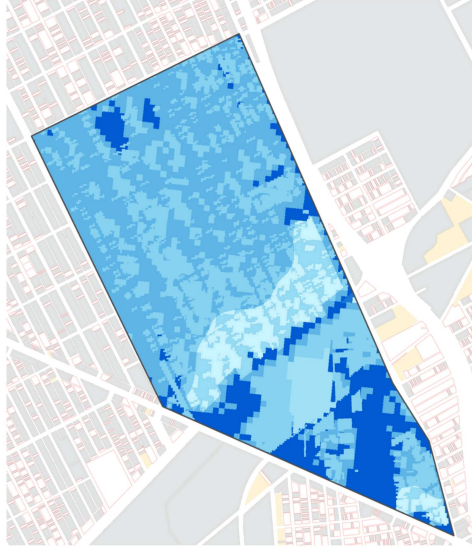
3

# GREEN STORMWATER INFRASTRUCTURE DESIGN PRINCIPLES



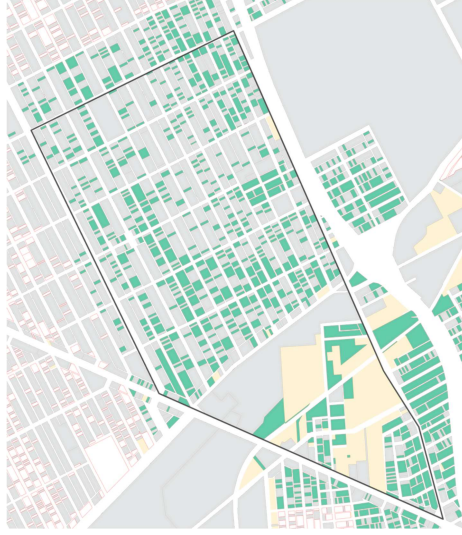
Placing Green Stormwater Infrastructures (GSIs) in areas that have a high risk of overflow.

1



Placing GSIs at or close to where runoff is high.

2



Placing GSIs at where vacant land is available.

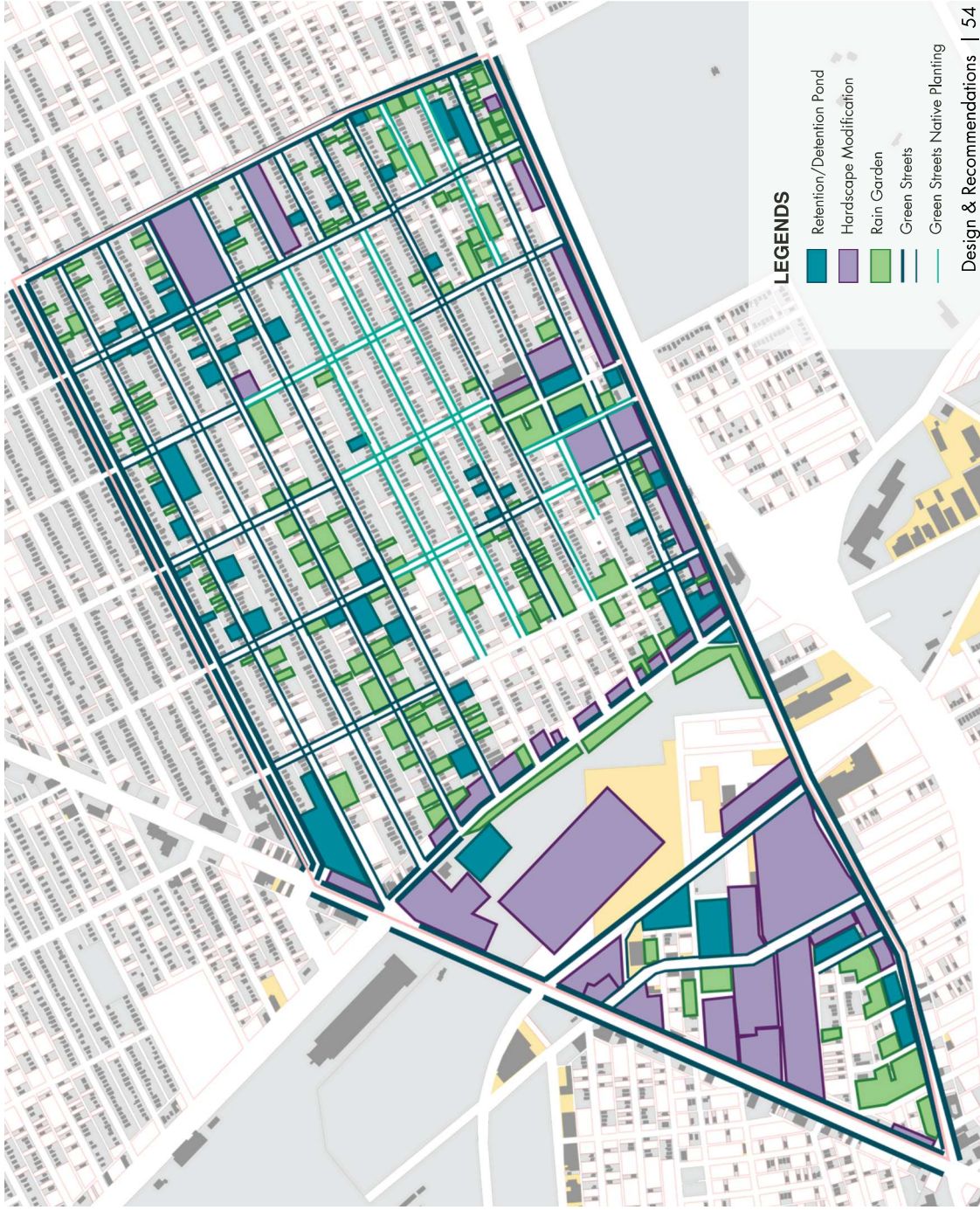
3



## GREEN STORMWATER INFRASTRUCTURE PLAN

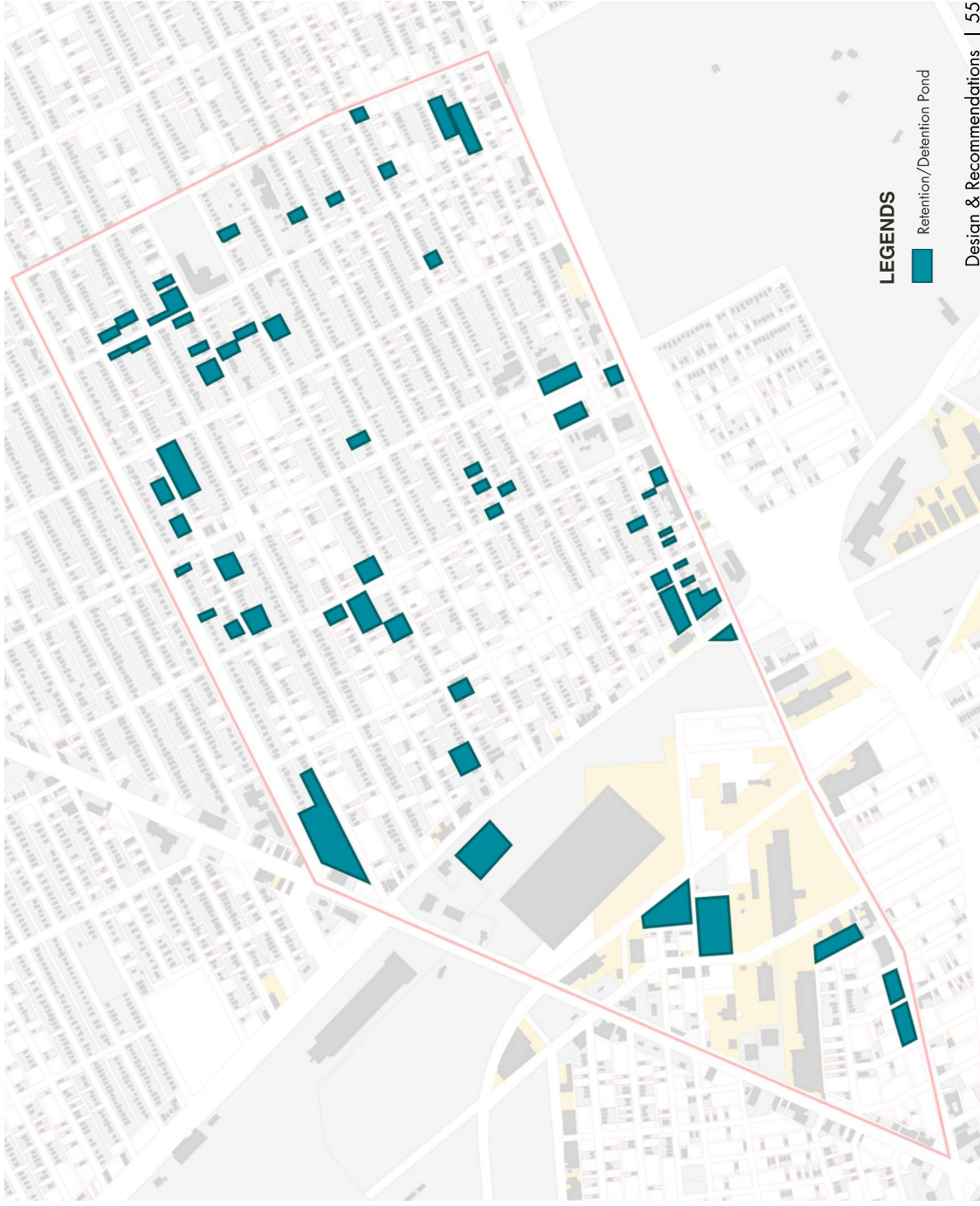
We aim to enhance retention to reduce runoff and overflow by implementing Green Stormwater Infrastructure (GSI). Considering the risk of overflow, the volume of runoff, and the availability of vacant land, we have identified four categories for GSI placement: retention or detention ponds, hardscape modifications, rain gardens, and green streets. The placement is generally at parcel level except green streets.

Please see Appendix II for GSI capacities.



## PLACEMENT OF RETENTION & DETENTION PONDS

Retention and detention ponds are situated in areas with a high risk of overflow, high runoff, and available vacant land, and not positioned at high points. They capture and store runoff during storm events to help mitigate flooding. Later, the water infiltrates or slowly discharges after the storm.



### LEGENDS

Retention/Retention Pond



## RETENTION & DETENTION PONDS

---

Retention ponds are designed to maintain a constant water level and are often planted with aquatic vegetation to filter pollutants from the runoff.

Detention ponds are depressions that temporarily contain water during storm events and can serve other purposes such as recreational grounds when dry.

RETENTION POND



DETENTION POND



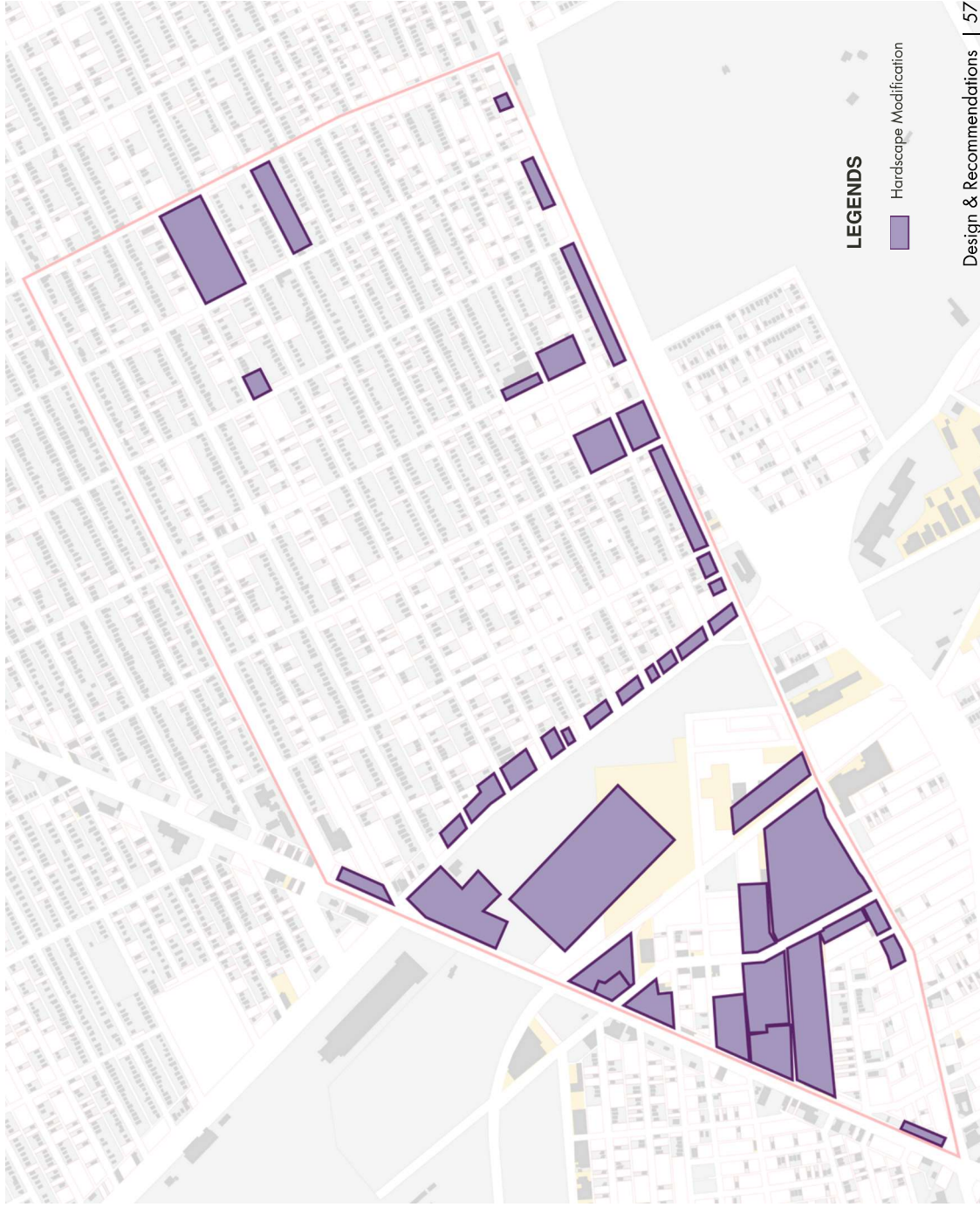
Image Source:  
Top Left: D.S. Franks & Associates, Inc.  
Top Right: Manuel Builders  
Bottom Left: Hatcher Landscape  
Bottom Right: City of Lincoln



## PLACEMENT OF HARDSCAPE MODIFICATIONS

Areas with high human development, high runoff, and a high overflow risk often lack vacant land for ponds. In such areas with active functions like factories, schools, and commercial hubs, we recommend hardscape modifications to enhance on-site retention and infiltration.

These modifications can include, but are not limited to, green roofs, downspout disconnections, permeable pavements, and rainwater harvesting systems.



## HARDSCAPE MODIFICATION: GREEN ROOFS

Green roofs are roofs equipped with living plants. The plants and their growing medium contribute to rainwater absorption, stormwater retention, and runoff reduction into the drainage system. They also help to mitigate the urban heat island effect and provide wildlife habitat.

### RESIDENTIAL & COMMERCIAL



### INDUSTRIAL



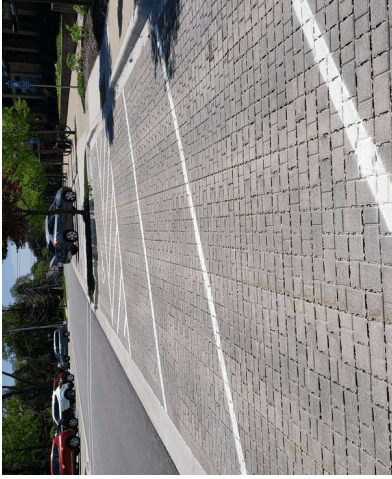
Image Sources:  
Top Left: Fraye Gennard  
Top Right: Sempergreen  
Bottom Left: Inhabitat  
Bottom Right: Greenroofs.com



## **HARDSCAPE MODIFICATION: PERMEABLE PAVEMENT**

Permeable pavements, consisting of permeable pavers, porous concrete, or porous asphalt, allow water to soak through the material or flow between the pavers, enhancing infiltration on-site and reducing runoff.

PERMEABLE PAVERS



POROUS CONCRETE



POROUS ASPHALT

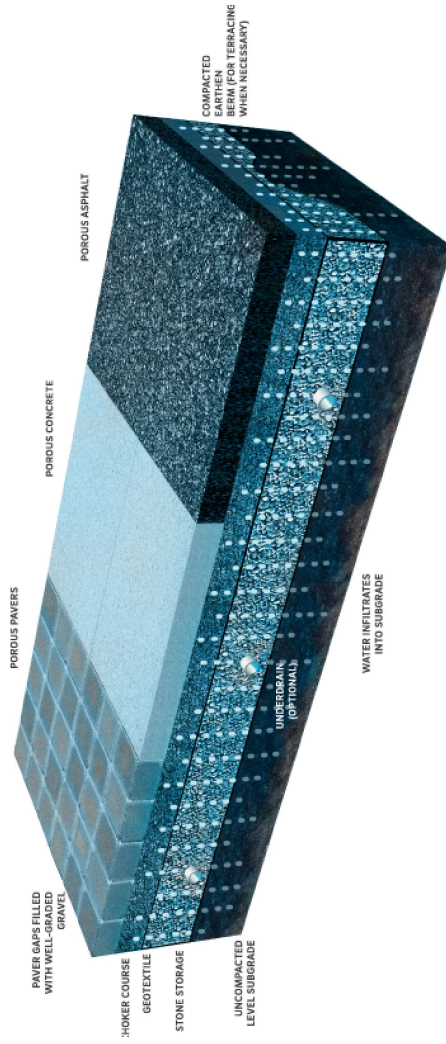


Image Sources:  
 Top Left: City of Warrentonville  
 Top Middle: Sophie Rhéaume, Techo-Bloc  
 Top Right: Portland Cement Association  
 Bottom: Philadelphia Water Department



## HARDSCAPE MODIFICATION: DOWNSPOUT DISCONNECTION & RAINWATER HARVESTING

Traditional architectural designs channel rainwater collected by built structures into the sewer system through downspouts. Repurposing this water to other GSIs, like rain barrels or gardens, by disconnecting downspouts, aids water storage and lessens runoff.

Rainwater harvesting systems collect and store rainwater before it runs off surfaces or directly enters the drainage system. The collected water is stored in facilities such as rain barrels, cisterns, or underground reservoirs and can be reused for irrigation.

### WATER STORAGE

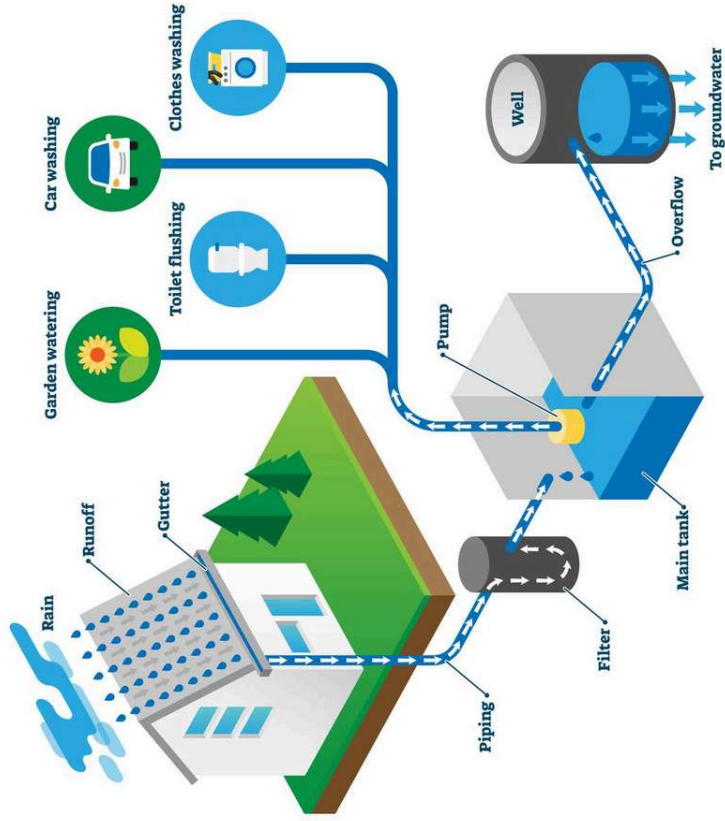


### DOWNSPOUT DISCONNECTION



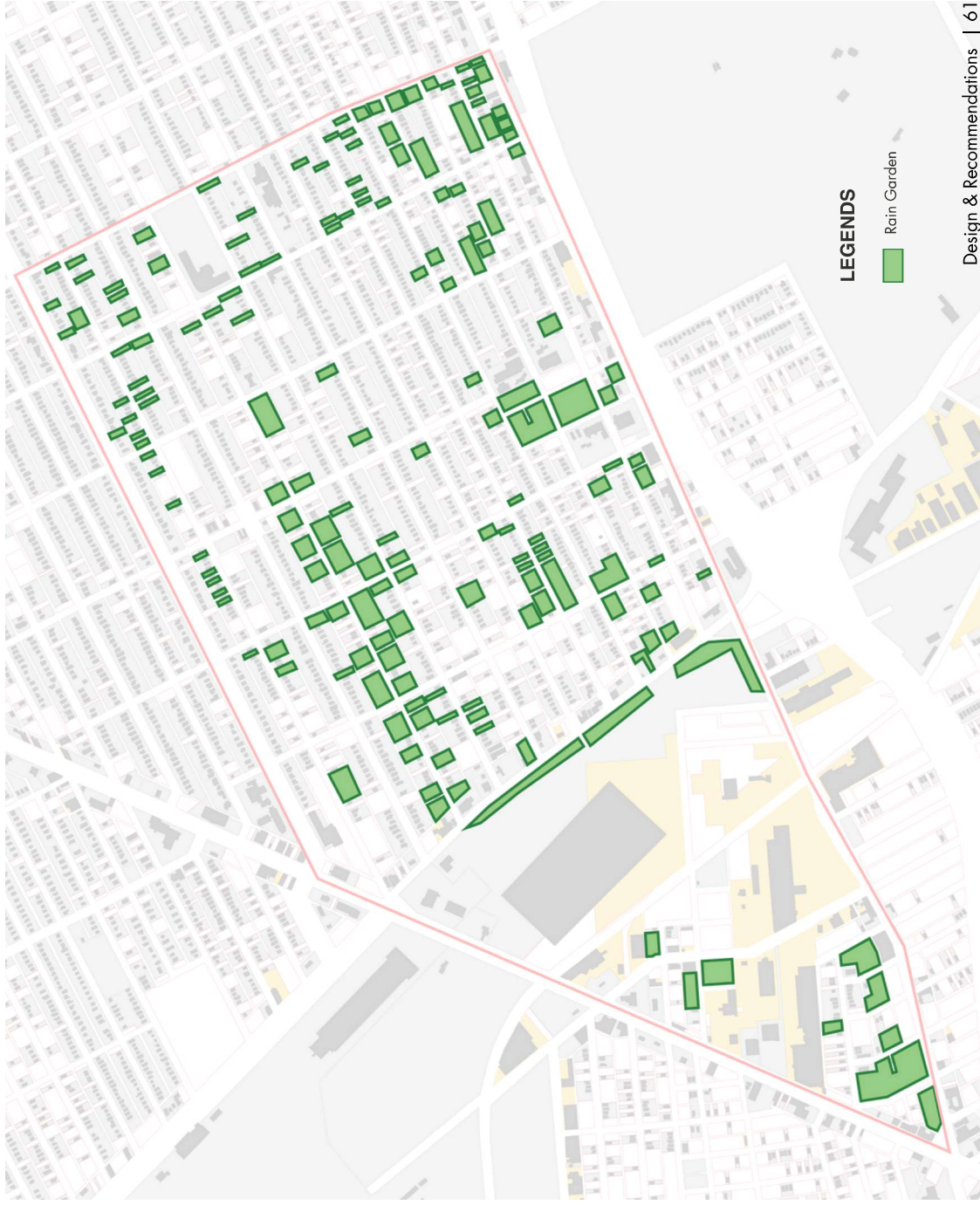
Image Sources:  
Top Left: 2024 New Jersey Future Green Infrastructure Developers Guide  
Bottom Left: NICK'S Window Cleaning  
Right: Dreamstime

# RAINWATER HARVESTING



## PLACEMENT OF RAIN GARDENS

In locations with moderate overflow risk and runoff volume, and where vacant land exists, rain gardens effectively collect, store, and infiltrate runoff. Outside the project scope, promoting rain garden installation in residential areas could further enhance stormwater management.





## RAIN GARDENS

Also known as bioretention cells, rain gardens are shallow planted depressions with bedding and base layers that enhance drainage and pollutant filtration before the water infiltrates the ground or enters the sewer system.

Please see Appendix I for native plants.

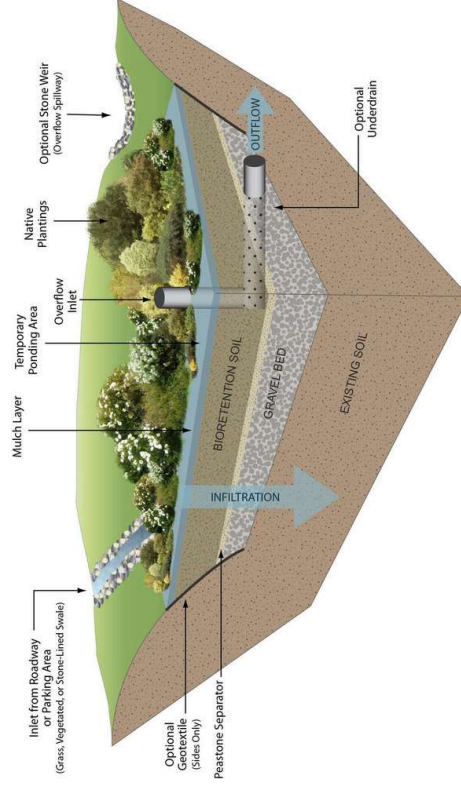
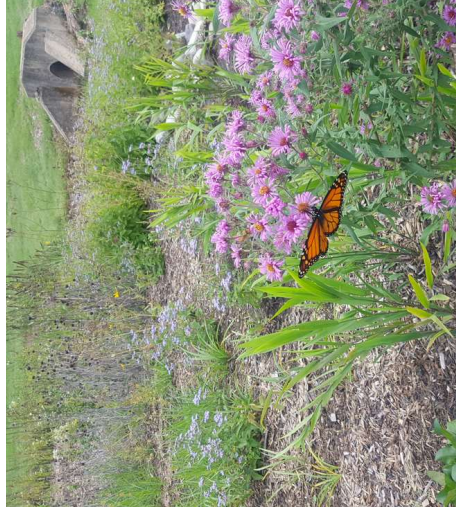


Image Sources:

Top Left: Rishya N.

Top Right & Bottom Left: Perkiomen Watershed Conservancy

Bottom Right: Borough of West Chester

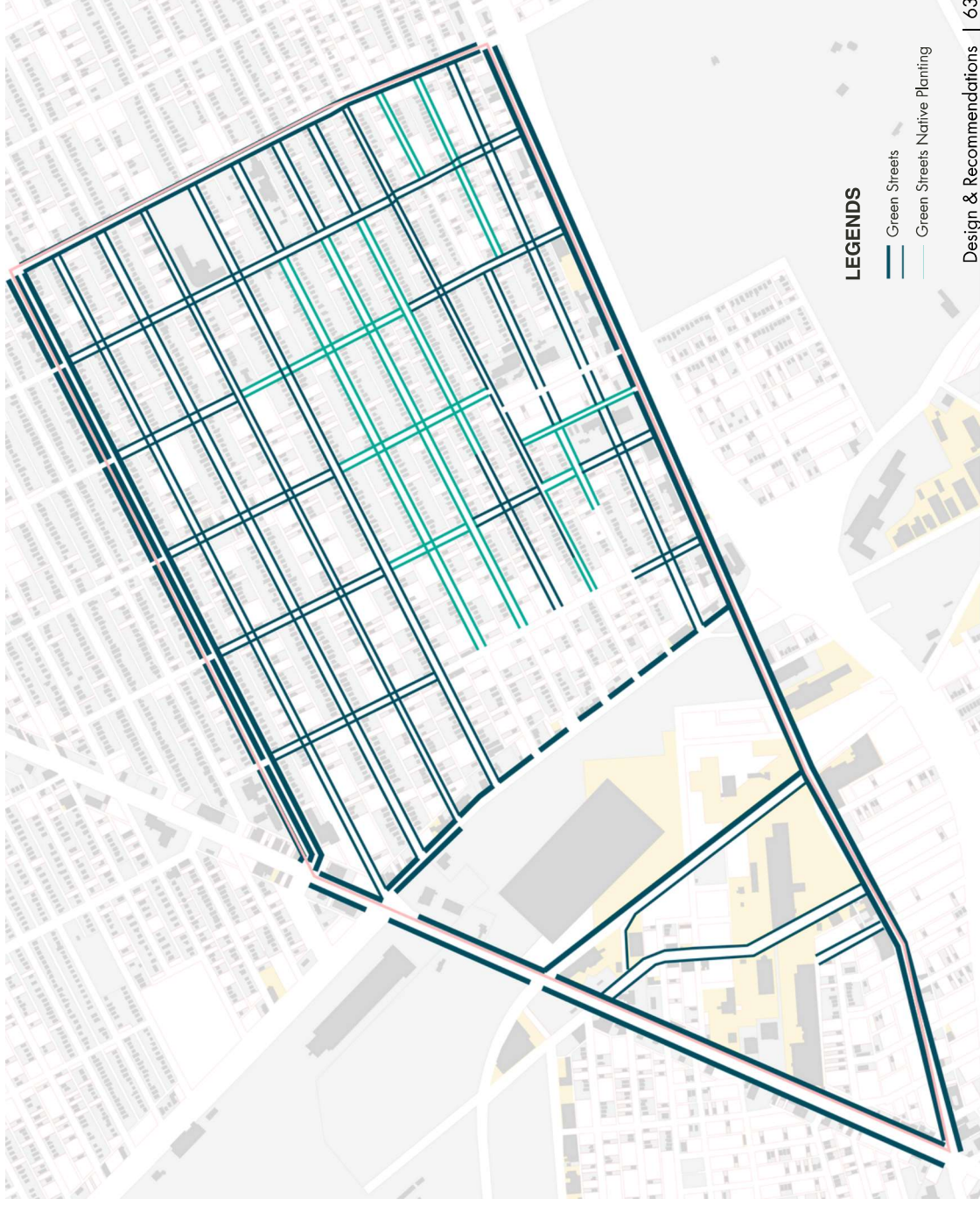


## GREEN STREETS

---

Green streets incorporate various forms of GSIs, such as bioswales and permeable pavements, into the streetscape.

Native plants are recommended for street segments with low to medium runoff and low risk of overflow.



## GREEN STREETS

Bioswales, similar to rain gardens, are installed along planting zones on medians, between curbs and sidewalks, or at the edges of rights-of-way. Selecting trees that can tolerate wet soil and temporary standing water further complements bioswale vegetation and street tree initiatives. Their benefits extend beyond stormwater management, also addressing heat island mitigation and aesthetic enhancement.

Please see Appendix I for native plants.

Permeable pavements can be utilized for driving lanes, parking areas, and sidewalks to support infiltration on the site. Both bioswales and permeable pavements play roles in filtering pollutants from runoff.

Image Sources:

Top Left: Clarion Associates.

Top Right: Mutual Materials

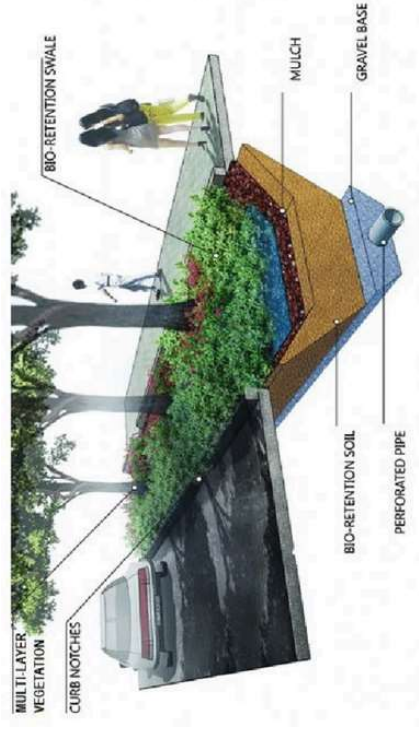
Bottom Left: Bay Area Bioswale

Bottom Right: City and County of San Francisco

BIOSWALE



PERMEABLE SURFACE





## GREEN STREETS: NATIVE PLANTING

In areas with narrow planting zones or established street trees, implementing bioswales may not be feasible. However, planting native species alone can enhance the soil's water storage capacity, increasing on-site retention and reducing runoff.

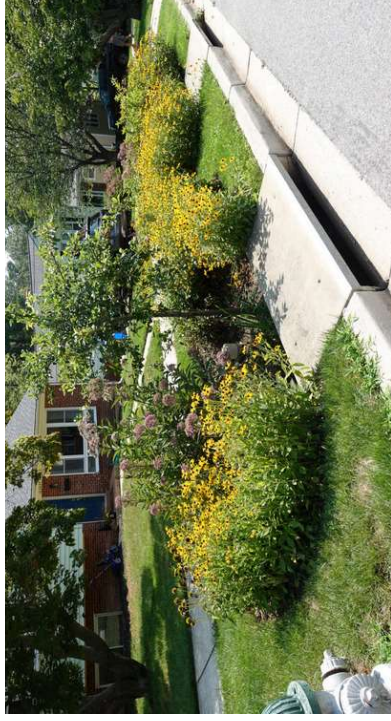


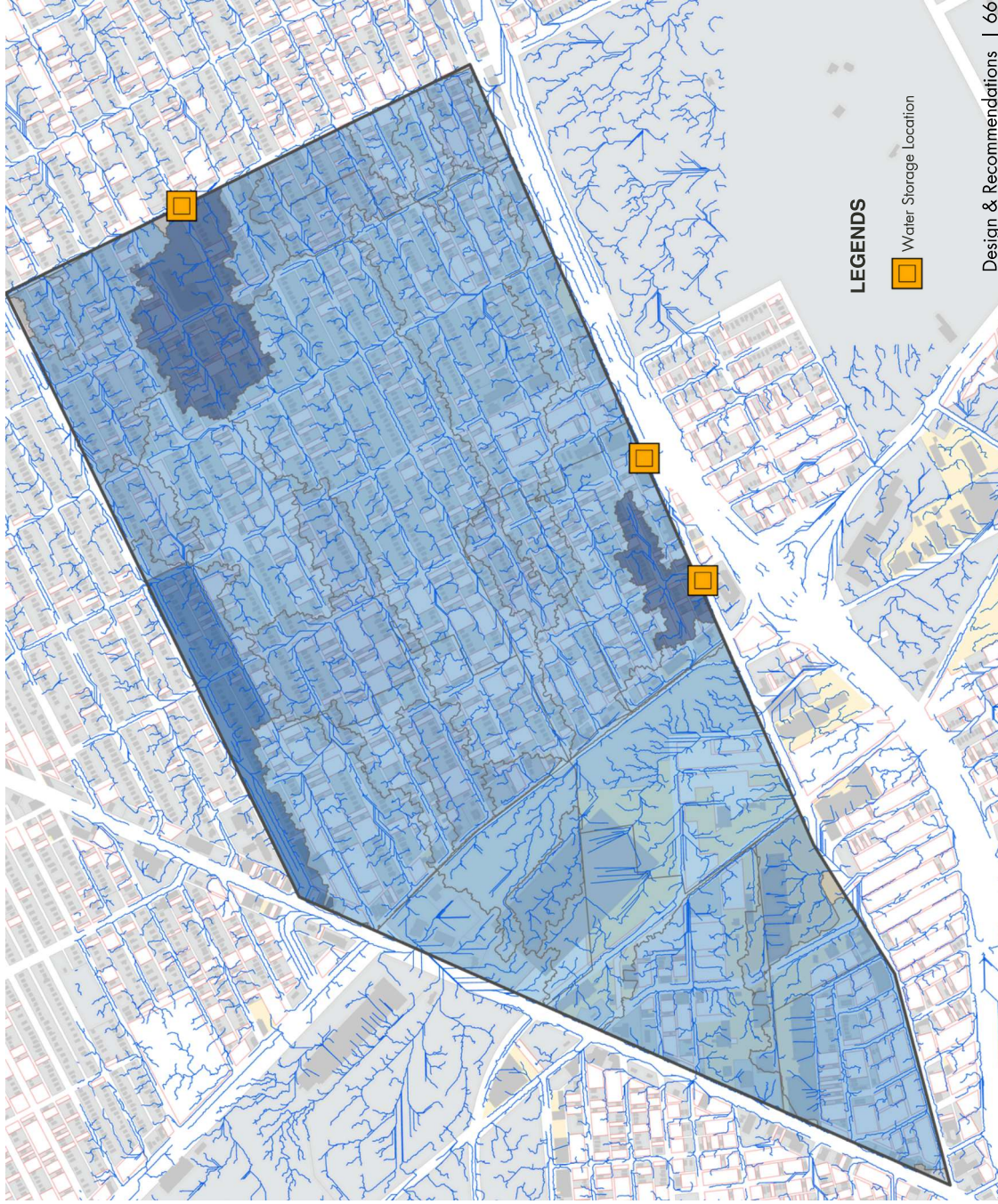
Image Sources:  
Top Left: City of Asbury Park and the Asbury Park Housing Authority  
Top Right: Alex Kim  
Bottom: Plant NOVA Natives



## **GREY INFRASTRUCTURE IMPROVEMENT RECOMMENDATION**

Considering the land availability constraints, GSIs alone are insufficient for addressing overflow issues in certain areas. We recommend enhancing drainage capacity to ensure reliable flood mitigation. By maintaining and improving existing sewer systems, their operating efficiency can approach full capacity, preventing sewer backups, a problem that GSIs cannot address. Effective results require watershed-level planning extending beyond the site's boundaries.

Please see Appendix II for underground water storage capacity recommendations.





## UNDERGROUND WATER STORAGE

---

In the short term, a reliable and more economically feasible option to curb flooding at particular spots is constructing underground water storage systems beneath roads or buildings. These systems, located at or downstream of high-risk overflow areas, do not necessitate extensive vacant land or open space. Stored stormwater can be extracted for later use or discharged slowly into the drainage system post-storm.

WATER STORAGE CELLERS



WATER STORAGE TANKS



STORMTRAP



Image Sources:

Top Left: Aggeres.

Top Right: Kristi Peterson,

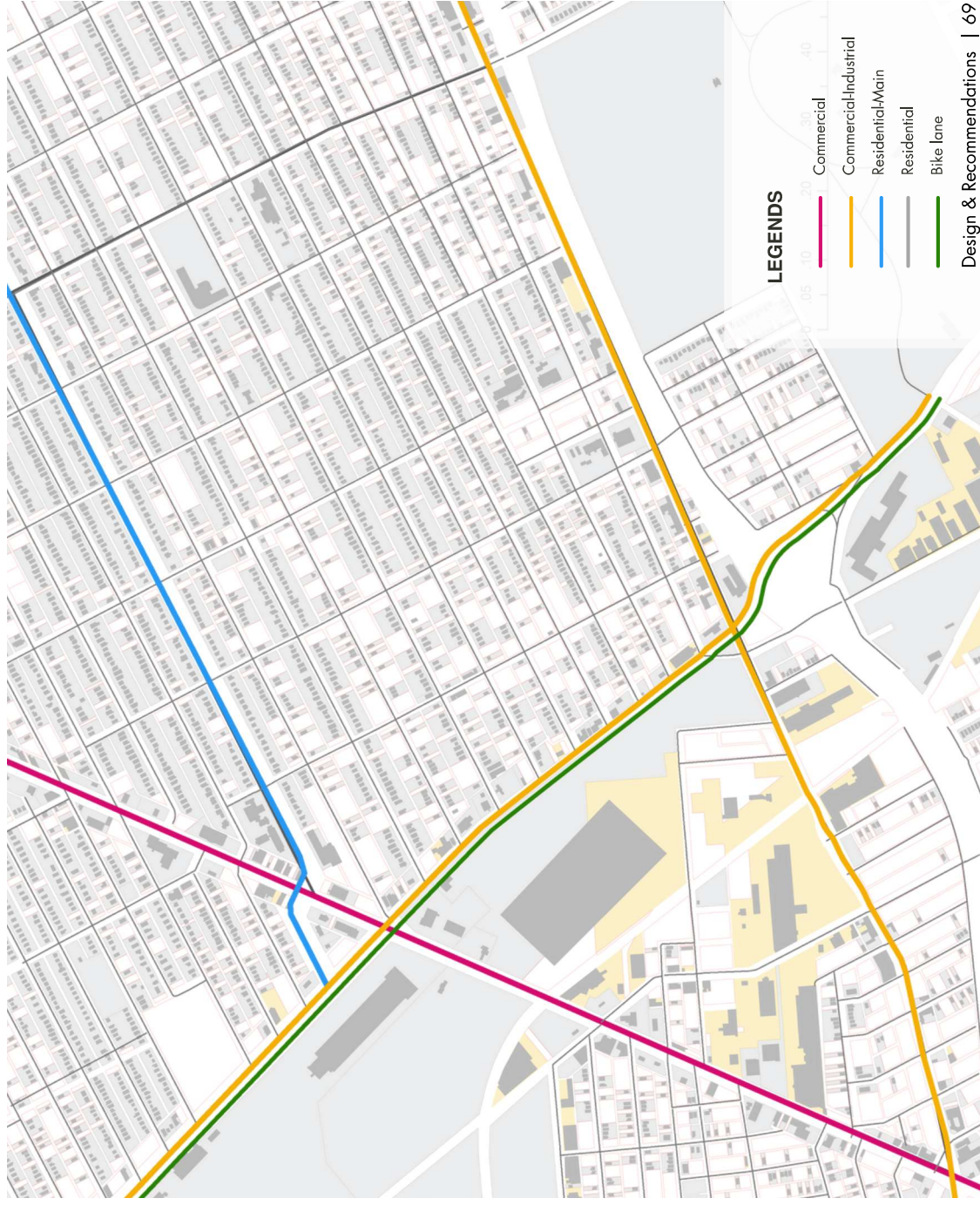
Bottom Left & Right: Stormtrap

# TRANSPORTATION & STREETSCAPE



## PROPOSED ROAD TYPE CLASSIFICATION

After a classification process, the new road system has five distinct categories: commercial, commercial-industrial, residential-main, residential, and bike line. This approach ensures that each road has referable road design standards to accommodate different traffic volumes, vehicle speeds and infrastructure requirements, thereby improving traffic safety and efficiency for vehicles and pedestrians, as well as urban beautification and greenway design. Ultimately this will lead to sustainable urban transportation and integrated use with surrounding land

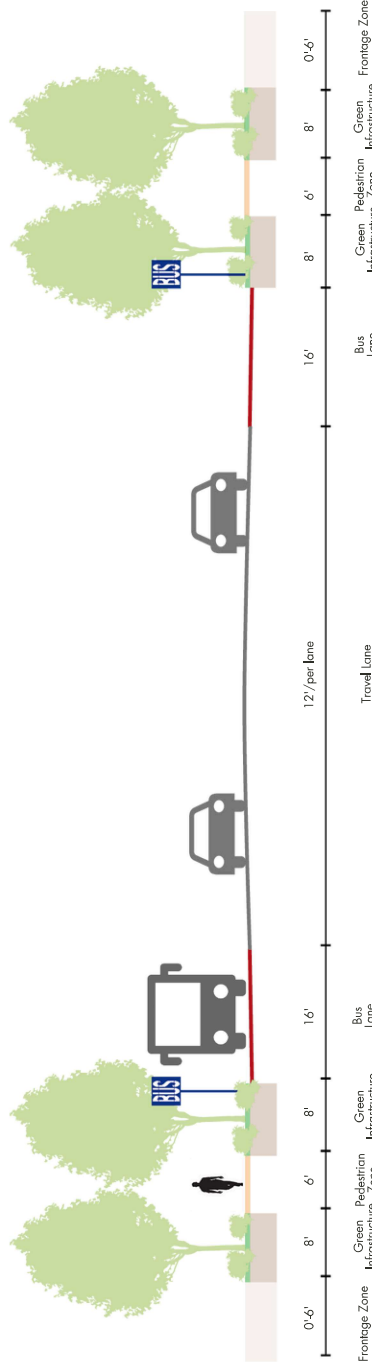
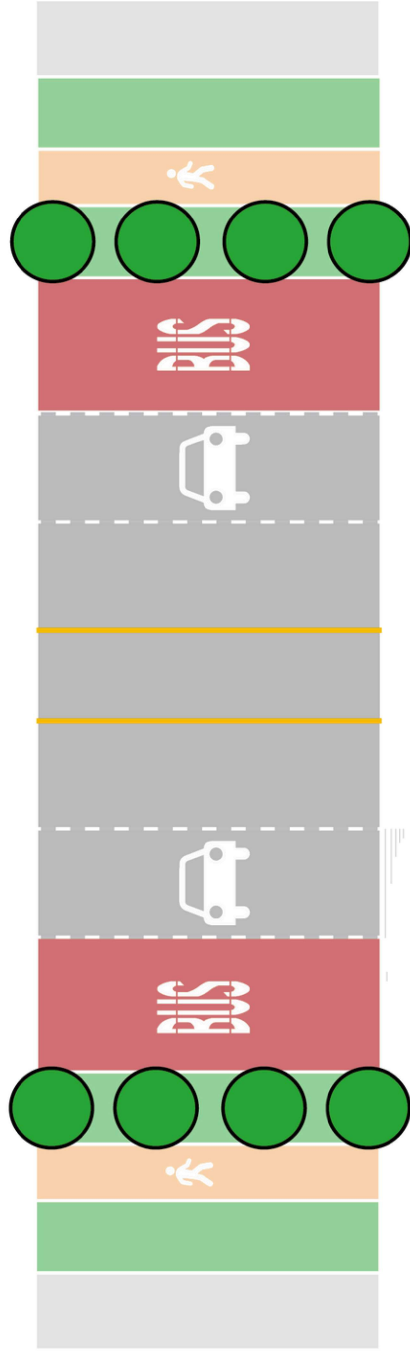


# 1 COMMERCIAL

## Gratiot Avenue

Recognizing the significance of the bus route, we have put forward a proposal to implement a distinctive red colored pavement. This is aimed at accentuating the importance of this transit artery and reinforcing its dedicated space within the urban landscape. In addition to this visual cue, we intend to enhance the experience for commuters by installing bus stop shelters, offering protection from the elements and a sense of comfort while waiting.

Furthermore, the inclusion of street trees along the route will not only contribute to a more aesthetically pleasing streetscape but also provide shade and improve the overall environment for pedestrians and transit users alike.





Bus lane

Adding Street Tree

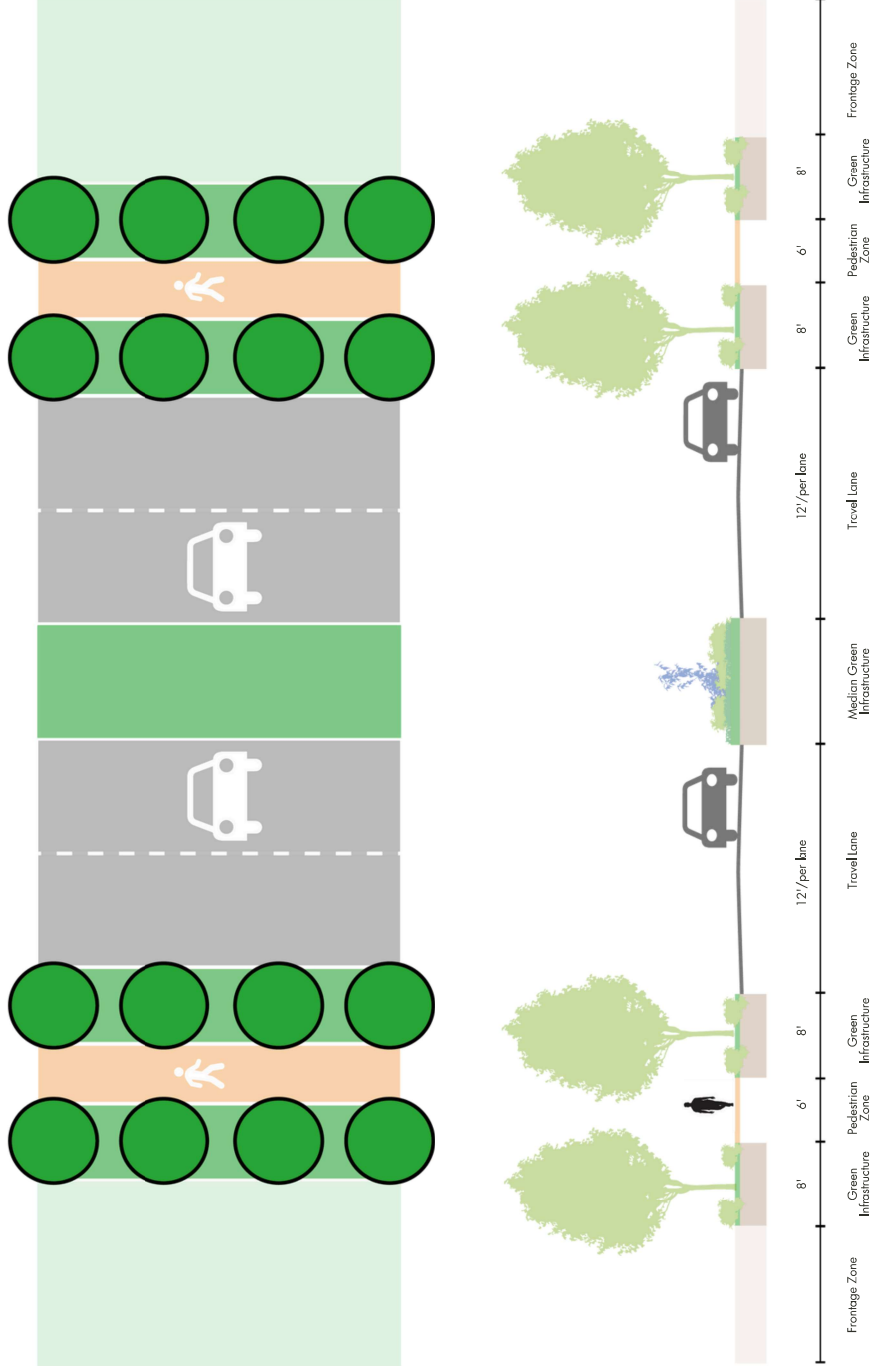
Bus Stop Shelters



## 2 COMMERCIAL - RESIDENTIAL

### Outer Drive East

Our proposal advocates for the retention of the current trees while integrating green infrastructure elements. This dual-purpose approach serves both stormwater management needs and enhances the overall streetscape aesthetics. Furthermore, to prioritize pedestrian safety, we plan to introduce pedestrian crosswalks at strategic points along the route. By blending environmental sustainability with safety considerations, our proposal aims to create a more resilient and people-friendly urban environment.





Median Green  
Infrastructure

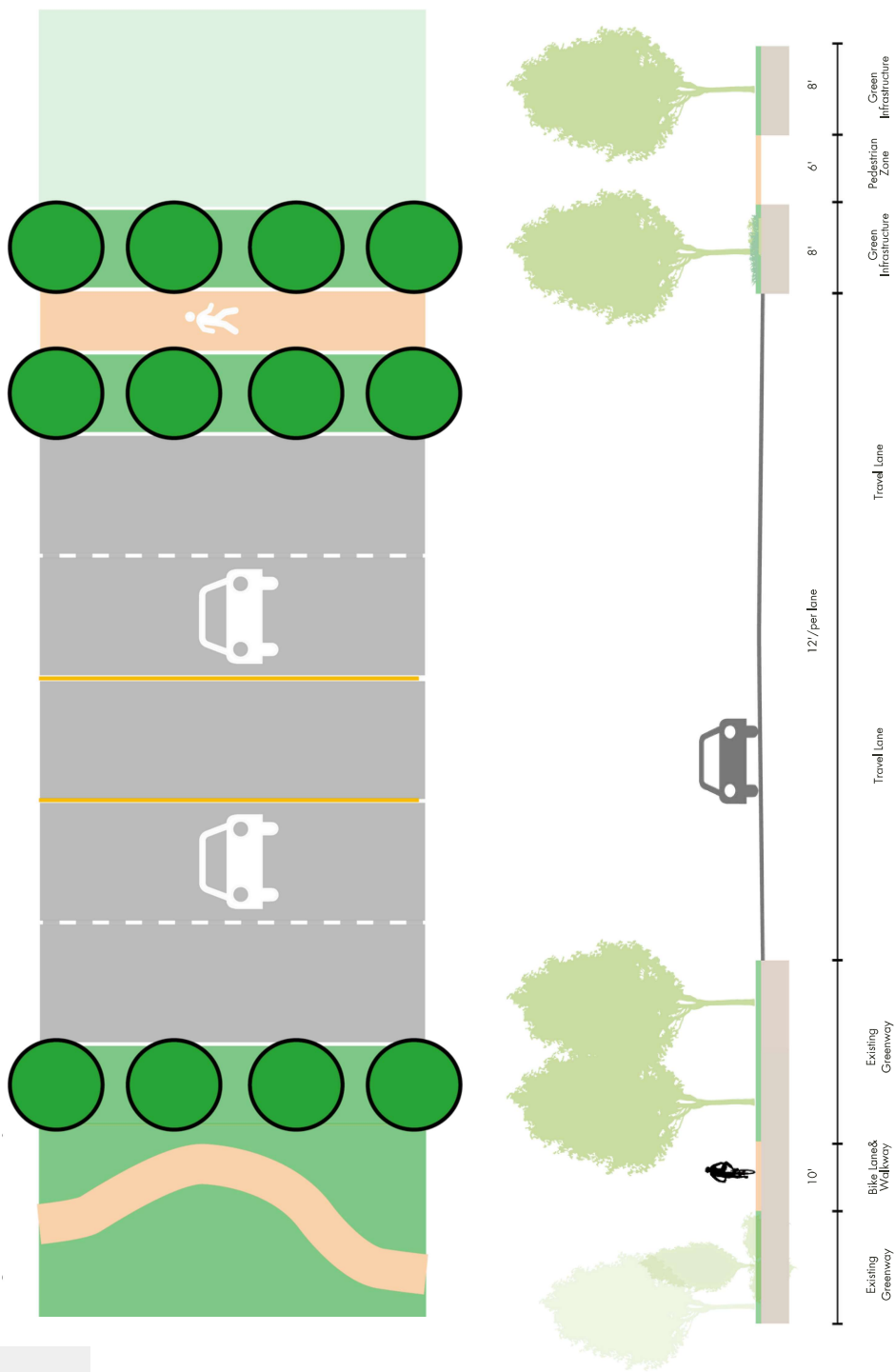
pedestrian  
crosswalk

### 3 COMMERCIAL - INDUSTRIAL

#### Conner Street

We propose the addition of street trees between driveways and pedestrian walkways, also preserving the existing bike lane infrastructure. By introducing these trees, we aim to not only improve the aesthetic appeal of the area but also provide shade and a sense of natural ambiance for both pedestrians and cyclists.

Retaining the bike lane ensures continued support for alternative modes of transportation, promoting a healthier and more sustainable urban lifestyle.







Street Tree

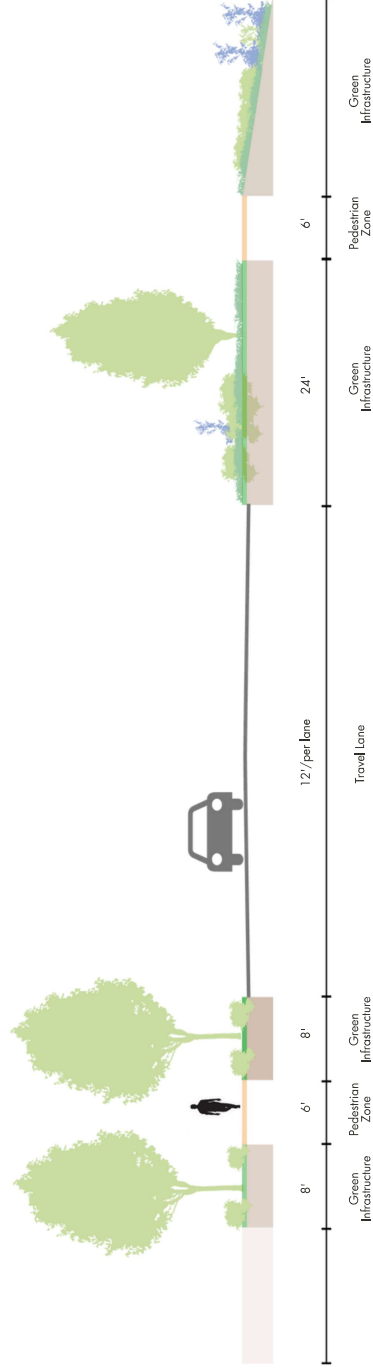
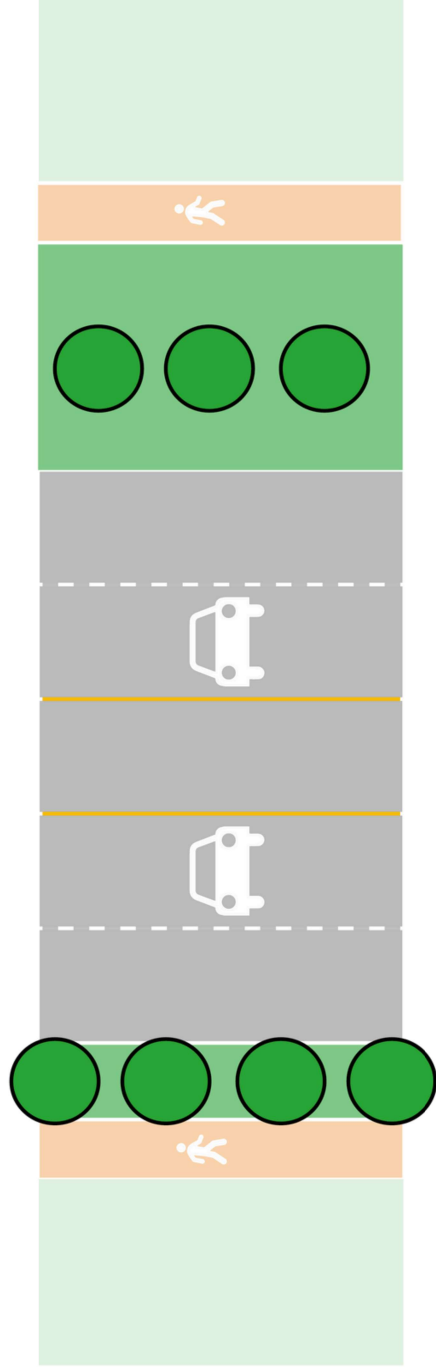
Bike Lane/  
Walkway

## 4 RESIDENTIAL - MAIN

### Harper Avenue

We propose the addition of street trees alongside the implementation of green infrastructure measures within the grass panels and slope areas. This serves to manage stormwater runoff effectively and improve the overall environmental resilience of the area.

By integrating street trees, we aim to enhance the visual appeal of the surroundings near the community center.







Green Infrastructure

Street Tree

Green Infrastructure

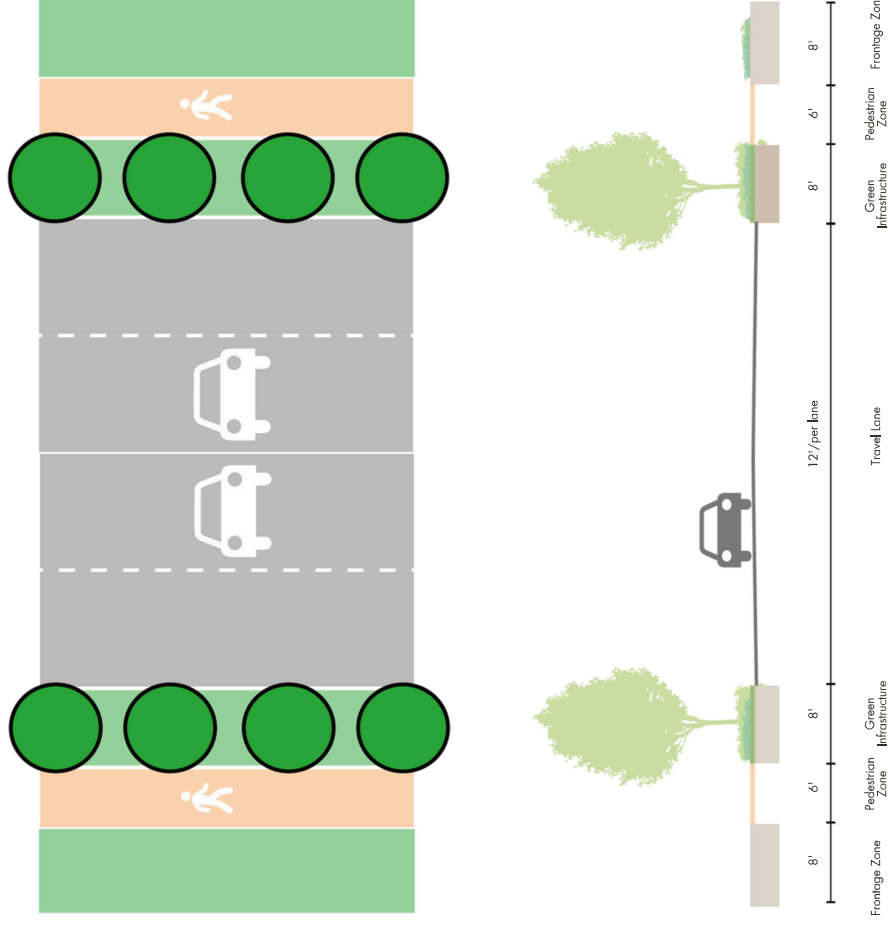


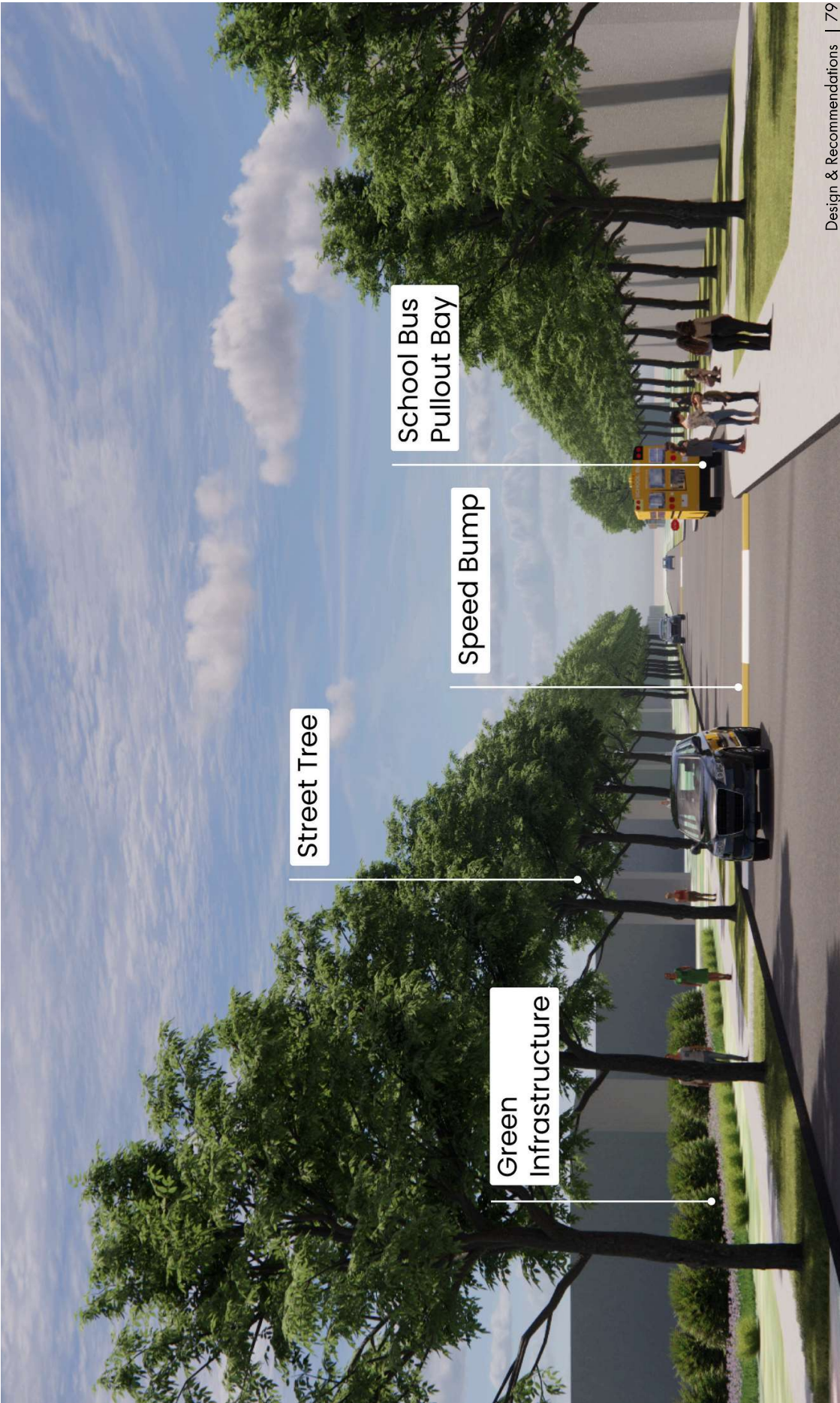
## 5 RESIDENTIAL

### Example: Chelsea Ave

We propose the addition of street trees along with the implementation of safety measures. To ensure the safety of residents, particularly in proximity to the school on Chelsea Avenue, we advocate for the installation of speed bumps aimed at reducing vehicle speeds and mitigating the risk of car accidents.

Additionally, we recognize the importance of school transportation, we plan to incorporate a designated pullout bay specifically for school buses, facilitating smoother traffic flow and ensuring the safety of students during drop-off and pick-up times.





Street Tree

Green Infrastructure

Speed Bump

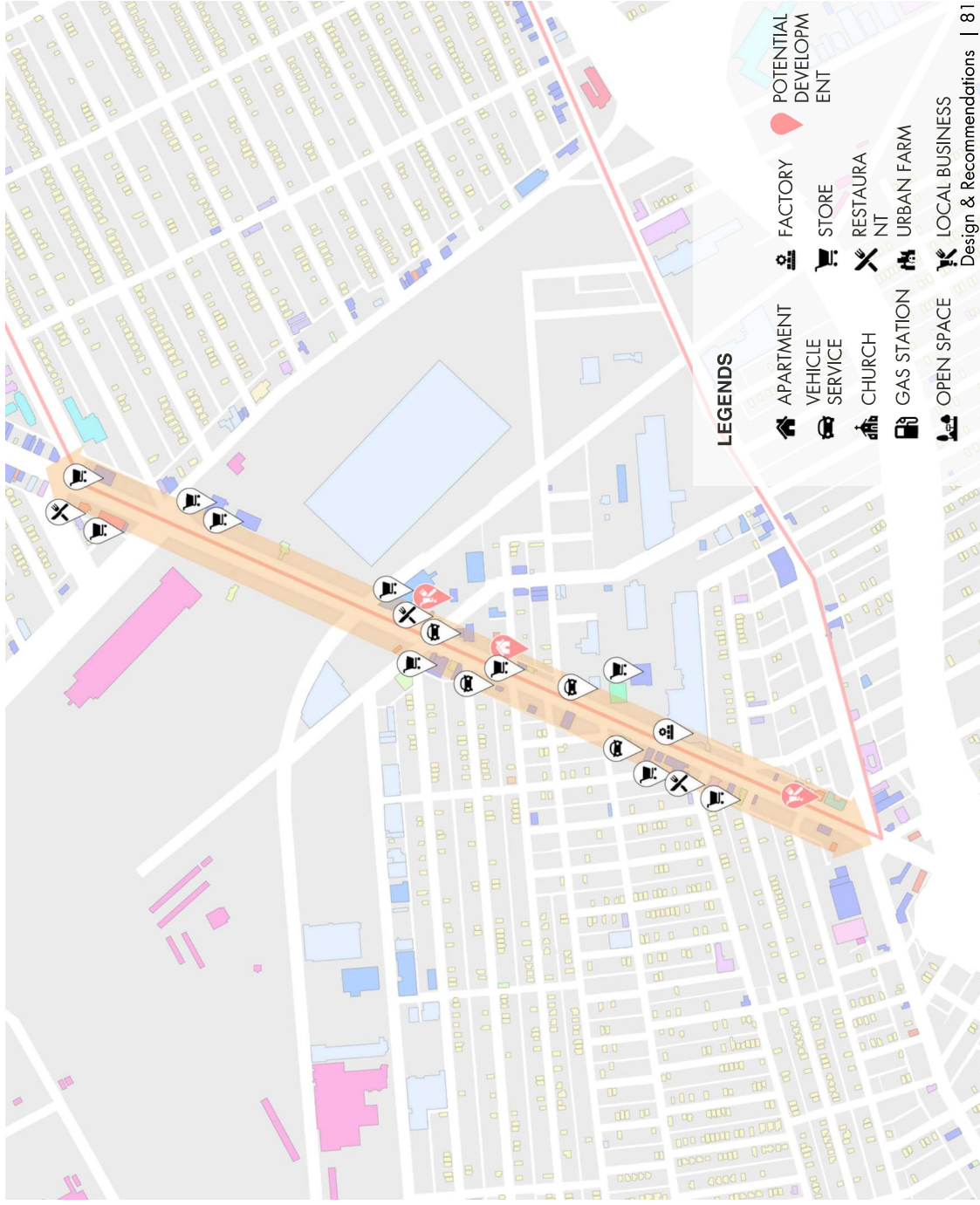
School Bus Pullout Bay

# COMMERCIAL AND MIXED-USE DEVELOPMENT



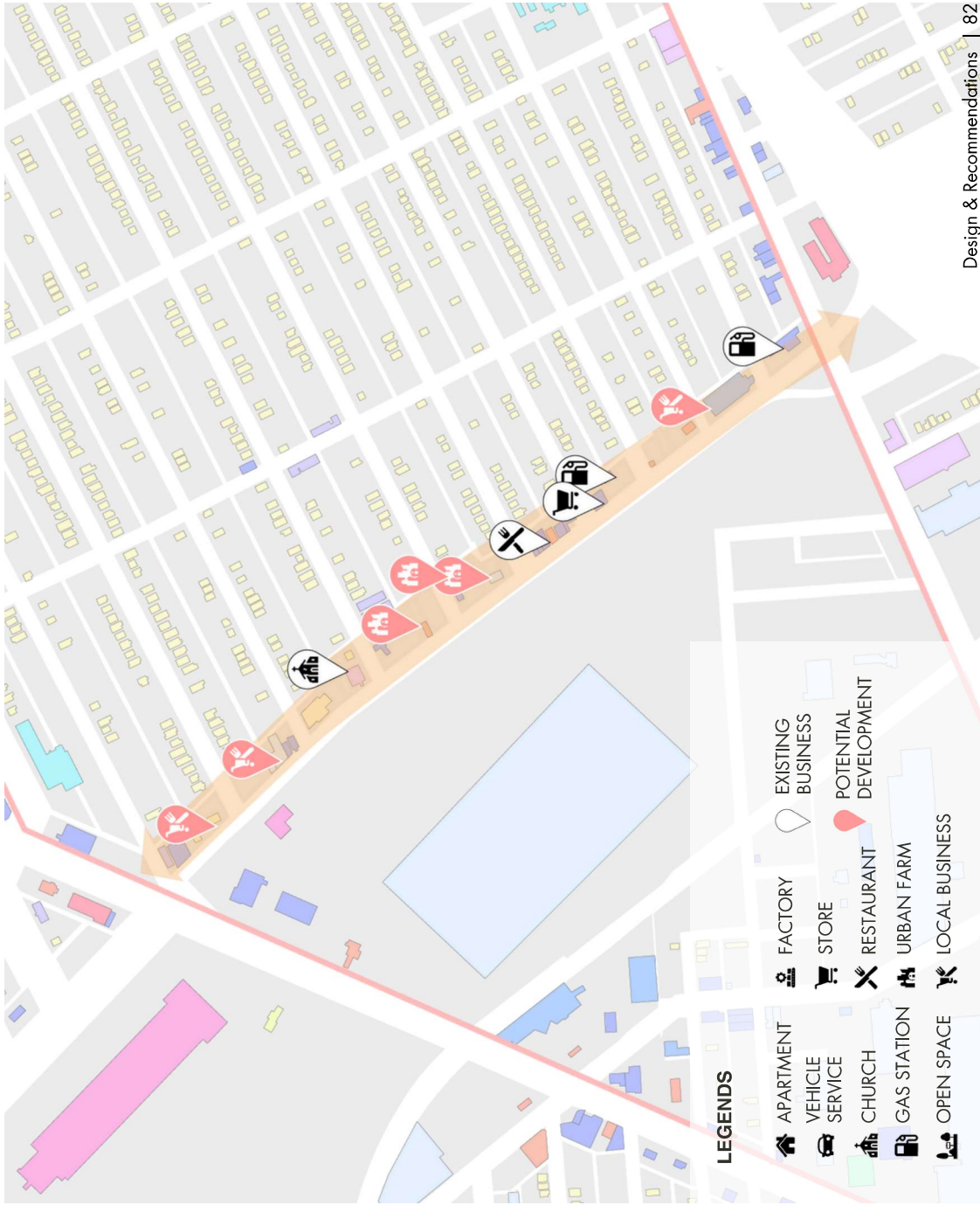
## GRATIOT AVENUE BUSINESS PLAN

On Gratiot Avenue, the main businesses here are car services and retail stores. There is a large amount of vacant land in the middle. We proposed to have a multi-story apartment to provide more affordable and modern homes to attract more residents to live here. They can easily get access to these stores nearby and find a job in these establishments.



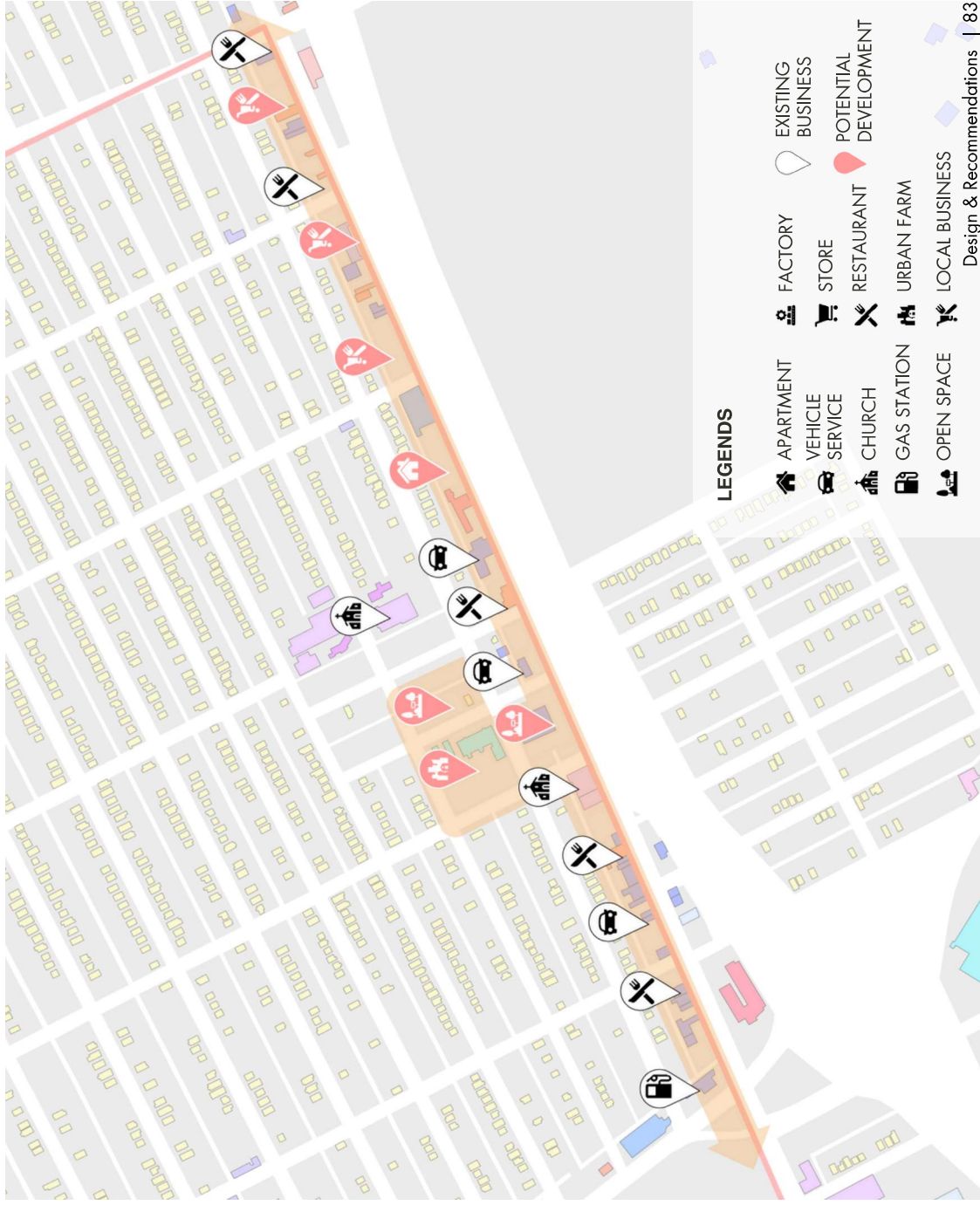
## CONNER STREET BUSINESS PLAN

Conner Street is not a busy street in this neighborhood. There are not many existing businesses, instead, only two gas stations, a church, a restaurant, and a store are still open. All we can see in this area is vacant land and abandoned buildings. For this street, we proposed to have a few urban farms here. Residents can plant their own vegetables here to ensure food security.



## HARPER AVENUE BUSINESS PLAN

Harper Avenue is adjacent to the highway and has more traffic and people. We proposed to have more diverse restaurants here. For the Thrifty Scot Supermarket area, there are two abandoned buildings and a area of large open space. The Thrifty Scot Supermarket building is abandoned and we decided to repurpose it into a community center. The building behind the Thrifty Scot Supermarket building was a school and it is also abandoned now, we proposed to transform it and its surrounding space into an urban farm. The open space will still be an open space for community activities.





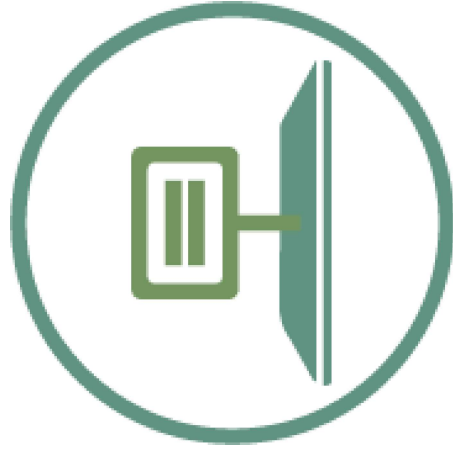
# COMMUNITY CENTER ENLARGEMENT PLAN

## DESIGN GOALS



Mitigate stormwater issues.

1



Reduce the vacant land by creating space for community activities and events.

2



Develop local businesses and increase revenue for current residents.

3

## ENLARGEMENT PLAN

The enlargement plan shows more details of our design. The plaza in front of the community center is a large space for events like the local market. These events will help create a stronger sense of community. In urban farm areas, the abandoned school building can be renovated for a vertical farm to increase the planting area. For the open space to the East, we proposed an amphitheater surrounded by a lawn. Residents can take a walk and enjoy nature here.





## GREEN INFRASTRUCTURE

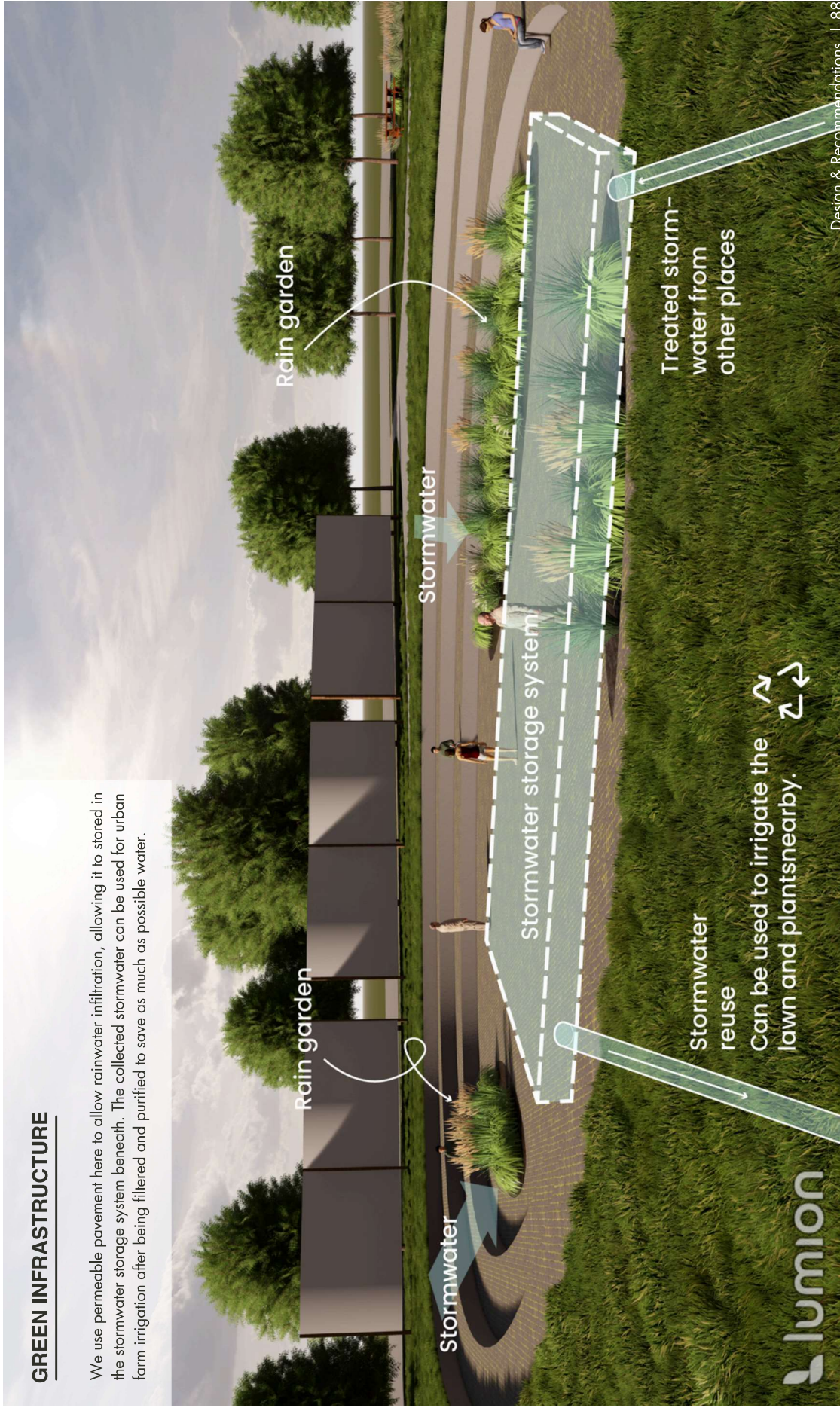
Green infrastructure including rain gardens, retention and detention ponds, and permeable pavements are set on this site. Most of them are along the side walk to collect the rain water from the impermeable surface.





## GREEN INFRASTRUCTURE

We use permeable pavement here to allow rainwater infiltration, allowing it to be stored in the stormwater storage system beneath. The collected stormwater can be used for urban farm irrigation after being filtered and purified to save as much as possible water.

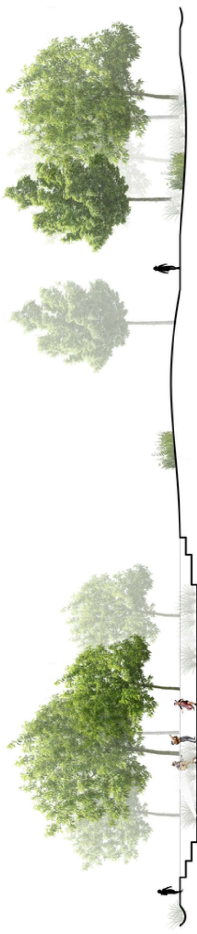


## GREEN INFRASTRUCTURE

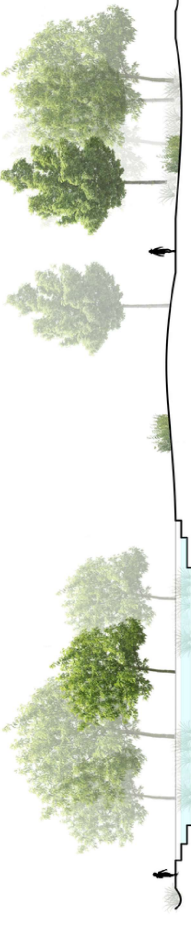
If it rains a lot, the Amphitheatre can also function as a detention pond to hold and distribute rain runoff and prevent flooding. During regular times, residents can sit, exercise and enjoy the space.

We picked some native plants to ensure the landscape of all seasons, including shrubs, perennials, grass, and ferns. They are all wet and salt-tolerant, perfect for rain gardens.

### NORMAL TIME



### DURING STORMWATER EVENT



### WETLAND PLANTS



**ILEX  
VERTICILLATA**



**DIRCA  
PALUSTRIS**



**ECHINOPS RITRO  
'VEITCH'S BLUE'**



**ECHINACEA  
PURPUREA**



**SCHIZACHYRIUM  
SCOPARIUM**



**SPOROBOLUS  
HETEROLEPIS**



**ATHYRIUM  
FILIX-FEMINA**



**COMPTONIA  
PEREGRINA**

Image Sources (left to right, up to down):

1. Lady Bird Johnson Wildflower Center Plant Database
2. North America Eco Floras
3. Gardenia
4. Lady Bird Johnson Wildflower Center Plant Database
5. Hoffman Nursery
6. Hoffman Nursery
7. Wikipedia
8. Gardenia



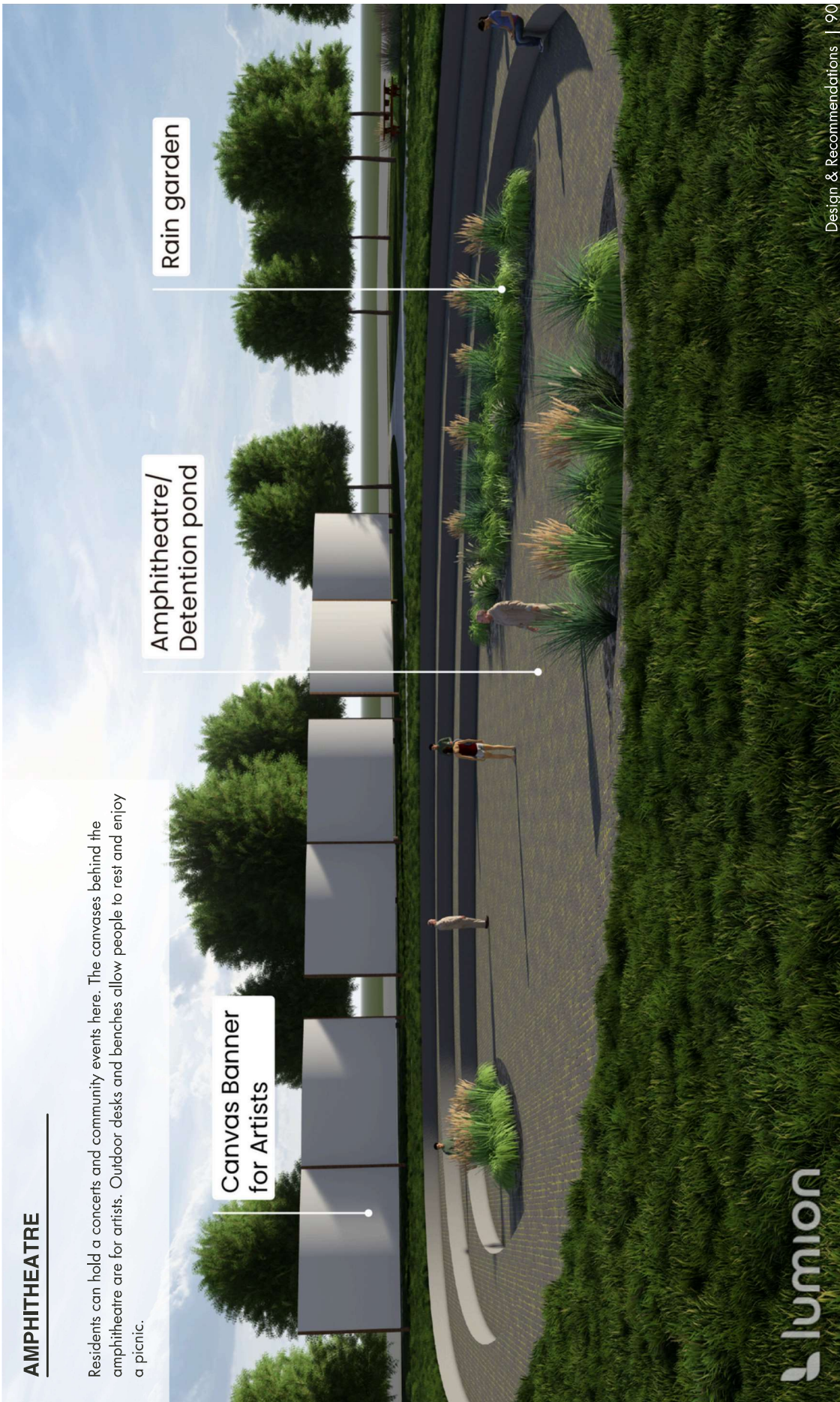
## AMPHITHEATRE

Residents can hold a concert and community events here. The canvases behind the amphitheatre are for artists. Outdoor desks and benches allow people to rest and enjoy a picnic.

Canvas Banner  
for Artists

Amphitheatre/  
Detention pond

Rain garden





## LOCAL MARKET

The local market will be set in front of the community center. People can sell their products produced in urban farms, as well as selling other things they don't need anymore.

Local market

Tree planter with bench

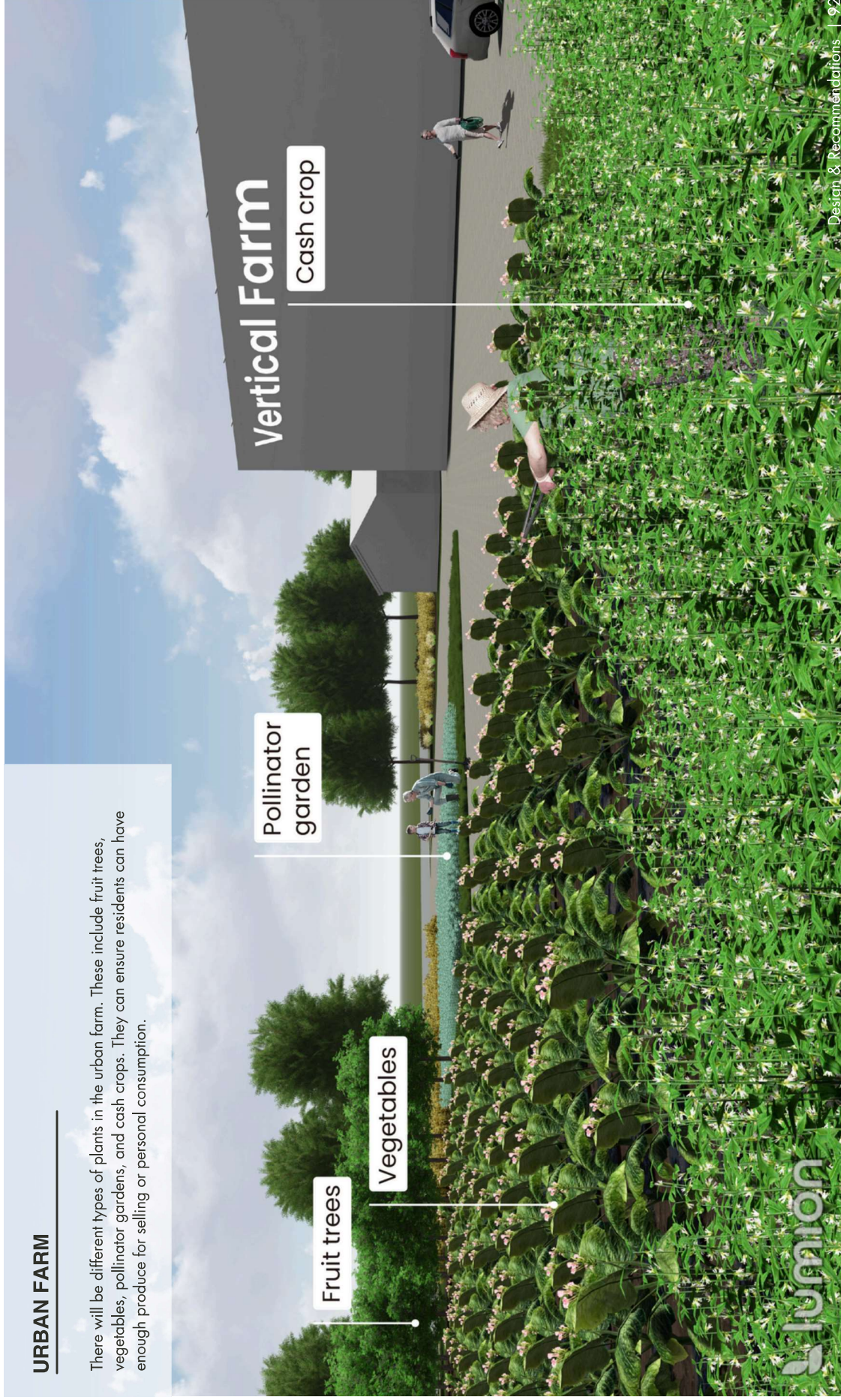
community center





## URBAN FARM

There will be different types of plants in the urban farm. These include fruit trees, vegetables, pollinator gardens, and cash crops. They can ensure residents can have enough produce for selling or personal consumption.





# POLICY RECOMMENDATIONS

## Introduction

Policies and programs focused on climate and environmental justice and community revitalization are crucial for several reasons. Firstly, they address systemic inequalities and promote social equity by ensuring that all communities, particularly marginalized ones, have access to resources and opportunities for growth. By prioritizing environmental justice, these initiatives aim to mitigate the disproportionate impact of pollution and climate change on vulnerable populations, fostering healthier and more sustainable living environments for all. Moreover, community revitalization effort contribute to economic stability and prosperity by fostering business growth, creating job opportunities and enhancing property values. Overall, these policies and programs not only improve quality of life but also promote resilience, inclusivity and long-term sustainability within the community.

### Community Urban Garden Program

Community urban garden programs offer a multitude of benefits, contributing to social, environmental, and economic well-being. Firstly, they foster community cohesion by providing spaces for residents to gather, collaborate, and cultivate meaningful relationships. These programs promote healthy living by increasing access to fresh, nutritious produce and encouraging physical activity through gardening. Moreover, urban gardens enhance urban biodiversity, mitigate urban heat island effects, and improve air quality by sequestering carbon dioxide and filtering pollutants. Economically, they can boost property values, generate income through produce sales or community-supported agriculture initiatives, and create job opportunities. Additionally, urban gardens provide educational opportunities, teaching valuable skills such as gardening, nutrition, and environmental stewardship, thus empowering individuals and communities to lead sustainable lifestyles. Overall, community urban garden programs play a vital role in promoting social equity, environmental sustainability, and community resilience in urban areas.

An example of previous implementation is the "GreenThumb" program in New York City. GreenThumb is a program under the New York City Department of Parks & Recreation that supports community gardens throughout the city. It provides resources, technical assistance, and educational opportunities to help residents create and maintain community gardens in urban areas.

### Community Driven GSI Management Program

Community-driven maintenance of GSI recommendations and plantings plays a crucial role in the sustainability and effectiveness of stormwater management initiatives. By actively involving residents in the care and upkeep of GSI features such as rain gardens, bioswales, and tree plantings, communities can foster a sense of ownership and responsibility, ensuring the long-term success of these projects. Additionally, educating residents on the importance of plant care not only enhances the aesthetic appeal of neighborhoods but also promotes environmental stewardship and biodiversity. Residents who understand the value of native plantings and GSI in managing stormwater runoff are more likely to actively participate in maintenance efforts, ultimately contributing to improved water quality, reduced flooding, and enhanced ecological resilience within their communities. Through collaboration between residents, local governments, and environmental organizations, community-driven maintenance and education initiatives can create lasting positive impacts on both the quality of the environment and the effectiveness of stormwater infrastructure. Collaboration with the Detroit Water and Sewerage Department would be beneficial for implementation.

An example of previous implementation is the "RainWise" program in Seattle, Washington. This program encourages residents to install rain gardens, cisterns, and other green infrastructure on their properties to manage stormwater runoff. The program provides financial incentives, technical assistance, and educational resources to participants, empowering them to take an active role in stormwater management while also improving the overall quality of the environment.

### "Workforce Innovation and Opportunity Act" (WIOA)

WIOA aims to strengthen the workforce development system and help job seekers, including those with barriers to employment, access high-quality employment, education, and training services. WIOA emphasizes collaboration between workforce development, education, and economic development entities to better align training programs with local labor market needs and support individuals in acquiring the skills and credentials necessary to secure well-paying jobs and advance in their careers.

### "Green Cities Partnership"

This recommendation comes from research about increasing the overall quality of life for residents in urban areas through green actions. A previous example of implementation is the "Green Cities Partnership" in Seattle, Washington. This collaborative initiative brings cities and other local organizations to promote urban forestry, parks, and green spaces as essential components of urban livability.

The Green Cities Partnership focuses on increasing tree canopy coverage, enhancing parks and natural areas, and engaging communities in stewardship activities such as tree planting, invasive species removal, and habitat restoration. By prioritizing green infrastructure and environmental conservation efforts, the Green Cities Partnership aims to improve air and water quality, mitigate urban heat island effects, provide access to nature and recreational opportunities, and foster community connections. Through partnerships, public engagement, and innovative green strategies, the program seeks to create healthier, more sustainable, and equitable urban environments for all residents.

#### **“Creative Placemaking”**

The "Creative Placemaking" initiative by ArtPlace America provides funding and technical assistance to support projects that integrate arts and culture into community development efforts. Creative Placemaking projects may include public art installations, cultural events, performances, and other creative activities that engage and reflect the unique identity of local communities. By leveraging the power of art and culture, these projects aim to revitalize neighborhoods, enhance social cohesion, promote economic development, and improve the overall quality of life for residents. Through partnerships with artists, community organizations, local governments, and other stakeholders, Creative Placemaking fosters creativity, innovation, and collaboration to transform public spaces and strengthen community connections.

#### **Greening of Vacant Properties**

There are numerous benefits that come along with greening vacant properties. Green spaces enhance the aesthetic appeal of neighborhoods, making them more attractive places to live, work, and visit. Green spaces provide opportunities for physical activity, relaxation, and social interaction, leading to improved mental and physical well-being for residents. Vegetation helps absorb and slow down rainwater, reducing stormwater runoff and mitigating flooding and erosion in urban areas. Greening vacant properties increases habitat diversity, supporting native plant and animal species and promoting urban biodiversity. Vegetation helps reduce the urban heat island effect by providing shade, cooling the air, and reducing temperatures in surrounding areas. Trees and plants absorb pollutants and carbon dioxide from the air, improving air quality and reducing the impacts of air pollution on human health. Green spaces enhance property values and attract investment, leading to economic revitalization and increased community wealth. Green spaces provide opportunities for community engagement, events, and activities, fostering social connections and building stronger neighborhoods. Overall, greening vacant properties contributes to sustainable urban development, environmental stewardship, and the overall quality of life for residents.

A previous example of implementation of these greening practices comes from "Reimagining the Civic Commons" initiative in Philadelphia, Pennsylvania. As part of this program, vacant lots and underutilized spaces in neighborhoods are transformed into green infrastructure projects such as rain gardens, pocket parks, and community gardens. These green spaces not only enhance the aesthetic appeal of the neighborhood but also help manage stormwater runoff, reduce flooding, and improve water quality in nearby waterways. By engaging residents in the design and maintenance of these green spaces, the initiative fosters a sense of ownership, promotes community pride, and strengthens social connections within the neighborhood.

#### **Monthly Community Cleanup Program**

A monthly community clean-up offers numerous benefits to both the environment and the community. Regular clean-up events help reduce litter in public spaces, making the community cleaner and more attractive for residents and visitors. Clean streets, parks, and neighborhoods enhance the overall appearance of the community and foster a sense of pride and well-being among residents. Removing litter and debris from natural areas helps protect local ecosystems, wildlife habitats, and waterways from pollution and harm. Community cleanup efforts can lead to cleaner environments that promote better physical and mental health for residents, as they are more likely to engage in outdoor activities and enjoy the benefits of green spaces. Community cleanup events bring residents together to work towards a common goal, fostering a sense of community spirit. Cleanup events provide opportunities for environmental education and awareness, teaching participants about the importance of waste reduction, recycling, and environmental stewardship. They also encourage volunteering and civic engagement, empowering residents to take an active role in improving their community. Moreover, cleaner community can attract businesses, tourism, and investment, leading to economic growth and development. Overall, monthly community clean-ups contribute to a healthier, more vibrant, and sustainable community for all residents to enjoy.

A previous example of implementation is the "Great American Cleanup" organized by Keep America Beautiful, a nonprofit organization dedicated to improving communities through litter prevention, waste reduction, and beautification initiatives. This program relies on volunteers to participate in cleanup events.



# FUNDING SOURCES

## **Introduction**

As the City of Detroit continues to develop into a robust community, identifying funding sources is essential in feasible development plans as it serves as the financial backbone necessary to bring projects to fruition. This capstone project provides several insightful opportunities for development and management of issues within the project site. While our recommendations are ambitious in nature, we strive to provide a framework the city may use in future development projects or neighborhood framework plans. Projects of this caliber are no small feat. The city is tirelessly working on projects to continue to develop the city and restore it to the greatness it is capable of. Therefore, we understand the need for providing easily accessible avenues of funding to ease financial stress. We have identified numerous essential sources of funding in regards to our main content deliverables.

The identification of funding sources consists of four main components. The first identifies the purpose behind the identification of the funding source. This will provide context as to how the source can be accessed to address our deliverables. The second component identifies the eligibility criteria needed to receive funding. Thirdly, the amount of funding to be received or available will be disclosed. Finally, any deadlines that need to be met within the foreseeable future will be discussed. If the funding source is not used directly for this project, we hope these recommendations can be useful for current and future projects. We will identify funding sources specific to our content deliverables, as well as sources that can be accessed for general community improvement.

## **Stormwater Management**

### **Strategic Water Quality Initiatives Fund (SWQIF) Loans**

SWQIF Loans can be accessed through the Michigan Department of Environment, Great Lakes and Energy (EGLE). The objective of SWQIF Loans is to assist municipalities in funding wastewater treatment system improvements, storm water treatment projects, and nonpoint source pollution control projects. These loans can be used to fund capital costs only (planning, design, construction), not operation and maintenance costs. SWQIF Loans include green infrastructure projects that aim in reducing or eliminating ground water or storm water from entering sewer leads. The eligibility requirements include municipalities that do not qualify for SRF assistance, projects on private property. Financing can be used for project design and construction engineering, legal and financial services, preparation of plans and specifications, construction costs, reasonable administration costs are covered. Criteria for funding in regards to our deliverables includes include: projects conducted on private property and used for on-site downspout and footing-drain disconnecting work; or the reduction or elimination of ground water or storm water from entering sewer leads.

Consideration points may also be considered if water quality improvement expected. Funds ranging between \$10,000,000 and \$20,000,000 are available annually. The annual deadline to apply for this loan is July 1st.

**Water Pollution Control Revolving Fund (Clean Water State Revolving Fund - CWSRF)**  
CWSRF funds can also be accessed through EGLE. The objective of these funds is to assist municipalities in addressing water quality problems identified in watershed management plan such as wastewater treatment system improvements, storm water treatment projects, and nonpoint source pollution control projects. In regards to CWS, this funding source includes investment in land conservation, reforestation, tree boxes, cisterns and rain barrels, downspout disconnections, wetland restoration, parks and greenways, rain gardens and bioinfiltration practices, permeable pavements, green roofs. Criteria for funding in regards to our deliverables includes municipalities investing in cisterns and rain barrels, downspout disconnections, parks and greenways, rain gardens and bioinfiltration practices, permeable pavements and/or green roofs. This funding program only funds capital costs (planning, design, and construction), no operational or maintenance expenses are included. Funds up to \$280,000,000 are awarded annually. The annual deadline to apply for CWSRF funding is July 1st.

## **Transportation & Streetscape**

### **Michigan Transportation Alternatives Program**

Funding for this program is available through the Michigan Department of Transportation (MDOT). The objective of this program is to fund projects that increase and improve Michigan's transportation system. Projects can include facilities for pedestrians and bicyclists, viewing areas, historic preservation and rehabilitation, and environmental mitigation efforts. Grants can be applied to treating or reducing storm water runoff from transportation facilities and structures. Those eligible to receive funding through this program include county road commissions, cities, villages, regional transportation authorities, transit agencies, state and federal natural resource or public land agencies, and tribal governments are eligible. The criteria for funding requires that projects should be identified as a result of a community's Complete Streets stakeholder involvement process and be part of community improvement or economic development plans. Funds up to \$16,500,000 are awarded annually on a continuous basis.

## **Community Development**

The sources identified in this sub-section can be applied to multiple deliverables found in our project. Many of them focus on improved community development and the creation of healthy, sustainable cities.

### **Land and Water Conservation Fund (LWCF)**

Grants are available through the Michigan Department of Natural Resources (MDNR) for the purpose of recreation development. Specifically, the LWCF grants can be used to develop land for public outdoor recreation. Any state, or local, government that has an approved DNR 5-Year Recreation plan are eligible for funding. Some of the criteria for selection includes how closely the proposed project aligns with the 5-year Recreation Plan, as well as how well it aligns with the overall State Comprehensive Outdoor Recreation Plan (SCORP). For this specific program, green infrastructure can be included as part of a larger park plan. Funds ranging between \$30,000 and \$150,000 are awarded annually. The annual deadline to apply for this grant is April 1st.

### **Community Forestry Grants**

Another program available through the MDNR are community forest grants. This program specifically provides competitive funding for the promotion, protection and management of urban trees. We found this funding source to be useful considering many of our designs include the use of street trees in an urban context. Green infrastructure plans that include trees (street trees, swales with trees, naturalized areas, etc.) could be funded from this grant. Those eligible to receive funding include non-profits and local units of government. The criteria for selection requires that projects are one year in duration and develop or enhance urban forestry resources in Michigan including: management, planning, and education. Funds up to \$20,000 depending on project category are available annually through a continuous application process.

### **National Urban and Community Forestry Program**

Through the United States Department of Agriculture (USDA) and under the U.S. Forest Service, this program's objectives are to establish sustainable community forests that improve the public's health, well-being, and economic vitality, and create resilient ecosystems for present and future generations. Street trees and tree boxes can be included as part of a sustainable urban forest. Funding eligibility requirements may be found by contacting the U.S Forest Service. Funding is variable and dependent on availability and type of grant. When funds are available, cost-share grants support urban and community forestry projects that have national and multistate application and impact. Funding deadlines may also be found by contacting the U.S Forest Service.

### **Ralph C. Wilson Jr. Foundation Healthy Communities Grants**

This private foundation provides community grants for the use of supporting community design and access to space, and programs that support healthy living; improving non-profit productivity and innovation; and economic development levers that spur regional growth, innovation and equity. Federal 501(c)(3) organizations, local units of government, school districts and universities located in Wayne County are eligible to receive funding. Green infrastructure as part of community design can be included in the grant. Funds and deadlines for applications vary depending on the grant being applied for.

### **Community Foundation for Southeast Michigan**

This private foundation supports effective program and project ideas that can improve life in Wayne County, as well as other municipalities. Federal 501(c)(3) organizations, local units of government and universities located in Wayne County are eligible to receive funding. Organizations are prioritized based on sustainability, regional impact, how the funds will be leveraged, and collaboration between multiple entities (nonprofit and/or government). Green infrastructure to improve quality of life in the area can be funded by this program. Funding ranges between \$5,000 and \$1,000,000, depending on the availability of funds. The deadline for application is continuous. However, the foundation prefers applications on or shortly before: February 15, May 15, August 15, or November 15

### **Environmental & Climate Justice Community Change Grants**

Funds made available through the Inflation Reduction Act (IRA), facilitated by the Environmental Protection Agency (EPA), can be accessed to enhance our project deliverables. These grants support comprehensive community and place-based approaches to redressing environmental and climate injustices for communities facing legacy pollution, climate change, and persistent disinvestment. These concentrated local investments will fund community-driven, change making projects that center collaborative efforts for healthier, safer, and more prosperous communities. The objective of this grant include: providing resources for community-driven projects to address environmental and climate challenges in communities facing disproportionate and adverse health, pollution, and environmental impacts, and suffering from generations of disinvestment; investing in strong cross-sectoral collaborations with partners who bring a robust commitment to working with and for communities with environmental and climate justice concerns; unlocking access to additional and more significant resources to advance environmental and climate justice goals from across the federal government and other sources; empowering communities and strengthen their capacity to drive meaningful positive change on the ground for years to come; and strengthening community participation in government decision-making processes that impact them.



# 5

## COMMUNITY ENGAGEMENT

## **Introduction**

Community engagement is an indispensable component of urban planning and neighborhood revitalization, particularly in cities like Detroit where each community has its own unique identity and set of challenges and where existing infrastructure and experiences must be addressed in the revitalization process. Engaging the community provides a platform for the voices of residents to be heard and integrated into the planning process; it ensures that the proposals are not just reflective of data and urban theory but grounded in the lived experiences and needs of those who inhabit the space. When residents are involved early and often, their feedback can validate and inform the draft designs, offering insights that can confirm or challenge initial assumptions and lead to more thoughtful, responsive proposals. This process not only increases the likelihood of successful implementation by securing public buy-in but also empowers residents, fostering a sense of ownership and responsibility towards the future of their neighborhoods - community engagement allows for ownership of revitalization.

In the context of Detroit's neighborhood revitalization efforts, community engagement is crucial for gauging reactions to proposed draft designs. Active dialogue with community members is necessary to elicit perspectives on what works, what requires greater investment, and why. Such engagement activities—whether they occur through town hall meetings, focus groups, or surveys—serve as a barometer for measuring the community's pulse on various aspects of the proposals, from aesthetic concerns to functional impacts. Engagement also is an opportunity to go deeper into understanding the community's ongoing needs, challenges, and the potential unintended consequences of proposed changes. By dissecting these elements with the community, city planners and decision-makers can adjust their strategies to better align with the community's vision, ensuring that interventions do more than just transform spaces, but rather mend and enhance the social and economic fabric of the neighborhoods they are intending to serve. Community engagement is not just a procedural step, but a continuous, evolving relationship between the city and its residents, crucial for fostering resilient and vibrant communities in Detroit's revival.

Our engagement process began with an intent towards a grassroots approach, organizing repeated small-group focus meetings aimed at fostering intimate and transparent conversations with residents and area stakeholders; our plan was to actively listen to the community, creating an environment where individuals felt comfortable to express their thoughts and concerns; we believed that starting at this local level, before bringing in expert opinions, would ground our work in the reality of resident experiences and needs and involve local stakeholders through the entirety of the design process.

As the project progressed, in response to evolving timelines and challenges in organizing and executing community meetings, we gradually opted for input from experts specializing in stormwater management, mixed-use development, streetscape and transportation design, and policy and funding, to provide a professional dimension to the community's insights; while not fully reflective of the residents of the area, we believe expert and practitioner insight can serve as a valuable first step in understanding broader community themes, which would prepare for future resident interfacing. By integrating technical expertise with local knowledge, our goal was to create proposals that were both visionary and pragmatic, grounded in addressing real concerns while being transformational.

To more efficiently navigate the complex web of feedback and to streamline our focus, we decided to concentrate our efforts on acquiring interim feedback directly from City of Detroit Departments and some select representative community and non-profit organizations, each of which encapsulate a diverse range of perspectives, shaped by their respective objectives and areas of expertise. Our scaled engagement was not only designed to assess the viability of our proposals but also to gather a more nuanced understanding of the area's challenges, current developments, and opportunities. This approach ensured that our revitalization strategies were in sync with the city's and community organizations' ongoing initiatives and long-term goals, ultimately aiming to create synergies that could amplify the positive impact of our collective efforts in Detroit's neighborhoods. A list and description of city departments and neighborhood organizations can be found on the following pages.

The Institutional Review Board (IRB) process is an essential component of any research activity that involves human subjects, established to ensure ethical standards are met and that the rights and welfare of participants are protected. In the context of our engagement process with the City of Detroit Departments and community organizations, we recognized that our research did not involve vulnerable populations or sensitive topics that IRB typically scrutinizes. We prepared a thorough application to the IRB that detailed our methods of data collection, including the nature of the conversations and the use of generalized, de-identified communication to protect individual privacy. Our conversations were primarily consultative and aimed at benefiting public welfare through infrastructure improvement, putting them outside the range of IRB's standard review. After a careful review of our research protocols and the nature of the engagement activities, we successfully filed for an exemption from full IRB review; this exemption affirmed that our project complied with regulatory frameworks and ethical standards for research, allowing us to proceed with confidence that our engagement approach was responsible and respectful of all participants' rights.

## **City Departments**

### **Detroit Water and Sewerage Department (DWSD)**

The Detroit Water and Sewerage Department is a municipal agency that has been providing water and wastewater services to residents of Detroit and neighboring communities since 1836. Its mission is to ensure the provision of high-quality drinking water and the safe treatment of wastewater, promoting public health and sustainability. DWSD serves more than 230,000 accounts that includes residential, commercial, and industrial customers in Detroit and partial service to 76 other communities in Southeast Michigan. It focuses on maintaining and improving water and sewer infrastructures, while also striving for environmental excellence and enhancing the quality of life for all its service recipients. Its goals and objectives include upgrading the water supply and sewage treatment facilities, ensuring regulatory compliance, and providing customer-focused, fiscally responsible service. We chose this department for communication owing to its stake in addressing stormwater management and flood mitigation efforts.

### **Detroit Department of Transportation (DDOT)**

The Detroit Department of Transportation is the public transit operator serving the city of Detroit, Michigan, and surrounding suburbs. DDOT provides bus services within Detroit and to neighboring cities, facilitating movement for residents and visitors through comprehensive transit options. DDOT aims to offer reliable, affordable, and accessible transportation to improve mobility, enhance the quality of urban life, and support economic growth and environmental sustainability. Serving its diverse ridership, the department is also dedicated to enhancing the safety and efficiency of its transit system as part of its broader goals. Its objectives include expanding service routes, improving bus fleets, optimizing schedules, and embracing technology for better rider experience. DDOT was selected to provide input on the status of transportation and streetscape.

### **Detroit Planning and Development Department (DPDD)**

The Detroit Planning Department is dedicated to shaping the physical, economic, and social spaces within Detroit. The department's responsibility is to guide the city's development through strategic urban planning, zoning, and land use policies. Serving residents, businesses, and stakeholders, the Planning Department's overarching goal is to create vibrant, equitable, and sustainable neighborhoods. It achieves this by engaging with communities to develop plans that reflect their vision, aspirations, and needs. Objectives include formulating master plans, overseeing design reviews, ensuring compliance with zoning laws, and advising on land-use decisions that foster orderly growth and development.

### **Detroit Department of Neighborhoods (DON)**

The Detroit Department of Neighborhoods (DON) was established to provide a direct connection between the city's administration and its residents at the neighborhood level. The department serves the residents of Detroit's diverse communities, investing in neighborhood stabilization and improvement. Its goal is to empower neighborhoods by facilitating access to city services, implementing beautification projects, and advocating for community needs. The department works towards creating a more engaged, vibrant, and resilient urban fabric. Objectives include improving housing quality, reducing blight, and supporting community organizations to enhance the quality of life within neighborhoods. We chose this department owing to its direct work and experience with residents and daily on-the-ground challenges associated with successful neighborhood organization and administration.

### **Detroit Economic Growth Corporation (DEGC)**

The Detroit Economic Growth Corporation is a nonprofit organization that works to design and implement innovative solutions for driving economic development in Detroit. Serving both the public and private sectors, DEGC works collaboratively to attract new investment, stimulate job growth, and support the overall economic vitality of the city. Its goals are to foster a robust, sustainable economy that provides opportunities for all Detroiters. The DEGC's objectives include business attraction and retention, entrepreneurial support, placemaking, real estate redevelopment, and the management of incentives to stimulate economic activity.

### **Detroit City Council (District #3)**

The Detroit City Council is the legislative body governing the city of Detroit, with individual council members representing different districts, including District #3; this district encompasses the northeastern part of the city and includes various neighborhoods, including the bulk of our focus area. The city council serves residents by addressing their concerns and advocating for their needs in the council. The goals and objectives of individual council members might focus on improving public safety, enhancing local infrastructure, encouraging economic development, and fostering community engagement specific to district constituents. Additionally, the council member is responsible for proposing and voting on laws, budgets, and initiatives that can have district-specific impacts, including zoning, policy, and financing opportunities.



## **Community Organizations**

### **Keep Growing Detroit**

Keep Growing Detroit is a non-profit organization focused on promoting a food sovereign city where the majority of fruits and vegetables Detroiters consume are grown by residents within the city's limits. The group aims to encourage the development of a food system that prioritizes health, affordability, and community strength. Keep Growing Detroit supports agriculture as a means to enhance quality of life for Detroiters by providing resources and education for urban gardens and farms. Their objectives include expanding community and school gardens, fostering market gardens and urban farms, and offering education in sustainable agricultural practices and healthy eating. By empowering residents to grow their own food, the organization not only serves the immediate needs of communities but also fosters long-term environmental stewardship and economic development. We chose this organization to provide feedback on proposals on urban farming and land reclamation for food production.

### **Detroit Eastside Community Collaborative (DECC)**

The Detroit Eastside Community Collaborative is focused on fostering the redevelopment and revitalization of Detroit's east side through collaborative efforts. They are actively involved in land use planning, green infrastructure development, and community organizing to improve the quality of life for Eastside residents. An essential component of their work is the development and maintenance of greenways and parks that enhance non-motorized transportation and recreational opportunities. Their objectives include creating sustainable and walkable communities, improving the neighborhood environment, and connecting people and places through greening projects. Much of their success relies on engaging residents in the planning process and partnering with local organizations and stakeholders.

### **Friends of the Detroit City Airport (DET)**

Friends of the Detroit City Airport (also referred to as Coleman A. Young International Airport) is a non-profit advocacy group focused on supporting and promoting the airport, ensuring its role as a vital component of regional transportation infrastructure. This organization serves local residents, businesses, educational institutions, and aviation enthusiasts by striving to highlight the airport's economic and social importance to the Detroit community. The group's goals include advocating for the sustained and improved operation of the airport, fostering community relations, and promoting aviation education and career opportunities. Objectives often comprise engaging with stakeholders to develop strategies to enhance airport facilities and services, and working alongside community organizations to integrate the airport into local development plans.

### **Connor Creek Greenway**

While Connor Creek Greenway is not an organization but rather a physical network of bike lanes, pathways, and parks, it is administered via the DECC and is representative of community buy-in and shared vision planning for infrastructure, green space, and mixed-use development. The greenway itself is designed to connect the Detroit River to Eight Mile Road along the historic Connor Creek; this project serves both recreational users and commuters, providing safe and scenic routes for biking, walking, and running. The primary goals of the greenway are to improve the quality of life for surrounding communities, promote physical activity, provide alternative transportation routes, increase environmental awareness, and to potentially facilitate economic development through increased connectivity. The greenway objectives include connecting gaps in the trail system, maintaining the infrastructure, and ensuring the safety and accessibility of the greenway for all users. We relied on the Greenway as an example of how community organization can be translated into concrete designs and strategies to enhance public and social well-being.

## Key Themes

### Resident-Centered Design

In the context of Detroit's infrastructure and economic revitalization efforts, resident-centered design is a crucial theme. This approach puts the needs, preferences, and experiences of Detroit's residents at the forefront of planning and development processes; the goal is to ensure that any changes are not just top-down impositions but are inclusive of the insights and participation of the community members who will be most impacted. Resident-centered design in Detroit may involve developing transportation systems that work for all neighborhoods, facilitating equitable access to essential services such as quality education, healthcare, and jobs, and ensuring that residents feel a sense of connection to the rest of the city—both physically and socially. This last point is salient in context of Detroit currently experiencing differential growth and development across neighborhoods, and the need for residents to feel connected with the city beyond their immediate area. For example, the expansion of public transit routes and improvements in digital infrastructure can help residents feel more integrated with the wider urban fabric.

### Sustainable, Adaptive Solutions

Detroit's approach to sustainable, adaptive solutions involves balancing long-term environmental goals with the immediate needs of its residents. The city's investment in green infrastructure, such as urban agriculture and the greenway networks, serves as an example of a long-term strategy that promotes sustainability and addresses climate resilience, which will be important in coming decades. These initiatives not only assist in managing issues like flood prevention in the short term but also contribute to improved air quality, reduced urban heat island effect, and enhanced recreational spaces for the long term. Solutions that are adaptive ensure the city remains agile and responsive to emerging challenges, such as shifts in climate patterns or economic turbulence, making sustainability a key component of Detroit's resilience. At the same time, immediate fixes need to be considered, such as replacement of aging stormwater infrastructure to prevent future flooding, which necessarily cannot wait for long-term implementation.

### Need to Address Underlying, Systemic Challenges

As Detroit works towards revitalization, acknowledging and addressing the underlying, systemic challenges is essential. These issues may include entrenched economic disparities, racial segregation, aging infrastructure, and policy frameworks that have historically put certain populations at a disadvantage. Detroit's efforts must go beyond superficial enhancements to tackle the structural roots of inequity to create lasting change. Initiatives may include reforming zoning laws, investing in neighborhood-specific development projects, implementing inclusive economic policies, and building educational programs that target systemic unemployment.

### Detroit Not a "Blank Slate"

Detroit is rich with history, culture, and tight-knit communities. Urban planning and economic revitalization initiatives must respect this fabric, rather than viewing the city as a "blank slate" open for development and potential gentrification at the expense of existing community composition and culture. Revitalization efforts should aim to preserve cultural and historical landmarks that celebrate Detroit's heritage, with a view towards reinforcing existing communities and relationships, rather than displacing them. This can be achieved by engaging local stakeholders in decision-making processes, coordinating with neighborhood groups, and honoring the city's legacy through restoration and integration of historical sites, in addition to innovating within existing infrastructural and spatial frameworks and understanding, respecting, and working with resident desires (which may include opposition to development).

### Tying Revitalization to Cultural, Historical Landmarks

Connecting new development to Detroit's cultural and historical landmarks can help foster a sense of community pride and continuity and encourage greater resident buy-in. Revitalization efforts that incorporate landmarks not only enhance the city's unique character but also contribute to a shared identity among residents. This approach can draw tourism, support cultural education, and broaden economic opportunities. For instance, rehabilitating iconic buildings and integrating them with new uses, or creating cultural hubs around these landmarks, can stimulate local economies while preserving the city's heritage. Upholding Detroit's unique character and architectural style, development efforts should progress within existing spaces as much as possible, as opposed to *de novo*, potentially anachronistic or incongruous efforts.

### Need for Greater Transparency, & Communication

For revitalization efforts to be successful and gain public trust, greater transparency and communication are imperative. This entails regularly informing residents about ongoing projects, forthcoming changes, and the city's long-term vision; moreover, it requires providing platforms for feedback and fostering a two-way dialogue where city officials and residents can openly discuss the impact of various initiatives. Such transparency helps ensure that policies and projects reflect the will and needs of Detroiters, and it minimizes the potential for misunderstanding or mistrust. Transparent communication can also help simplify complex processes like budget allocations, zoning changes, or the introduction of new technologies, making the city's growth more inclusive.

### **Current State of Engagement, and Concerns**

We received overall positive feedback to draft designs for stormwater management, transportation and streetscape design, and mixed-use planning from city departments as well as community organizations; this generally indicates that our plans were understood of area problems and inclusive of stakeholder and client needs, while being culturally and socially sensitive; additionally positive feedback bolsters the notion that our designs are forward-thinking and aesthetically pleasing and sensible. At the same time, proposal feedback highlighted some concerns that underscore the ongoing, iterative process of design and the continuing demand for further community engagement to better gauge area challenges and barriers to proposal implementation and long-term impact.

### **Feasibility**

Questions regarding the feasibility of proposals are critical as they touch on how realistic the plans are given Detroit's economic climate, social fabric, and existing infrastructure state. Feasibility concerns drive stakeholders to thoroughly examine the resource availability, technical requirements, and potential regulatory hurdles associated with draft designs. Our draft designs piqued questions on how much such transformative revitalization efforts would cost, and whether investment of time and limited resources would be realistic to such a scope; given that most large-scale, publicly financed development efforts occur piecemeal and are conservative in their objectives, we may in the future have to scale down our proposals, or seek more lean, cost-efficient fixes.

### **Timeline**

The timeline for when draft designs will materialize into tangible projects is a focal concern among Detroit's residents and stakeholders. Hypothetical timelines serve as a roadmap for the implementation process and provide a sense of the pace at which changes will occur. Timelines need to be realistic and account for project phases including community consultation, planning, funding, construction, and post-construction evaluation, as well as stochasticity; given that Detroit continues to grapple with socioeconomic barriers and must prioritize projects, and that community engagement, zoning, and construction management and execution are grounded in uncertainty, it is very possible that our proposed plans may not materialize for decades, or may evolve.

### **Beneficiaries**

Identifying who the proposed ideas will benefit is central to equitable urban development strategies. In Detroit, this means ensuring that revitalization efforts do not disproportionately favor certain groups but are inclusive of all demographics, particularly those who have historically been marginalized. Draft designs should be evaluated to ascertain benefits for various constituencies, including homeowners, renters, small businesses, local entrepreneurs, and vulnerable populations.

### **Ongoing Needs**

#### **Greater Interfacing with Residents**

A key ongoing need is to maintain and even increase the interface with residents, ensuring that their voices continue to shape the revitalization efforts. This could involve more frequent and varied community meetings, integrating feedback tools, and ensuring there are continuous channels open for residents to share concerns, ideas, and suggestions as the projects evolve. As we did not get to directly communicate with area residents, this would be a priority moving forward.

#### **More Detailed Conversations with City Departments, Community Organizations, and Partners in Policy and Funding**

To transform proposals into reality, detailed conversations are required with various city departments, community organizations, and partners in policy and funding. These talks should focus on aligning visions, refining the details of draft designs, allocating roles, and securing the financial resources necessary for implementation. It is through these coordinated efforts that the city can turn conceptual plans into actionable projects.

#### **Need to Bring Together Stakeholders, Communicate a Cohesive Agenda**

Revitalization requires a collaborative approach that involves all relevant stakeholders, including residents, businesses, non-profits, and government entities. Establishing a common agenda that reflects all perspectives is essential for unified citywide support. This involves building consensus, reconciling different interests, and establishing a shared path that all parties can commit to and support.

#### **Need for Integrative, Evolving Dialogue**

Finally, keeping the dialogue ongoing and allowing it to evolve as conditions change and new information emerges is fundamental to the successful implementation of revitalization plans. This dialogue should be integrative, considering various factors such as economic trends, technological advancements, and changing community demographics. An evolving conversation ensures that the city's strategies remain dynamic and adaptable, addressing the needs of Detroit as they arise and shifting. It ensures a continuous feedback loop and the ability to make informed adjustments to revitalization strategies in real-time.



# 6 CONCLUSION

In summary, our project, as requested by the Detroit Planning Department in concert with the UM SEAS Sustainability Clinic, sought to revitalize a Detroit neighborhood that has historically grappled with challenges, notably flooding and poor watershed management, lack of safe and sustainable transportation infrastructure, and diminished business presence and absent community space. Having analyzed the current state of stormwater control, streetscape and transit opportunities, and commercial and mixed-use development, we identified areas of potential intervention, and drafted designs to address these challenges.

Our designs, incorporating contemporary and historical data as well as real-time social and cultural context, united principles of sustainable urban development and in tandem with recommendations sought to address a multiplicity of interwoven environmental and social challenges. The draft designs developed through this project—rooted in community ownership and green innovation—touch on pivotal issues such as mitigating flooding through improved stormwater management and green infrastructure (including water diversion, retention, and local use, and reinstating of native flora), reclassification and redesign of roadways, and proposal of new business plans and site improvements for community access and use. These designs are supported by policy and funding recommendations which offer tangible avenues towards execution.

Preliminary engagement with the community via expert and practitioner insight support our proposals and also highlight nuances and additional challenges to be overcome. While the proposals have been met with positivity, engagement has highlighted the necessity of their practical implementation—carefully considering feasibility, contextual appropriateness, and inclusivity of benefits. Moving forward, the project's trajectory is focused on sharpening these draft designs with a dynamic, resident-centered approach involving deeper collaboration with city departments and community entities, fortifying an ongoing dialogue that is transparent and inclusive. The path ahead is framed by the goal of not simply reforming an area of Detroit, but rather initiating transformative momentum that can serve as a model for holistic and responsible urban regeneration.

Our project has come to fruition with the assistance and influence of a diverse group of individuals whose contributions have been invaluable. Foremost, we are immensely grateful to Dr. Mark Lindquist, our faculty advisor. His unwavering support, robust advice, and consistent encouragement throughout our capstone experience have been indispensable. Dr. Lindquist's dedication to our project is unmatched.

Furthermore, we wish to express our sincere appreciation to a host of dedicated professionals and institutions that have played critical roles in bringing our project to reality. We are thankful for the expertise and insights from Khalil Ligon, the Lead Urban Planner for the City of Detroit and our project client, whose insight and guidance helped keep us on track and focused to the end. The various departments within the City of Detroit, including the Planning and Development Department, the Water and Sewage Department, the Department of Transportation, the Department of Neighborhoods, the City Council's 3rd District, and the Detroit Economic Growth Corporation, provided us with resources and support that were essential to our project's success.

Additionally, the local community partners have been instrumental in our work: Friends of Detroit City Airport, Detroit Eastside Community Collaborative, the Connor Creek Greenway, and Keep Growing Detroit, all of whom have lent their valuable time and expertise and with whom we hope to continue collaborating in the future.

Lastly, our academic journey has been enriched and facilitated by the Faculty members from the University of Michigan's School for Environment & Sustainability, specifically Professor Runzi Wang and Professor Andrew Gronewold, who have imbued us with critical knowledge and perspective in stormwater and watershed management and modelling. And not to be overlooked, we thank University of Michigan PhD candidates, Chen Zuo and Shuying Liu, whose support has enhanced the depth and quality of our work. To all mentioned, and implicitly to all contributors, our heartfelt thanks for your instrumental roles in our project.

We recognize that our work is a first step in a long and diverse journey that we hope will conclude with real, meaningful, and lasting change in the City of Detroit. Collaborative design is a perpetual process, and we are excited to see how this project progresses in the future.

# APPENDICES

---

WATERSHED & NATIVE PLANTINGS | STORMWATER INFRASTRUCTURE CAPACITY



# WATERSHED & NATIVE PLANTINGS

APPENDIX I

## Watershed & Native Planings Report

### II. Project Site & Watershed Background

The project site for the City of Detroit Gratiot/Harper Development MS Project includes three neighborhoods that struggle to mitigate major flooding issues. These include the Ravenadle and Wade neighborhoods as well as a section of the subdivision by the Coleman A. Young International Airport. This site rests on 1,100 acres of property throughout the City of Detroit. The main watersheds for this project are the Rouge River watershed and the Clinton River/Lake St. Clair watershed. The project site boundary also lies within the sub-watershed called the Clinton River Spillway-Frontal Lake Saint Clair. These watersheds are no stranger to pollution and environmental degradation. A non-profit group called Friends of the Rouge, has been working to raise awareness about the need to clean up the Rouge River. The mission statement for this organization is “to restore, promote and enhance the Rouge River watershed through stewardship, education and collaboration” (Friends of the Rouge, 2020). Similarly, the Clinton River Watershed Council (CRWC) shares the same beliefs. The four pillars of their mission include aspects to protect, enhance, celebrate and engage within the watershed (CRWC, 2024). The CRWC “has served to coordinate the efforts of local governments, businesses, community groups, and individuals in improving water quality, promoting innovative watershed management techniques, and celebrating the river as a natural and recreational resource” (CRWC, 2024). These watersheds combine to form a complex ecological system. To better understand this system, this next section will detail the history of the Great Lakes Watersheds.

A watershed is an area of land that drains into a body of water. (Friends of the Rouge, 2020). The Rouge River watershed is located in Southeast Michigan and drains 467 miles into the Detroit River (Friends of the Rouge, 2017). Included in the local Rouge Watershed is the sub-watershed of the Clinton River Spillway-Frontal Lake Saint Clair (Figure 1). The watershed has four major branches (Main, Upper, Middle and Lower) with 127 river miles and numerous tributaries (Friends of the Rouge, 2020). In addition to the flowing water, there are more than 400 lakes, impoundments and ponds. Within the watershed, there are over 1.35 million people in 47 municipalities (Friends of the Rouge, 2020). Many of these people rely on the watershed in receiving their drinking water.

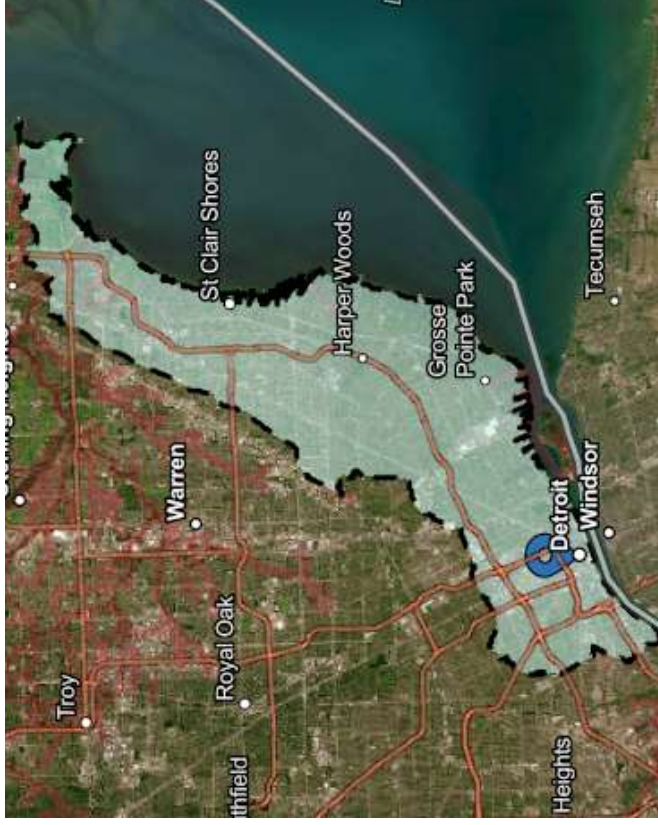
### Table of Contents

- I. Introduction
- II. Project Site & Watershed Background
- III. History of Detroit’s Water Issues & Environmental Protection
- IV. Ecological Research
  - A. Native Planings Research
  - B. Recommendations

### I. Introduction

The City of Detroit has faced significant challenges in regards to environmental issues, including, but not limited to, stormwater management, poor water quality and a lack of native plantings in landscape designs. In regards to stormwater management, the City of Detroit has invested in innovative techniques and green stormwater infrastructure to combat flooding in many neighborhoods throughout the city. Through the implementation of these management practices, the city can continue to focus on improving resilience in Detroit. Water quality issues can continue to be mitigated through management techniques and complemented by informed landscape designs in commercial corridors, residential areas and vacant lands. This report will detail history on the project site, a background of the watersheds within the site, ecological research in regards to native plantings recommendations and green stormwater infrastructure definitions and recommendations of placements.

The counties of Oakland, Washtenaw and Wayne are part of the watershed and the land is more than 50% urbanized with less than 25% remaining undeveloped (Friends of the Rouge, 2020). With such an urbanized area, the watershed falls victim to many stressors which lower the quality of the water found within the system. The Clinton River/Lake St. Clair watershed is another large watershed. This watershed encompasses a 760 square mile area that is comprised of thousands of lakes, ponds, wetlands, marshes, and bogs, as well as coldwater tributaries, brooks and streams. These streams and rivers all drain into one common body of water, Lake St. Clair (CRWC, 2024). This large watershed stretches through 71 communities and five counties, including Oakland, Macomb, Lapeer, Wayne, and St. Clair (CRWC, 2024).



**Figure 1:** Outline of the Clinton River Spillway-Frontal Lake Saint Clair sub-watershed. Map courtesy of Earthstar Geographics | Province of Ontario, Esri Canada, Esri, HERE, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, NPS, NRCan, Parks Canada.

### III. History of Detroit's Water Issues & Environmental Protection

Detroit underwent a period of intense industrialization during the 1970's and 80's, in which the City relied heavily on its waterways for transportation of products. During this time, there were little environmental regulations in place to protect the waterways so desperately needed for transport. The Rouge River caught on fire in October of 1969 due to the millions of gallons of waste that had been mindlessly dumped into the river over a course of many years (Fox 2 Detroit, 2017). The Flint River was also no stranger to the dumping of raw sewage and wastewater, which led to its current status as another Area of Concern (AOC). These environmental disasters occurred years before the monumental inception of the National Environmental Policy Act in 1970 and impactful Clean Water Act in 1972. After these pieces of legislation came into effect, the dumping of waste and sewage into many of the Great Lakes was greatly reduced and restorative efforts began to become increasingly popular.

Both the Detroit River and the Rouge River have been named as "Areas of Concern" under the U.S. - Canada Great Lakes Water Quality Agreement. These AOC's can be seen in Figure 2. This precedent piece of legislation has been a driving factor in remediating the environmental impacts felt by the Great Lakes Watershed. This agreement is "a commitment between the United States and Canada to restore and protect the waters of the Great Lakes." (EPA, 2024). Through coordination with the Environmental Protection Agency (EPA), this Agreement provides a framework for identifying binational priorities and implementing actions that improve water quality. (EPA, 2024). The Agreement was first signed in 1972 and has been amended multiple times, first in 1983 and again in 1987. These amendments include mechanisms to "enhance water quality programs that ensure the "chemical, physical, and biological integrity" of the Great Lakes." (EPA, 2024). The 2012 amendment to the Agreement will allow the United States and Canada to facilitate action on threats to Great Lakes water quality and includes strengthened measures to anticipate and prevent ecological harm. New provisions address aquatic invasive species, habitat degradation and the effects of climate change, and support continued work on existing threats to people's health and the environment in the Great Lakes Basin such as harmful algae, toxic chemicals, and discharges from vessels (EPA, 2024).



#### IV. Ecological Research

The watersheds within the project site form a complex ecological system, making the range of threats it encounters vast. The Great Lakes watershed is susceptible to several ecological threats impacting the health and overall quality of the watershed. Due to the heavily urbanized area the watersheds lie within, the EPA has determined that the main threats to the watershed's health and quality are due to sediment and water contamination from industrial development and discharge, combined sanitary sewer overflows, and nonpoint source pollution and non-native species (EPA, 2024). Contaminants found in the water include heavy metals, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), mercury, oil and grease (EPA, 2024). Several remediation plans have been put into place in order to mitigate these threats and restore the watershed back to a higher quality. Specific threats to the Rouge Watershed include flooding and streambank erosion, combined sewer overflows, illicit and illegal discharges, loss of wildlife habitat, and invasive species (Friends of the Rouge, 2024). The Clinton River/Lake St. Clair watershed faces similar threats. In regards to our project site, the main threats being addressed by the research in this report are combined sewer overflows, flooding, loss of wildlife habitat and non-native species.

The urban ecosystem is a growing system that is susceptible to changes over time. Increased urbanization and development poses a threat to the fragile nature of the urban ecosystem. The natural urban ecosystem is not only its own, but a combination of many interacting ecosystems within the boundaries of the city. Urban ecosystems provide its residents with many important ecosystem services. Ecosystem services can be defined as benefits humans receive from the ecosystem. Natural urban ecosystems can contribute to public health and improve overall quality of life to the residents (Bolund & Hunhammar, 1999). Examples of this include, but are not limited to, improving air quality, reducing noise pollution and regulating the micro-climate of the urban context, or reducing the urban heat island effect. An urban ecosystem consists of many components, including street trees, green stormwater infrastructure, parks, ponds, lawns, urban forests and other recreation areas (Bolund & Hunhammar, 1999).

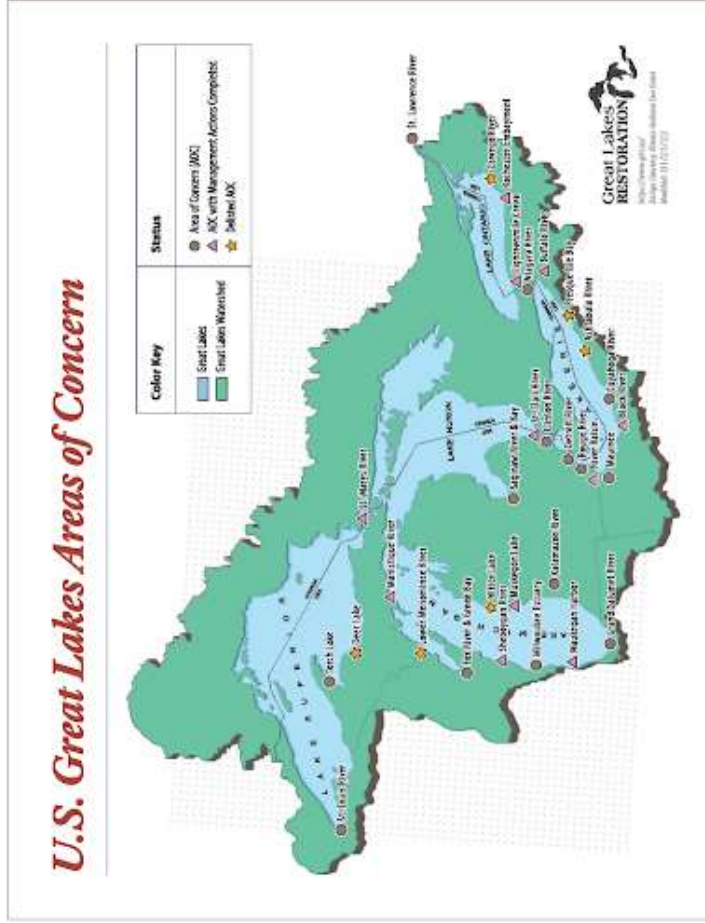


Figure 2: U.S Great Lakes Areas of Concern. GRLI

In addition to this Agreement, the Great Lakes Restoration Initiative (GRLI) has accelerated efforts to "protect and restore the largest system of fresh surface water in the world – the Great Lakes." (GRLI, 2024). The GRLI is a multi-agency initiative founded in 2010 that functions as a catalyst in federal agency coordination efforts to strategically target the biggest threats to the Great Lakes ecosystem and to accelerate progress toward achieving long term goals (GRLI, 2024). The long term goals named in the initiative include fish safe to eat, water safe for recreation, safe source of drinking water, to delist all Areas of Concern, eliminate harmful algal blooms, manage and control existing invasive species, and to protect and restore the native habitat in order to sustain native species (GRLI, 2024). The GRLI Action Plan III, a continuing restoration plan, details action plans for meeting the previously mentioned long term goals.

Stormwater and rainfall events bring a new set of issues to the natural urban ecosystem. Stormwater can accumulate and transport pollutants such as nutrients, toxic metals, oil and grease, trace organic contaminants, and pathogens into waterways (EPA, 1992). There are many consequences that come with the runoff associated with stormwater events. These include, but are not limited to, degradation to aquatic ecosystems, erosion of streambanks, human exposure to pathogens, pollution of drinking water and overall degradation to the quality of a watershed (Muerdter et al., 2018). Elements of green stormwater infrastructure (GSI) can be incorporated into development plans in order to combat these issues. Some examples of such GSI's include retention and detention ponds, bioswales, rain gardens, green roofs, rainwater harvesting collection, permeable pavement. Other gray stormwater infrastructure elements may also be included in order to manage excessive stormwater events, such as water storage cellars, water storage tanks and StormTraps. All of these elements will be discussed in the later sections of this report.

### **A. Native Plants**

Native plants are flora that are indigenous to a defined region, contribute to the local food web, have co-evolved with the organisms around them, resulting in complex ecological relationships, and have adapted to regional environmental factors such as climate and geology (Detroit Wildflower Nursery, 2024). While many restorative efforts have focused on regulatory actions at both a state and federal level, it can be understood that these efforts are expensive and slow-moving. Native plants found in Michigan and Wisconsin are great recommendations for native plantings in GSI's. One way cities and municipalities can work towards improving their watersheds, and overall urban ecosystems, is to adopt the practice of using native plants in landscape design. Vegetated areas have shown to reduce flooding and increase filtration during heavy rainfall and stormwater events. While not the only avenue of restoration, the use of ecological restoration efforts is paramount in protecting the delicate natural urban ecosystem. The City of Detroit has been an area of intense development for several years now. With this development comes the need for the production and use of native species in landscape design in order to bring back native wildlife habitat and improve biodiversity within the replaced ecosystem (Martinson, 2020).

Above ground vegetation can aid in the facilitation of infiltration and storage of water through the surface (Muerdter et al., 2018). Additionally, plantings can aid in reducing surface flow and increasing infiltration which may help in the reduction of surface erosion and filtration of contaminants (Muerdter et al., 2018). Correctly planting and placing vegetation that aids in these measures depends on the ability and makeup of the actual planting itself. Detroit is a city that is undergoing numerous projects at once, making it difficult to manage these vegetated areas. For the purpose of this project, we are recommending plantings that require low maintenance in order to allow the City to allocate appropriate management schedules based upon their availability of resources.

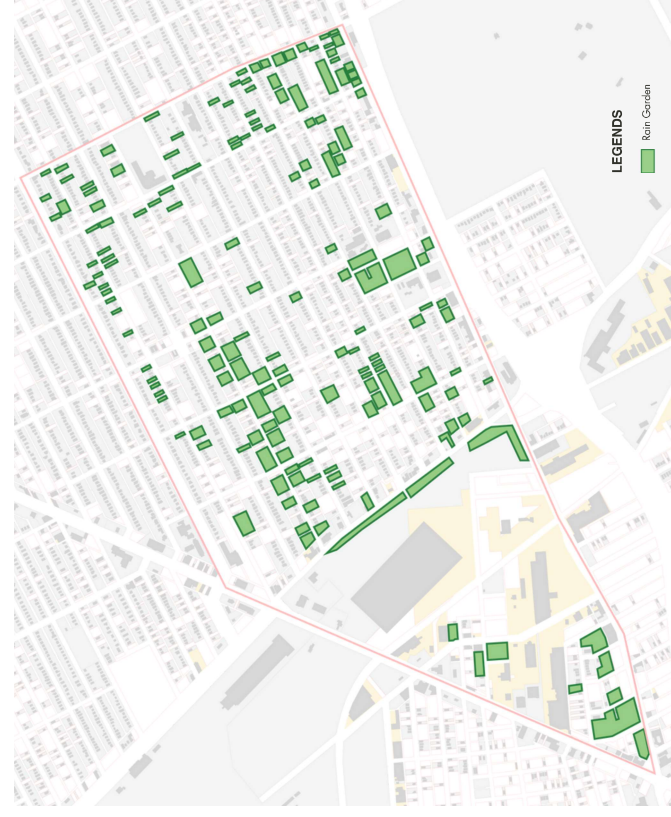
Fortunately, the State of Michigan is home to many beautiful species of plants and trees that can be implemented into informed landscape design. Many of Michigan's native plants have adapted to all of Michigan's soil types - as well as woodlands, wetlands, ponds, streams, meadows, and prairies (CRWC, 2024). Some of Michigan's native plants have root systems that extend up to 15 feet or more underground (CRWC, 2024), therefore functioning as an effective way to manage stormwater. Due to the nature of many native plants being perennial or self-seeding plants (CRWC, 2024), the maintenance levels of these plants is relatively low and financially feasible. Native plants require very little care and maintenance once established. Most gardens, or planted vegetated areas can rely on natural rainwater as a watering source and only require mulching efforts when planted and once a year to prevent weeds and increase moisture retention (CRWC, 2024). Finally, the use of GSI's can have a positive economic impact by reducing the need for expensive wet weather treatment facilities (DWSD, 2022).

### **B. Recommendations**

This section will detail where the native plantings are recommended to be placed in the green stormwater infrastructure elements addressed in our project report. For reference to siting practices, requirements and permitting guidelines on the use and implementation of green stormwater infrastructure, we recommend referencing the 2022 City of Detroit Water and Sewage Department's Stormwater Management Design Manual.

## Rain Gardens

A rain garden is a depressed area in the landscape that collects rain water from a roof, driveway or street and allows it to soak into the ground (EPA, 2024). We recommend placing rain gardens in areas designated by the map in Figure 3. Rain gardens provide many benefits to the environment and also to the people living near them. This GSI can enhance natural beauty within a community while functioning as a great way to naturally control stormwater. Additionally, rain gardens have many environmental benefits. They can improve groundwater by increasing the amount of rain water that filters into the ground, which can aid in the recharge of groundwater. Rain gardens also function as a way to remove pollutants from entering into the water in nearby lakes and streams that empty into their respective watersheds. Another benefit of using rain gardens is that it can function as a way to bring local pollinators and wildlife back into the urban landscape. The recommended plants to be used in rain gardens include grasses and flowering perennials (EPA, 2024). Once established, rain gardens require minimal maintenance. Maintenance includes the removal of dead plants, weeding and seasonal maintenance which includes mulching. Other forms of maintenance include the removal of trash and debris. A list of plants recommended for use in rain gardens, both commercial and residential can be seen in Figure 4. It is important to note that these lists are just recommendations and information related to sun/shade tolerance, soil conditions, watering needs, bloom periods and insect attractiveness should be referenced through the Michigan State University Plant Search Tool on the MSU Native Plants and Ecosystem Services website extension page.



**Figure 3:** Placement of rain gardens within the City of Detroit Gratiot/Harper Development MS Project site. Map courtesy of Bingqing Han | City of Detroit Gratiot/Harper Development MS Project team.



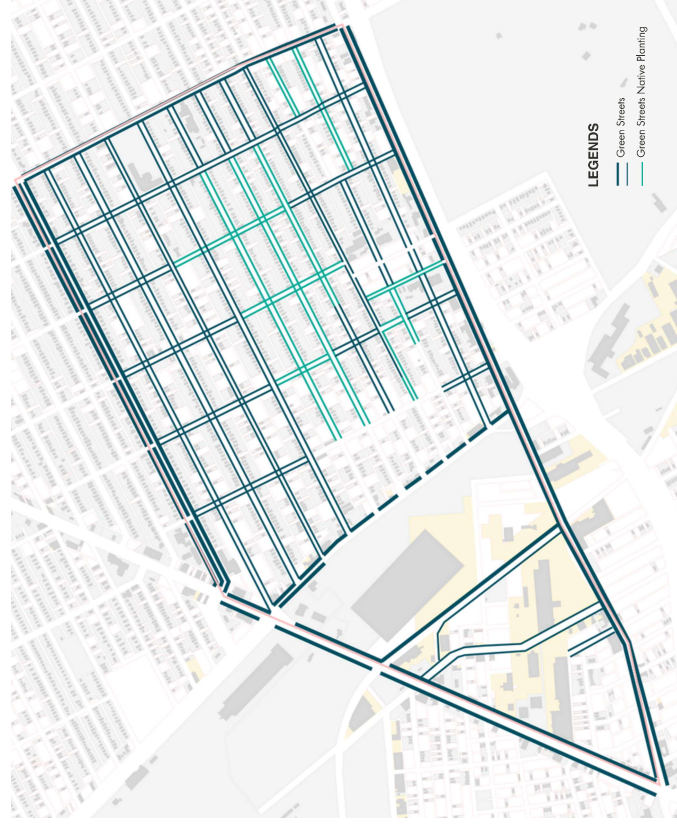
**Figure 4:** List of native plantings recommendations for rain gardens.

Blue Flag Iris (*Iris versicolor*)  
Cardinal Flower (*Lobelia cardinalis*)  
Swamp Milkweed (*Asclepias incarnata*)  
New England Aster (*Symphoricarichum novae-angliae*)  
Joe Pye Weed (*Eutrochium purpureum*)  
Purple Coneflower (*Echinacea purpurea*)  
Blue Vervain (*Verbena hastata*)  
Turtlehead (*Chelone glabra*)  
Swamp Rose Mallow (*Hibiscus moscheutos*)  
Great Blue Lobelia (*Lobelia siphilitica*)  
Marsh Marigold (*Caltha palustris*)  
Wild Bergamot (*Monarda fistulosa*)  
Boneset (*Eupatorium perfoliatum*)  
Black-eyed Susan (*Rudbeckia hirta*)  
Swamp Sunflower (*Helianthus angustifolius*)  
Bluejoint Grass (*Calamagrostis canadensis*)  
Swamp Loosestrife (*Decodon verticillatus*)  
Sedge (*Carex* spp.)  
Sweetflag (*Acorus americanus*)  
Monkeyflower (*Mimulus ringens*)  
Swamp Smartweed (*Polygonum amphibium*)  
Golden Alexander (*Zizia aurea*)  
Marsh Phlox (*Phlox glaberrima*)  
Great St. John's Wort (*Hypericum pyramidatum*)  
Blue Waterleaf (*Hydrophyllum virginianum*)  
Skunk Cabbage (*Symplocarpus foetidus*)  
Marsh Marigold (*Caltha palustris*)  
Wild Columbine (*Aquilegia canadensis*)  
Swamp Milkweed (*Asclepias incarnata*)  
Jack-in-the-pulpit (*Arisaema triphyllum*)

**Figure 4 Source:** Bhakta, B. (n.d.). Rain Gardens: A Design Guide for Michigan Homeowners [Brochure]. Michigan State University Extension. <https://www.canr.msu.edu/resources/rain-gardens-a-design-guide-for-michigan-homeowners>

## Bioswales & Green Streets

Bioswales are shallow channels with vegetation that are designed to slow, filter, infiltrate, and convey runoff (Water Resources Commissioner-Washtenaw County). We recommend placing bioswales in areas designated by the map in Figure 5. These types of GSI's come in many variations including vegetated swales along streetscapes or elongated patches of vegetated land in residential and commercial corridors. These may be used in place of streetside curb and gutter systems, proving to be an economic benefit. Bioswales and streetscape GSI's provide many environmental benefits, similar to those of rain gardens. In order to maintain the quality of bioswales, occasional maintenance is required to ensure they maintain their functionality and aesthetic. This maintenance includes semi-routine weeding, removal of sediment and scheduled seasonal mowings. However, once established, bioswales are low maintenance and can be worked into a routine seasonal city maintenance schedule. The recommended plants to be used in bioswales include a variety of native grasses. The use of native grasses in bioswales offer a plethora of ecological benefits, including providing a habitat and food source for insects and stormwater controls. Lists of both plants, trees and shrubs recommended for use in bioswales, both commercial and residential can be seen in Figures 6 & 7. It is important to note that these lists are just recommendations and information related to sun/shade tolerance, soil conditions, watering needs, bloom periods and insect attractiveness should be referenced through the Michigan State University Plant Search Tool on the MSU Native Plants and Ecosystem Services website extension page.



**Figure 5:** Placement of bioswales and streetscape GSI's within the City of Detroit Graftiot/Harper Development MS Project site. Map courtesy of Bingging Han | City of Detroit Graftiot/Harper Development MS Project team.

**Figure 6:** List of herbaceous native plantings recommendations for bioswales and green streets.

Switchgrass (*Panicum virgatum*)  
Little Bluestem (*Schizachyrium scoparium*)  
Big Bluestem (*Andropogon gerardii*)  
Prairie Dropseed (*Sporobolus heterolepis*)  
Wild Bergamot (*Monarda fistulosa*)  
New England Aster (*Symphoricarpon novae-angliae*)  
Butterfly Weed (*Asclepias tuberosa*)  
Culver's Root (*Veronicastrum virginicum*)  
Swamp Milkweed (*Asclepias incarnata*)  
Marsh Marigold (*Caltha palustris*)  
Blue Flag Iris (*Iris versicolor*)  
Great Blue Lobelia (*Lobelia siphilitica*)  
Cardinal Flower (*Lobelia cardinalis*)  
Swamp Rose Mallow (*Hibiscus moscheutos*)  
Sneezeweed (*Helenium autumnale*)  
Virginia Bluebells (*Mertensia virginica*)  
Boneset (*Eupatorium perfoliatum*)  
Blue Vervain (*Verbena hastata*)  
Red Osier Dogwood (*Cornus sericea*)  
Joe-Pye Weed (*Eutrochium purpureum*)  
Ohio Spiderwort (*Tradescantia ohioensis*)  
Wild Geranium (*Geranium maculatum*)  
Spiderwort (*Tradescantia* spp.)  
Black-Eyed Susan (*Rudbeckia hirta*)  
Purple Coneflower (*Echinacea purpurea*)  
Showy Goldenrod (*Solidago speciosa*)  
Nodding Onion (*Allium cernuum*)  
Prairie Smoke (*Geum triflorum*)  
Prairie Coreopsis (*Coreopsis palmata*)  
Wild Lupine (*Lupinus perennis*)

**Figure 7:** List of tree and shrub species recommendations for bioswales and green streets.

Red Maple (*Acer rubrum*)  
Swamp White Oak (*Quercus bicolor*)  
Silky Dogwood (*Cornus amomum*)  
Black Chokeberry (*Aronia melanocarpa*)  
Buttombush (*Cephalanthus occidentalis*)  
River Birch (*Betula nigra*)  
Red Osier Dogwood (*Cornus sericea*)  
Elderberry (*Sambucus canadensis*)  
Winterberry Holly (*Ilex verticillata*)  
Sweet Gale (*Myrica gale*)

**Figure 7 Source:** Gregg, B. (n.d.). Native Plants for Michigan Rain Gardens and Bioswales. Michigan State University Extension. Michigan Department of Environment, Great Lakes, and Energy (EGLE). (n.d.). Bioswales: A Guide for Homeowners. Michigan State University Extension. [https://www.michigan.gov/documents/deq/wrd-bioswale-manual-2004\\_109151\\_7.pdf](https://www.michigan.gov/documents/deq/wrd-bioswale-manual-2004_109151_7.pdf)

**Figure 6 Source:** Sterrett Isley, E (n.d.). EGLE Rain Garden Manual. Rain Gardens: A How-to Manual for Homeowners. Michigan Department of Environment, Great Lakes, and Energy (EGLE)



## References

- Bolund, P., & Hunhammer, S. (1999, May). Ecosystem services in urban areas. *Ecological Economics*, 29(2), 293-301. [https://doi.org/10.1016/S0921-8009\(99\)00013-0](https://doi.org/10.1016/S0921-8009(99)00013-0)
- Checchi, E., & Cognetti, G. (2022, October). *The City of Detroit Water and Sewerage Department Stormwater Management Design Manual*. [www.detroitmi.gov. https://detroitmi.gov/sites/detroitmi.localhost/files/2022%20DWSW%20Design%20Manual.pdf](https://detroitmi.gov/sites/detroitmi.localhost/files/2022%20DWSW%20Design%20Manual.pdf)
- Clinton River Watershed Council. (n.d.). *Environmental Expertise — Clinton River Watershed Council*. <https://www.crwcc.org/what-we-do>
- Cregg, B. (n.d.). *Native Plants for Michigan Rain Gardens and Bioswales*. Michigan State University Extension. Michigan Department of Environment, Great Lakes, and Energy (EGLE). (n.d.). *Bioswales: A Guide for Homeowners*. Michigan State University Extension. [https://www.michigan.gov/documents/deq/wrd-bioswale-manual-2004\\_109151\\_7.pdf](https://www.michigan.gov/documents/deq/wrd-bioswale-manual-2004_109151_7.pdf)
- Fineschi, J., & Loreto, F. (2020, March 24). *A Survey of Multiple Interactions Between Plants and the Urban Environment*. *Frontiers in Forests and Global Change*, 3. <https://doi.org/10.3389/ffgc.2020.00030>
- Foukhar, B., DeGaynor, S., Heimstra, C., & Endrud, S. (n.d.). *An Analysis of Rouge River Water Quality and Study of Issues Surrounding the Great Lakes Watershed*. <https://waterslifeschools.com/wp-content/uploads/2022/11/ES6.pdf>
- Friend of the Rouge. (n.d.). *Mission, Vision, and Core Values — Friends of the Rouge*. <https://therouge.org/about-us/mission/>
- Friends of the Rouge. (n.d.). *Our Watershed — Friends of the Rouge*. <https://therouge.org/about-us/our-watershed/>
- GLRI Action Plan III - October 2019. (2019). *Environmental Protection Agency*. <https://www.epa.gov/sites/default/files/2019-10/documents/glri-action-plan-3-201910-30pp.pdf>
- Great Lakes Restoration. (n.d.). *About*. *Great Lakes Restoration Initiative*. <https://www.glri.us/about>
- Martinson, R. (2024, March 5). *Native plants in urban landscapes: a biological imperative*. *Native Plants Journal*, 21(3), 275-280. DOI: 10.3368/npj.21.3.275
- Michigan Department of Environment, Great Lakes, and Energy (EGLE). (n.d.). *Rain Gardens: A How-to Manual for Homeowners*. Elaine Sterrett Isely (Author). EGLE Rain Gardens Manual.
- Muedter, C. P., Wong, C. K., & LeFevre, G. H. (2018). *Emerging investigator series: the role of vegetation in bioretention for stormwater treatment in the built environment: pollutant removal, hydrologic function, and ancillary benefits*. *Environmental Science: Water Research & Technology*, 4, 592-612. DOI: 10.1039/C7EW00511C
- Nissen, J. (2019, October 8). *In 1969 the Rouge River burned. 50 years and more than a billion dollars later, life has returned to the water*. FOX 2 Detroit. <https://www.fox2detroit.com/news/in-1969-the-rouge-river-burned-50-years-and-more-than-a-billion-dollars-later-life-has-returned-to-the-water>
- US EPA. (n.d.). *List of Great Lakes AOCs* | US EPA. *Environmental Protection Agency*. <https://www.epa.gov/greatlakes-aocs/list-great-lakes-aocs>
- US EPA. (n.d.). *Rouge River AOC* | US EPA. *Environmental Protection Agency*. <https://www.epa.gov/great-lakes-aocs/rouge-river-aoc>
- US EPA. (1992). *NIPDES Stormwater Program* | US EPA. *Environmental Protection Agency*. <https://www.epa.gov/npdes/npdes-stormwater-program>
- US EPA. (2024, February 21). *Great Lakes Water Quality Agreement (GLWQA)* | US EPA. *Environmental Protection Agency*. <https://www.epa.gov/glwqa>
- US EPA. (2024, March 8). *What is GLWQA?* | US EPA. *Environmental Protection Agency*. <https://www.epa.gov/glwqa/what-glwqa>
- Water Resources Commissioner Washtenaw County. (n.d.). *Bioswales (Vegetated Swales)*. Washtenaw County. <https://www.washtenaw.org/2584/Bioswales>

# STORMWATER INFRASTRUCTURE CAPACITY

APPENDIX II

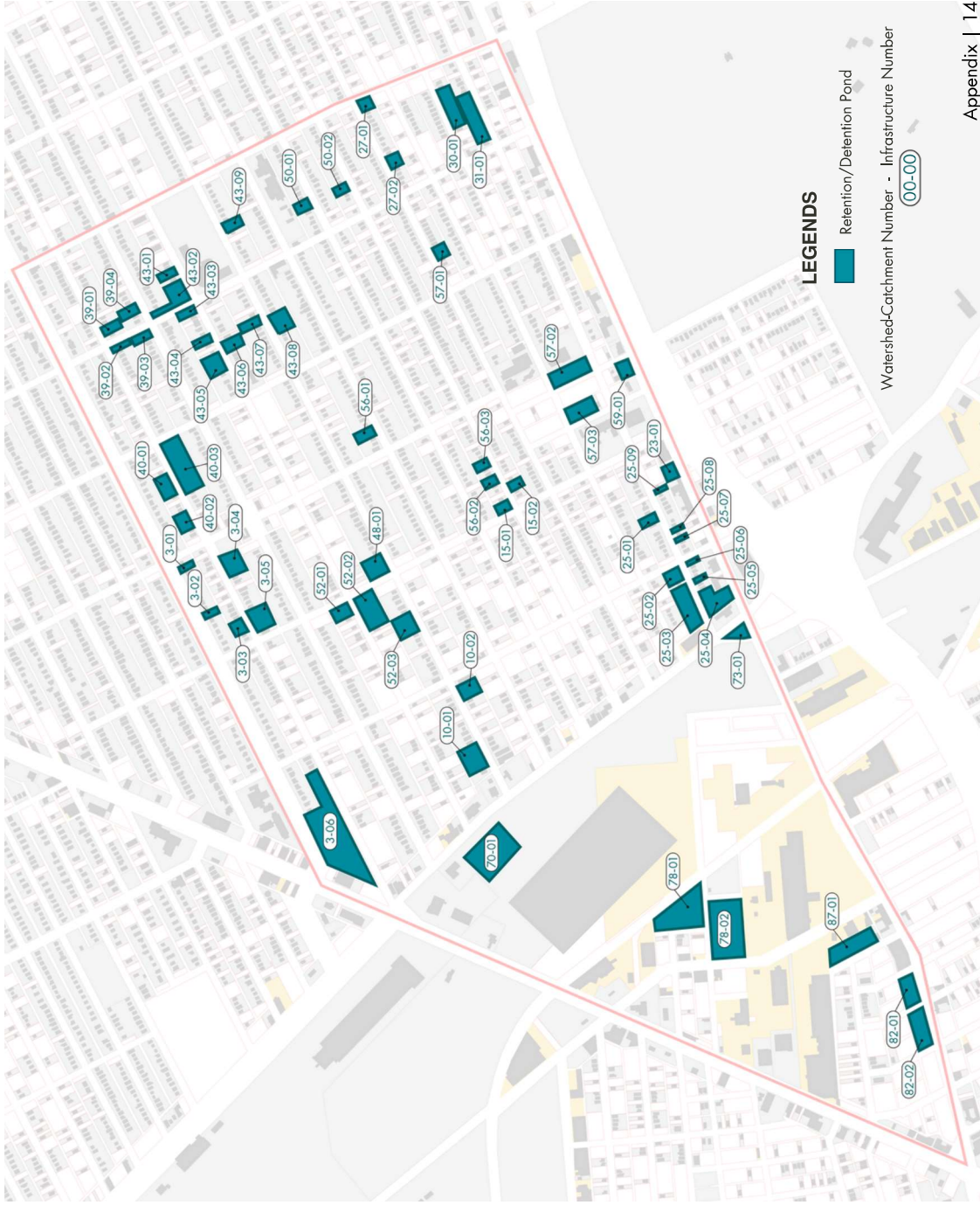
## WATERSHED-CATCHMENT INDEX MAP

The Watershed-Catchments are numbered as displayed on the map to the left. The retention and detention ponds, hardscape modification, and rain gardens at the parcel level will be assigned numbers corresponding to the Watershed-Catchment they are designed to manage stormwater for. It is important to note that the installation of retention ponds, detention ponds, rain gardens, and bioswales may alter the topography, potentially changing the boundaries of the watersheds.





# RETENTION & DETENTION POND MAP

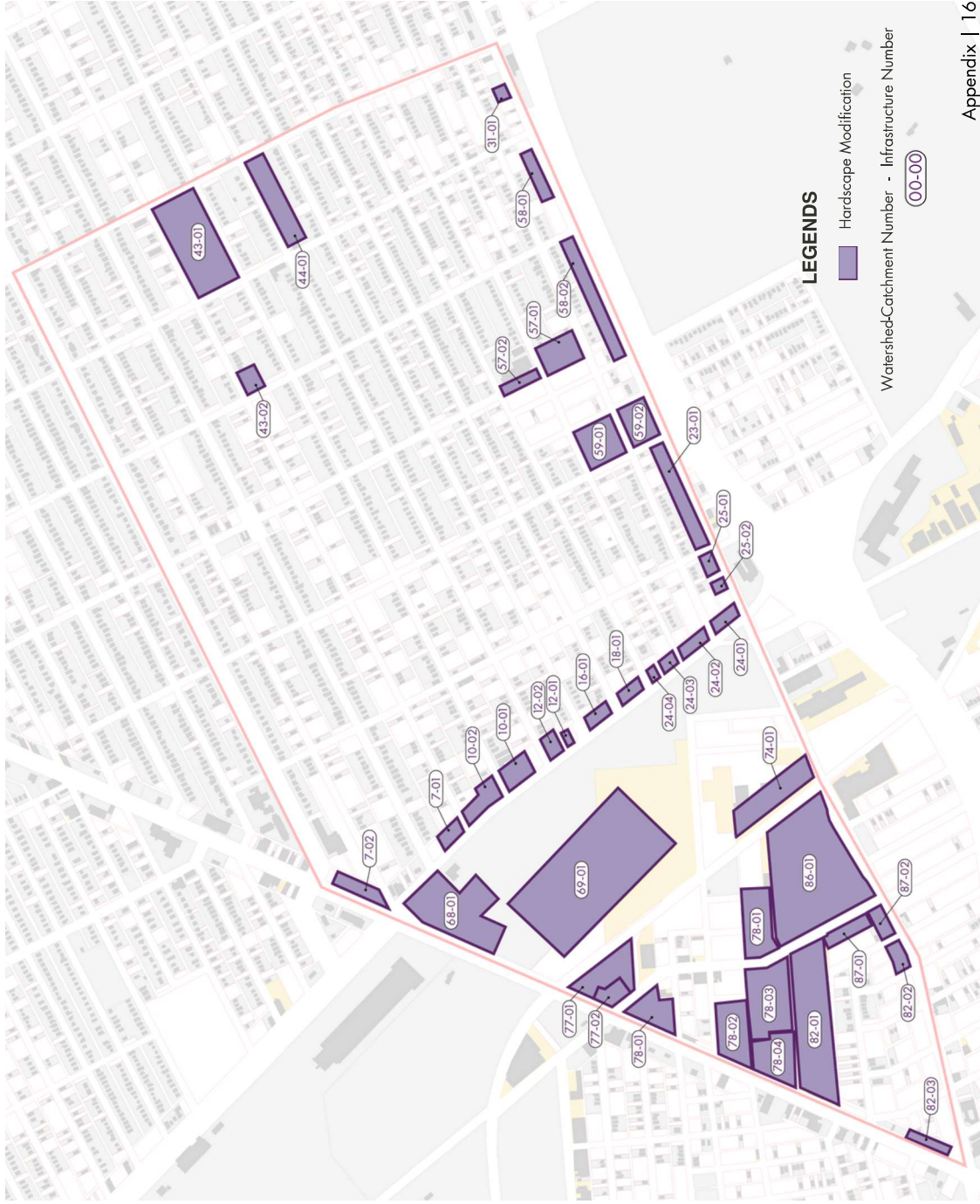


## RETENTION & DETENTION POND CAPACITY

Watershed-Catchment #	Infrastructure #	Capacity (Gal.)
3	01	124,600
3	02	124,600
3	03	311,400
3	04	373,700
3	05	373,700
3	06	6,062,700
10	01	585,500
10	02	137,000
15	01	336,400
15	02	485,800
23	01	299,000
25	01	583,000
25	02	467,200
25	03	1,540,600
25	04	1,374,500
25	05	62,300
25	06	62,300
25	07	62,300
25	08	62,300
25	09	62,300
27	01	299,000
27	02	336,400
30	01	747,500
31	01	789,000
39	01	351,300
39	02	99,700
39	03	261,600
39	04	373,700
40	01	598,000
40	02	373,700
40	03	1,494,900
43	01	317,700
43	02	1,153,600
43	03	224,200
43	04	224,200
43	05	631,200
43	06	431,900
43	07	174,400
43	08	705,900
43	09	477,500
48	01	784,800
50	01	224,200
50	02	224,200
52	01	355,000
52	02	743,700
52	03	556,400
56	01	261,600
56	02	249,200
56	03	249,200
57	01	261,600
57	02	336,400

Watershed-Catchment #	Infrastructure #	Capacity (Gal.)
57	03	87,200
59	01	373,700
70	01	Existing
73	01	249,200
78	01	1,204,200
78	02	36,127,300
82	01	467,200
82	02	784,800
87	01	373,700

# HARDSCAPE MODIFICATION MAP

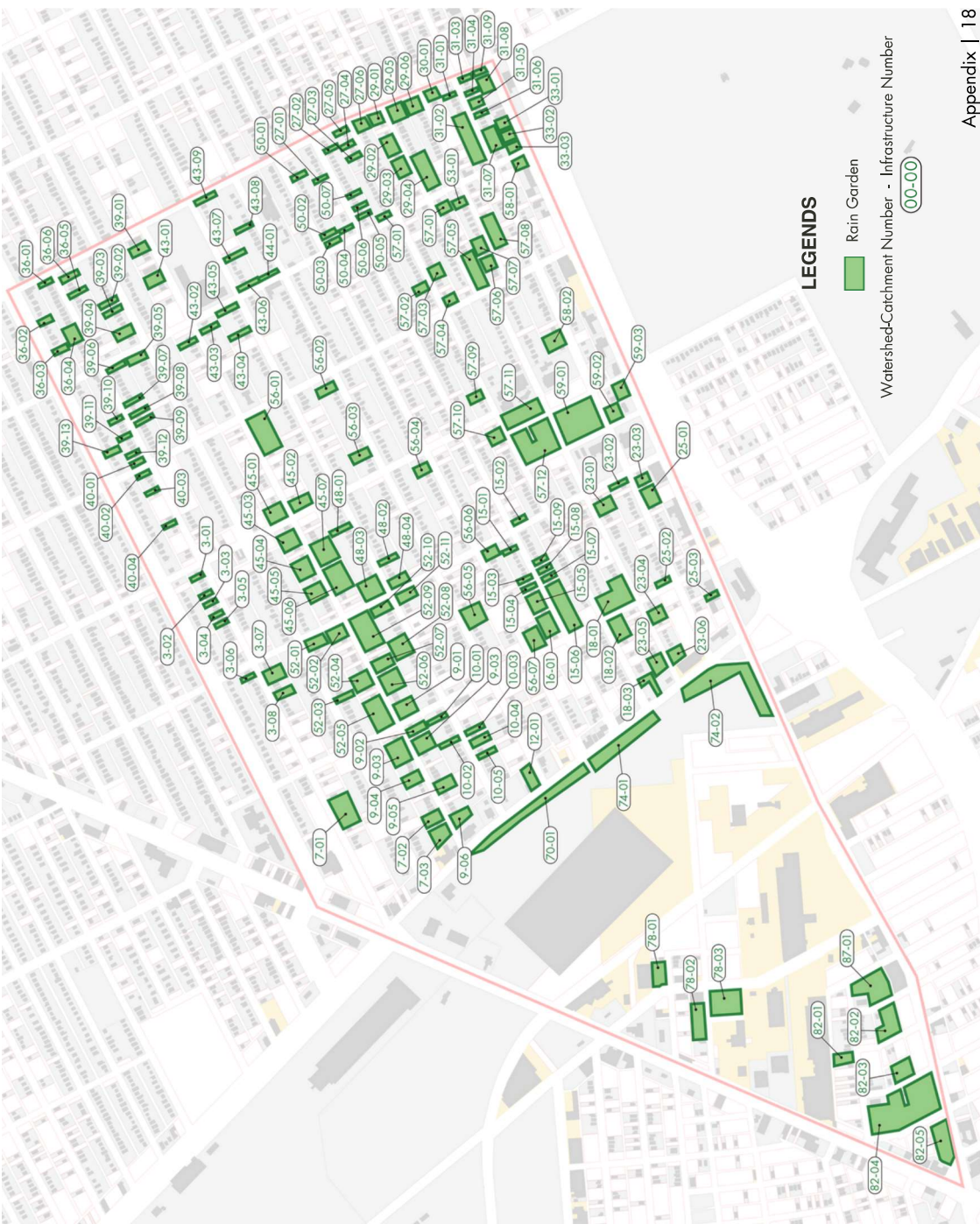




# HARDSCAPE MODIFICATION CAPACITY

Watershed/Catchment #	Infrastructure #	Capacity (Gal.)
7	01	130,800
	02	149,500
10	01	211,800
	02	280,300
12	01	52,900
	02	124,600
16	01	161,900
	01	143,300
23	01	498,300
24	01	149,500
	02	149,500
24	03	102,800
24	04	34,300
25	01	49,800
25	02	24,900
31	01	54,800
	01	2,989,800
43	02	174,400
44	01	598,000
57	01	316,900
	02	77,700
58	01	239,200
58	02	508,300
59	01	560,600
59	02	373,700
68	01	999,700
69	01	7,474,600
74	01	373,700
77	01	626,000
	02	205,600
78	01	479,600
	02	875,200
78	03	875,200
78	04	750,600
82	01	1,868,700
82	02	1,195,900
82	03	112,100
86	01	3,737,300
87	01	221,100
87	02	1,245,800

# RAIN GARDEN MAP



# RAIN GARDEN CAPACITY

Watershed-Catchment #	Infrastructure #	Capacity (Gal.)
3	01	10,400
3	02	10,400
3	03	10,400
3	04	10,400
3	05	10,400
3	06	10,400
3	07	70,600
3	08	22,800
7	01	91,400
7	02	18,700
7	03	49,800
9	01	18,700
9	02	10,400
9	03	64,400
9	04	6,200
9	05	35,300
9	06	24,900
10	01	6,200
10	02	18,700
10	03	124,600
10	04	33,200
10	05	20,800
12	01	68,500
15	01	6,200
15	02	16,600
15	03	12,500
15	04	12,500
15	05	64,400
15	06	135,000
15	07	10,400
15	08	10,400
15	09	10,400
16	01	72,700
18	01	85,100
18	02	45,700
18	03	6,200
23	01	39,400
23	02	18,700
23	03	14,500
23	04	29,100
23	05	51,900
23	06	37,400
25	01	35,300
25	02	58,600
25	03	18,700
27	01	6,200
27	02	6,200
27	03	2,100
27	04	6,200
27	05	12,500
27	06	14,500

Watershed-Catchment #	Infrastructure #	Capacity (Gal.)
29	01	6,200
29	02	22,800
29	03	16,800
29	04	106,000
29	05	35,300
29	06	31,100
30	01	29,100
31	01	8,300
31	02	83,100
31	03	14,500
31	04	12,500
31	05	24,900
31	06	6,200
31	07	45,700
31	08	18,700
31	09	10,400
33	01	16,600
33	02	29,100
33	03	24,900
36	01	12,500
36	02	12,500
36	03	12,500
36	04	41,500
36	05	4,200
39	01	35,300
39	02	12,500
39	03	6,600
39	04	31,100
39	05	26,200
39	06	18,700
39	07	6,200
39	08	12,500
39	09	14,500
39	10	10,400
39	11	10,400
39	12	10,400
39	13	12,500
40	01	10,400
40	02	10,400
40	03	10,400
40	04	10,400
43	01	35,300
43	02	22,400
43	03	22,400
43	04	26,600
43	05	26,600
43	06	20,800
43	07	20,800
43	08	20,800
43	09	20,800
44	01	20,800
45	01	48,500

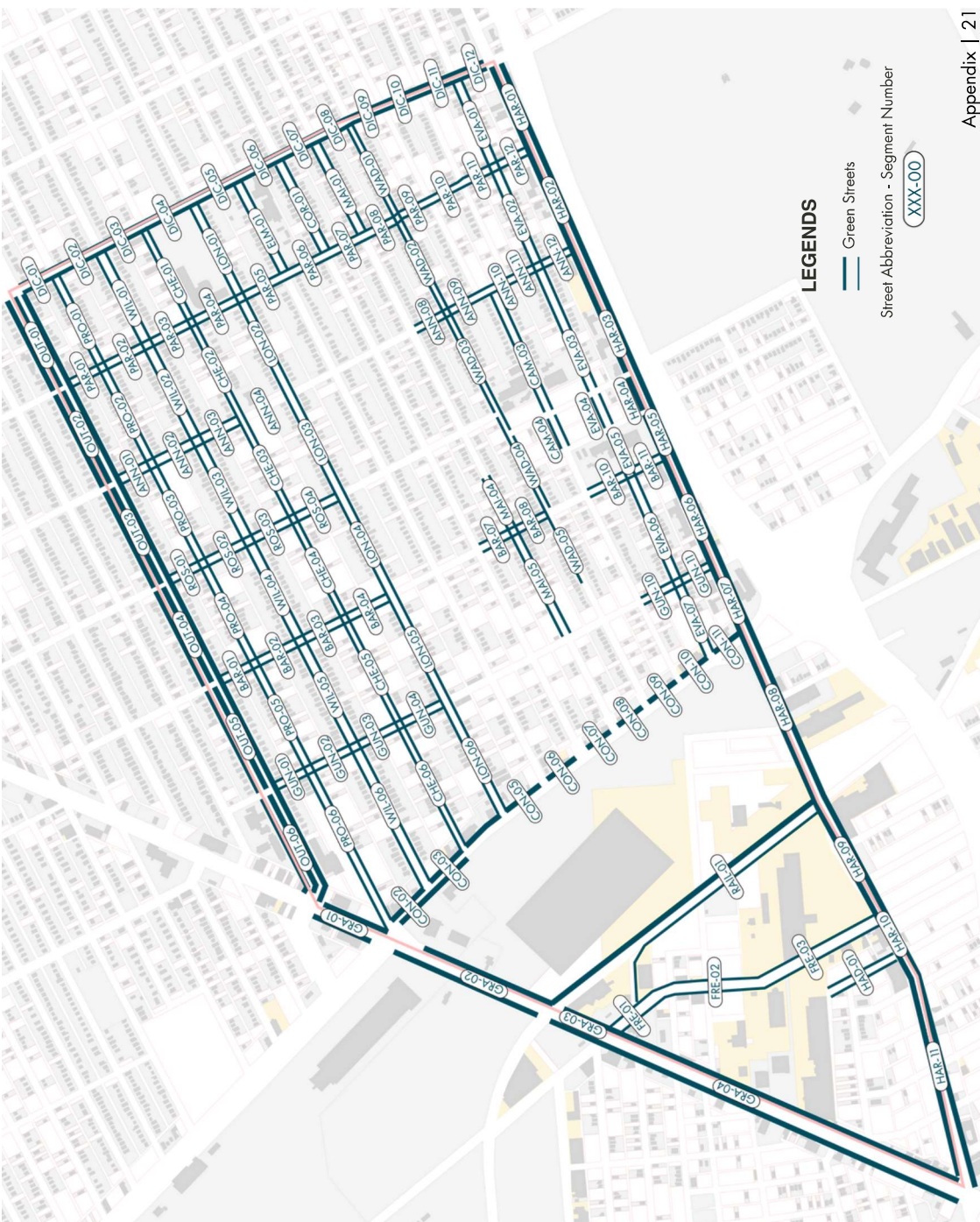


# RAIN GARDEN CAPACITY

Watershed/Catchment #	Infrastructure #	Capacity (Gal.)
45	02	47,800
45	03	51,900
45	04	24,900
45	05	12,500
45	06	47,800
45	07	31,100
48	01	14,500
48	02	10,400
48	03	66,400
48	04	27,000
50	01	8,300
50	02	10,400
50	03	8,300
50	04	8,300
50	05	4,200
50	06	4,200
50	07	12,500
52	01	41,500
52	02	20,800
52	03	14,500
52	04	22,800
52	05	62,300
52	06	33,200
52	07	9,600
52	08	41,500
52	09	62,300
52	10	37,400
52	11	14,500
53	01	12,500
56	01	93,400
56	02	20,800
56	03	16,600
56	04	8,300
56	05	27,000
56	06	18,700
56	07	29,100
57	01	10,400
57	02	8,300
57	03	12,500
57	04	18,700
57	05	37,400
57	06	12,500
57	07	20,800
57	08	70,600
57	09	14,500
57	10	22,800
57	11	39,400
57	12	83,100
58	01	29,100
58	02	24,900
59	01	43,600
59	02	20,800

Watershed/Catchment #	Infrastructure #	Capacity (Gal.)
59	03	20,800
70	01	124,600
74	01	83,100
74	02	124,600
78	01	27,000
78	02	27,000
78	03	83,100
82	01	20,800
82	02	56,100
82	03	49,800
82	04	267,000
82	05	124,600
87	01	76,800

**GREEN STREET MAP**



## GREEN STREET CAPACITY

Street Name	Street Abbr.	Segment #	Side	Capacity (Gal.)
Outer Drive East	OUT	01	North	16,700
			Median	50,300
		02	South	16,100
			North	17,200
		03	Median	49,500
			South	16,700
			North	16,400
			Median	49,500
		04	South	15,900
			North	16,900
		05	Median	49,500
			South	16,900
06	North	18,000		
	Median	57,800		
01	South	17,300		
	North	16,700		
02	Median	65,200		
	South	22,400		
03	North	15,400		
	South	15,400		
04	North	15,100		
	South	13,100		
05	North	17,500		
	South	17,500		
06	North	14,600		
	South	14,600		
01	North	18,000		
	South	18,000		
02	North	32,300		
	South	32,300		
03	North	19,000		
	South	19,000		
04	North	20,300		
	South	20,300		
05	North	24,200		
	South	24,200		
06	North	24,200		
	South	24,200		
01	North	26,200		
	South	26,200		
02	North	29,800		
	South	29,800		
03	North	10,300		
	South	4,300		
04	North	11,300		
	South	11,300		
05	North	12,700		
	South	12,700		
06	North	12,700		
	South	12,300		
01	North	12,300		
	South	13,500		
02	North	16,100		
	South	16,100		

Street Name	Street Abbr.	Segment #	Side	Capacity (Gal.)
Longview Street	LON	01	North	8,800
			South	9,100
		02	North	8,500
			South	8,500
		03	North	9,200
			South	9,200
		04	North	8,400
			South	8,400
		05	North	9,800
			South	9,800
		06	North	11,100
			South	11,100
		01	North	8,800
			South	9,100
01	North	10,600		
	South	10,600		
01	North	10,800		
	South	10,800		
01	North	10,800		
	South	10,800		
01	North	8,500		
	South	8,500		
02	North	8,000		
	South	8,000		
03	North	8,800		
	South	8,800		
04	North	11,600		
	South	11,600		
05	North	9,500		
	South	9,500		
06	North	7,800		
	South	7,800		
03	North	10,300		
	South	10,300		
04	North	3,200		
	South	3,200		
01	North	8,500		
	South	8,500		
02	North	8,000		
	South	8,000		
01	North	7,400		
	South	7,400		
02	North	8,700		
	South	8,700		
03	North	12,300		
	South	12,300		
04	North	3,500		
	South	3,500		
05	North	4,200		
	South	4,200		
06	North	10,000		
	South	10,000		
07	North	7,700		
	South	7,700		



## GREEN STREET CAPACITY

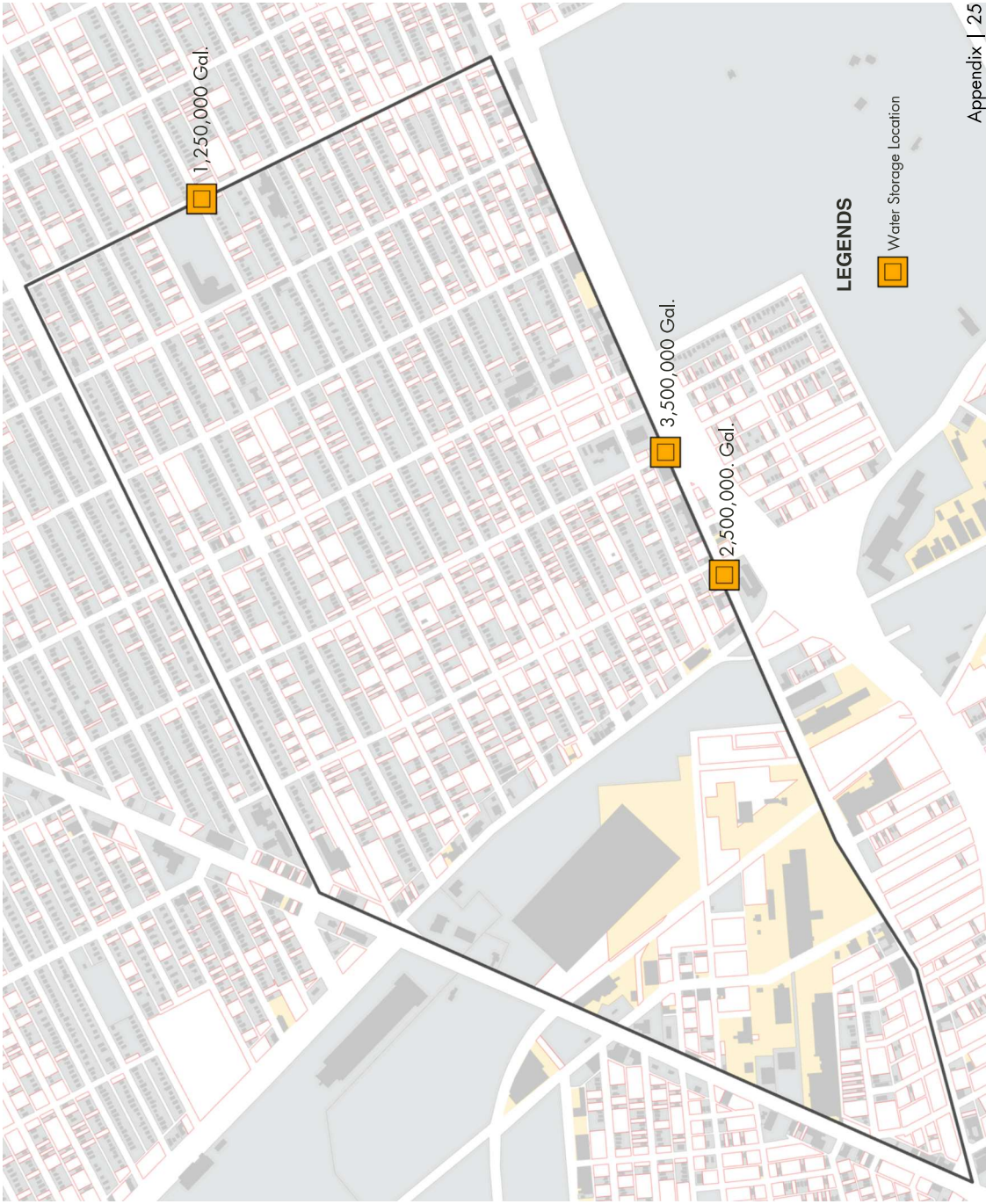
Street Name	Street Abbr.	Segment #	Side	Capacity (Gal.)
Harper Avenue	HAR	01	North	6,200
			South	9,100
		02	North	7,300
			South	17,800
		03	North	12,600
			South	5,600
		04	North	4,200
			South	7,000
		05	North	4,300
			South	6,200
		06	North	10,000
			South	10,000
07	North	11,200		
	South	10,900		
08	North	12,800		
	South	17,600		
09	North	8,900		
	South	8,900		
10	North	2,900		
	South	2,900		
11	North	14,600		
	South	14,600		
01	DICKERSON AVENUE	East	3,100	
		West	3,100	
02	DICKERSON AVENUE	East	4,100	
		West	4,100	
03	DICKERSON AVENUE	East	4,100	
		West	4,100	
04	DICKERSON AVENUE	East	4,800	
		West	5,000	
05	DICKERSON AVENUE	East	4,200	
		West	4,200	
06	DICKERSON AVENUE	East	4,100	
		West	4,100	
07	DICKERSON AVENUE	East	3,200	
		West	3,200	
08	DICKERSON AVENUE	East	3,400	
		West	3,400	
09	DICKERSON AVENUE	East	3,100	
		West	3,100	
10	DICKERSON AVENUE	East	3,500	
		West	3,500	
11	DICKERSON AVENUE	East	3,100	
		West	3,100	
12	DICKERSON AVENUE	East	3,100	
		West	3,100	

Street Name	Street Abbr.	Segment #	Side	Capacity (Gal.)
Park Drive	PAR	01	East	4,500
			West	4,500
		02	East	5,500
			West	5,500
		03	East	3,800
			West	3,800
		04	East	5,500
			West	5,500
		05	East	5,100
			West	5,100
		06	East	4,500
			West	4,500
07	East	4,300		
	West	4,300		
08	East	3,800		
	West	3,800		
09	East	3,800		
	West	3,800		
10	East	3,900		
	West	3,900		
11	East	3,800		
	West	3,800		
12	East	3,800		
	West	3,800		
01	ANN	East	3,600	
		West	3,600	
02	ANN	East	4,800	
		West	4,800	
03	ANN	East	4,500	
		West	4,500	
04	ANN	East	4,800	
		West	4,800	
08	ANN	East	3,100	
		West	2,800	
09	ANN	East	2,500	
		West	1,000	
10	ANN	East	3,200	
		West	2,800	
11	ANN	East	2,500	
		West	4,500	
12	ANN	East	3,100	
		West	3,100	
01	ROS	East	3,600	
		West	3,600	
02	ROS	East	4,600	
		West	4,600	
03	ROS	East	4,500	
		West	4,500	
04	ROS	East	4,500	
		West	4,500	

## GREEN STREET CAPACITY

Street Name	Street Abbr.	Segment #	Side	Capacity (Gal.)
Barrett	BAR	01	East	4,500
			West	4,500
		02	East	5,500
			West	5,500
		03	East	5,500
			West	5,500
		04	East	5,700
			West	5,700
		07	East	4,500
			West	4,500
		08	East	4,100
	West	4,100		
	East	5,300		
	West	5,000		
	East	3,900		
	West	3,900		
	East	5,100		
	West	5,100		
	East	6,900		
	West	6,900		
	East	6,500		
	West	6,500		
	East	6,900		
	West	6,900		
	East	5,500		
	West	5,500		
	East	4,500		
	West	4,500		
	East	6,500		
	West	6,500		
	East	10,500		
	West	7,700		
	East	12,400		
	West	6,900		
	East	4,000		
	West	2,500		
	East	6,500		
	West	6,100		
	East	5,100		
	West	4,500		
	East	4,000		
	West	33,100		
	East	39,700		
	West	29,400		
	East	29,900		
	West	8,400		
	East	7,900		
	West	39,700		
	East	39,700		
	West	9,200		
	East	9,200		
	West	13,400		
	East	11,100		
	West	16,700		
	East	17,800		
	West	6,100		
	East	6,800		
	West	13,600		
	East	14,800		
	West			

**UNDERGROUND WATER STORAGE CAPACITY**





# BIBLIOGRAPHY

---

**All GIS maps were produced by members of the project team, unless otherwise noted.**

- 2024 New Jersey Future Green. (2024). Cistern. ENVIRONMENTAL FINANCE CENTER, 2018. Cistern. <https://developersguide.njfuture.org/bmp/cistern/>. Aggeres. (n.d.). Aggeres Realities Waterbergingskelder 2. CASE STUDY :<https://www.aggeres.com/en/case-studies/underground-water-storage-in-roeselare-built-to-collect-water-for-reuse/#images-preview-1>.
- Aquilina, D. (2013, October 22). Aerial photo, July 2003. Ford Dearborn Truck Plant Green Roof at the Rouge Complex: Looking Back Ten Years. <https://www.greenroofs.com/2013/10/22/ford-dearborn-truck-plant-green-roof-at-the-rouge-complex-looking-back-ten-years/>.
- ArtPlace America. (n.d.). Creative Placemaking. <https://www.artplaceamerica.org/creative-placemaking>
- Bay Area Bioswale. (2024). Bab\_Homefing. Welcome To Bay Area Bioswale. <http://bayareabioswale.com/>.
- Borough of West Chester. (n.d.) Document. Adopt-a-Rain Garden. <https://www.westchester.com/781/Adopt-a-Rain-Garden>.
- Change Grants Program Notice of Funding Opportunity. <https://www.epa.gov/inflation-reduction-act/inflation-reduction-act-community-change-grants-program>
- City and County of San Francisco. (2015). Greening and Stormwater Management. Greening Overview. SF Better Streets. <https://www.sfbetterstreets.org/find-project-types/greening-and-stormwater-management/greening-overview/>.
- City of Asbury Park and the Asbury Park Housing Authority. (n.d.). Native plants enhance a streetscape with less required maintenance. Encourage planting of native plant species in vegetated areas. <http://asburyparkchoice.com/strategies/encourage-planting-of-native-plant-species-in-vegetated-areas>.
- City of Bud. (n.d.) RETENTION & DETENTION PONDS: HOW DO THEY FUNCTION AND WHY ARE THEY IMPORTANT? <https://www.budatx.gov/ArchiveCenter/ViewFile/Item/858>.
- City of Detroit Planning and Development Department. (2020). 5. Stormwater Management Network Plan. Eastern Market Neighborhood Framework. [https://detroitmi.gov/sites/detroitmi.localhost/files/2020-01/Part4\\_EasternMarketNeighborhoodFrameworkandStormwaterManagementNetworkPlan\\_FINAL.pdf](https://detroitmi.gov/sites/detroitmi.localhost/files/2020-01/Part4_EasternMarketNeighborhoodFrameworkandStormwaterManagementNetworkPlan_FINAL.pdf).
- City of Detroit. (2019). East Warren / cadieux neighborhood plan. <https://detroitmi.gov/departments/planning-and-development-department/neighborhood-plans/east-design-region/east-warren-cadieux-neighborhood-plan>
- City of Detroit. (2022, April 19). RMS crime incidents. Detroit's Open Data Portal. <https://data.detroitmi.gov/datasets/detroitmi::rms-crime-incident/about>
- City of Detroit. (2022, April 25). Bus schedules. Detroit Department of Transportation. <https://detroitmi.gov/departments/detroit-department-transportation/bus-schedules>
- City of Detroit. (2023). Park Finder. City of Detroit Open Data Portal. <https://data.detroitmi.gov/apps/park-finder/explore>. Retrieved on 2023, May 14.
- City of Lincoln. (n.d.). Extended Detention Basin. Owner/Operator Maintenance Requirements. <https://www.lincoln.ne.gov/City/Departments/LTU/Utilities/Watershed-Management/Sustainable-Landscapes/Post-Construction-BMPs/Maintenance-Requirements>.
- City of Warrenville. (n.d.) Permeable Parking Spaces on Warren Avenue. Permeable Pavement. <https://www.warrenville.il.us/459/Permeable-Pavement>.
- Clarion Associates. (2006, November 6). Rain Garden (14418205110).jpg. Wikimedia Commons. [https://commons.wikimedia.org/wiki/File:Rain\\_Garden\\_\(14418205110\).jpg](https://commons.wikimedia.org/wiki/File:Rain_Garden_(14418205110).jpg).
- D. S. Franks & Associates, Inc. (n.d.). Wet Detention Pond. Wet Detention Ponds. <http://www.dsfranks.com/wet-detention-ponds>.
- Department of Public Works. (2021, October 30). Street design guidelines. City of Detroit. <https://detroitmi.gov/departments/department-public-works/complete-streets/street-design-guidelines>
- Detroit Historical Society. (2012). The Spirit of Detroit. Detroit Historical Society. <https://detroithistorical.pastperfectonline.com/photo/801F51EC-060E-470F-96DA-185020334621>
- Dreamstime. (n.d.). Rainwater Harvesting System Isometric Diagram. <https://www.dreamstime.com/rainwater-harvesting-system-isometric-diagram-rainwater-harvesting-system-isometric-diagram-vector-illustration-scheme-hose-image170058717>.
- Environmental Protection Agency. (2022). Environmental and Climate Justice Community Forterra. (n.d.). Green Cities Partnership. <https://forterra.org/initiative/green-cities>

Gardenia. (2024). Echinops Ritro "Veitch's Blue" (Globe Thistle). <https://www.gardenia.net/plant/echinops-ritro-veitchs-blue-globe-thistle>

Gardenia. (2024). *Comptonia peregrina* (sweet fern). <https://www.gardenia.net/plant/comptonia-peregrina>

Gennard, F. (2024, February). An extensive green roof in East Sussex. LinkedIn Post. [https://www.linkedin.com/posts/faye-gennard-7a2210121\\_suds-drainage-greenandbluroofs-activity-7160550248602288128-D-jk](https://www.linkedin.com/posts/faye-gennard-7a2210121_suds-drainage-greenandbluroofs-activity-7160550248602288128-D-jk)

Hoffman Nursery. (2016). *Schizachyrium scoparium* "Miniblue" PP17310. <https://hoffmannursery.com/plants/details/schizachyrium-scoparium-miniblue-blue-heaven-pp17310>

Hoffman Nursery. (2016). *Sporobolus heterolepis*. <https://hoffmannursery.com/plants/details/sporobolus-heterolepis>

Inhabitat. (2006, October 2). Ford Green Roof 1. WIRED NEXTFEST: The Future of Green. <https://inhabitat.com/wired-nextfest-the-future-of-green/ford-green-roof-nextfest-dearborn/>.

Keep America Beautiful. (n.d.). Great American Cleanup. <https://www.kab.org/our-programs/great-american-cleanup>

Kim, A. (2022, June 14) Residents seek signs of care in the rain garden, such as noticeable patterns of plant arrangement, defined edges, and flowers. In I.Am.Georgia.Harris (Eds). *Ecological Amenity or Weedy Pit?* <https://www.ecolandscaping.org/06/managing-water-in-the-landscape/rain-gardens/ecological-amenity-or-weedy-pit/>.

LADY BIRD JOHNSON WILDFLOWER CENTER. (2022). Plant database. Lady Bird Johnson Wildflower Center - The University of Texas at Austin. [https://www.wildflower.org/plants/result.php?id\\_plant=ecpu](https://www.wildflower.org/plants/result.php?id_plant=ecpu)

LADY BIRD JOHNSON WILDFLOWER CENTER. (2022). Plant database. Lady Bird Johnson Wildflower Center - The University of Texas at Austin. [https://www.wildflower.org/plants/result.php?id\\_plant=ILVE](https://www.wildflower.org/plants/result.php?id_plant=ILVE)

Manuel Builders. (2019, June 10). Detention Ponds. Retention Pond Vs. Detention Pond. <https://www.manuelbuilders.com/blog/retention-pond-vs-detention-pond>.

Michigan Department of Transportation. (2023, November). M-3 (Gratiot Ave) PEL study - Detroit. <https://www.michigan.gov/mdot/projects-studies/studies/planning-and-environmental-linkages-studies/m-3-in-detroit>

Michigan Seas Grant. (2024). GI Funding Opportunities. <https://www.michiganseagrant.org>.

Mutual Materials. (n.d.). Mm Westmoreland Permeable Paver Program-16x9-1 (1). Westmoreland Permeable Pavement Pilot Project | Portland, OR | Mutual Materials. <https://www.mutualmaterials.com/projects/westmoreland-permeable-pavement-project/>.

National Oceanic and Atmospheric Administration (NOAA). (2017, April 21). NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES: MI. National Weather Service, Office of Water Prediction (OWP). [https://hdsc.nws.noaa.gov/pfds/pfds\\_map\\_cont.html?bkmrk=mi](https://hdsc.nws.noaa.gov/pfds/pfds_map_cont.html?bkmrk=mi).

New York City Department of Parks & Recreation. (n.d.). GreenThumb: About Us. Retrieved from <https://www.greenthumbnyc.org/about>

NICK'S Window Cleaning. (2017, May 12). Disconnected downspout in front of a Toronto home. What is Downspout Disconnection and Why Do It? <https://nickswindowcleaning.ca/2017/what-is-downspout-disconnection-and-why-do-it/>.

North America Eco Floras. (2017). *Dirca palustris*. Ecoflora - *Dirca palustris*. <https://biokic3.rc.asu.edu/seinet/ecoflora/portal/taxa/index.php?fid=81443&taxauthid=1&clid=5392>

Oregon State University. (2006) Manning's Equation. Corvallis Forestry Research Community. [https://www.fsl.orst.edu/geowater/FX3/help/8\\_Hydraulic\\_Reference/Manning\\_s\\_Equation.htm](https://www.fsl.orst.edu/geowater/FX3/help/8_Hydraulic_Reference/Manning_s_Equation.htm).

Perkiomen Watershed Conservancy. (n.d.). A monarch butterfly enjoying our rain garden at Bucher Park. Rain Gardens. <https://www.perkiomenwatershed.org/rain-gardens>.

Perkiomen Watershed Conservancy. (n.d.). Summer 2022. HUNTER'S LANE, TELFORD. Rain Gardens. <https://www.perkiomenwatershed.org/rain-gardens>.

Peterson, K. (2015, June 1). Versatility of fiberglass tanks make them ideal for commercial fire protection systems. Plumbing and Mechanical Engineer. <https://www.pmengineer.com/articles/91897-versatility-of-fiberglass-tanks-make-them-ideal-for-commercial-fire-protection-systems>.

Philadelphia Water Department. (n.d.). Diagram of permeable pavement showing three types of surface material. Permeable Paving. <https://water.phila.gov/gsi/tools/permeable-paving/>.

Plant NOVA Natives. (n.d.). Another gardener's experience: Moss Phlox and Coreopsis. Streetside Gardens. <https://www.planinovanatives.org/streetside-gardens>.



Portland Cement Association. (n.d.). Pervious Hand. Storm Water Management by Pervious Concrete. <https://www.cement.org/cement-concrete/cement-specific-materials/pervious-concrete/storm-water-management-by-pervious-concrete>.

Reimagining the Civic Commons. (n.d.). Philadelphia, Pennsylvania. <https://civiccommons.us/cities/philadelphia-pennsylvania/>

Rhéaume, S. (2018, June 15) Non-porous asphalt vs porous asphalt. Porous Asphalt vs Segmental Permeable Pavement. Techo-Bloc. <https://pros.techo-bloc.com/porous-asphalt-vs-segmental-permeable-pavement>.

Rishya N. (2021, April 7). A residential rain garden in Leominster, MA – EPA. When it Rains, it Pours – This Type of Garden Helps. <https://blogs.massaudubon.org/yourgreatoutdoors/rain-gardens/>.

Seattle Public Utilities. (n.d.). RainWise Program. <https://www.seattle.gov/utilities/your-services/stormwater/stormwater-projects/rainwise-projects>

SEMCOG (Southeast Michigan Council of Governments). (2023, November 21). Roads. Open Data Portal. [https://maps-semcog.opendata.arcgis.com/datasets/a6606a24a2bc4d22becf100d8c88e922\\_69/explore?location=42.439105%2C-83.287611%2C8.91](https://maps-semcog.opendata.arcgis.com/datasets/a6606a24a2bc4d22becf100d8c88e922_69/explore?location=42.439105%2C-83.287611%2C8.91)

Sempergreen. (n.d.). SWE Taby Scandinavian Villa 02. Scandinavian villa. <https://www.sempergreen.com/en/references/scandinavian-villa-taby-sweden>.

Southeast Michigan Council of Governments (SEMCOG). (2021, December 9). Land Use, 2020. Open Data Portal. [https://maps-semcog.opendata.arcgis.com/datasets/1251ecc66a943bb91a1c2597614386e\\_7/explore?location=42.395689%2C-83.001896%2C18.57](https://maps-semcog.opendata.arcgis.com/datasets/1251ecc66a943bb91a1c2597614386e_7/explore?location=42.395689%2C-83.001896%2C18.57).

Southeast Michigan Council of Governments (SEMCOG). (2022, October 17). Building Footprints, 2020. ArcGIS. <https://maps-semcog.opendata.arcgis.com/datasets/0950e79d41914845a8f35760fbc7553/explore?location=42.412313%2C-82.904245%2C16.58>.

Southeast Michigan Council of Governments (SEMCOG). (2023). Elevation Datasets for Southeast Michigan. Aerial Imagery and Elevation Data. <https://www.semco.org/desktopmodules/SEMCOG:Publications/GetFile.ashx?filename=ElevationDatasetsForSoutheastMichigan.pdf>.

Stanford University. (n.d.). Urban Flood Risk Mitigation. InVEST. The Natural Capital Project. [https://storage.googleapis.com/releases.naturalcapitalproject.org/invest-userguide/latest/en/urban\\_flood\\_mitigation.html](https://storage.googleapis.com/releases.naturalcapitalproject.org/invest-userguide/latest/en/urban_flood_mitigation.html).

Stormtrap (n.d.). Crescent+Main-pic1\_Gallery (1). Crescent Main. Stormtrap. <https://stormtrap.com/project/crescent-main/>.

Stormtrap. (2019, May 20). Treatment Train Solutions. Stormtrap. <https://stormtrap.com/solutions/treatment-train-solutions/>.

TRUEGRID Paver. (n.d.). Pond Problems. 3 DETENTION POND PROBLEMS AND A NEW SOLUTION. <https://www.truegridpaver.com/detention-pond-problems/>.

U.S. Department of Housing and Urban Development. (n.d.). Community Development Block Grant (CDBG) program. [https://www.hud.gov/program\\_offices/comm\\_planning/communitydevelopment/programs](https://www.hud.gov/program_offices/comm_planning/communitydevelopment/programs)

U.S. Environmental Protection Agency. (2024, February 12). What is Green Infrastructure? Green Infrastructure. <https://www.epa.gov/green-infrastructure/what-green-infrastructure>.

U.S. Geological Survey (USGS). (2021, June). National Land Cover Database (NLCD) 2019 Products. U.S. Geological Survey. <https://data.usgs.gov/datacatalog/data/USGS:60cb3da7d34e86b938a30cb9>.

United States Department of Agriculture (USDA). (2019, July 31). Web Soil Survey (WSS). Natural Resources Conservation Service (NRCS). <https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx>. Retrieved on 2023, November 26.

United States Department of Labor. (n.d.). Workforce Innovation and Opportunity Act (WIOA). <https://www.dol.gov/agencies/eta/wioa>

US Census Bureau. (2021). 2021 USA Median Household Income. <https://www.arcgis.com/home/item.html?id=39001018f2924cb5a7d4cd65932a9484>.

US Forest Service.(n.d.). Native Gardening. Wildflowers. [https://www.fs.usda.gov/wildflowers/Native\\_Plant\\_Materials/Native\\_Plant\\_Materials/index.shtml](https://www.fs.usda.gov/wildflowers/Native_Plant_Materials/Native_Plant_Materials/index.shtml).

Wikipedia. (2024, April 20). Athyrium Filix-Femina. [https://en.wikipedia.org/wiki/Athyrium\\_filix-femina](https://en.wikipedia.org/wiki/Athyrium_filix-femina)