

DRAFT REPORT  
AUGUST 2025

# Hydrological and Hydraulic Stormwater Drainage Study Mid-City, City Park, and Navarre

Prepared for:  
**CITY OF NEW ORLEANS**





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Prepared for:

**CITY OF NEW ORLEANS**

PROJECT NO.: DPW723

CONTRACT NO.: K23-192



**CDM  
Smith**

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# Acronyms and Abbreviations

Ac-ft	acre-feet
Ave	Avenue
bls	below land surface
Blvd	Boulevard
CD	constant duty
CFS	cubic feet per second
cu ft	cubic feet
CWSRF	Clean Water State Revolving Fund
DCIA	directly connected impervious area
DPS	Drainage pump station
DPW	Department of Public Works
GIS	Geographical Information Systems
GSI	Green stormwater infrastructure
ft	feet
FEMA	Federal Emergency Management Agency
H&H	Hydrologic and Hydraulic
HGL	Hydraulic grade line
HSG	Hydrologic soil group
HU	Hydraulic unit
LaDOTD	Louisiana Department of Transportation and Development
LID	Low-Impact Development
LiDAR	Light Detection and Ranging topography
LOS	Level of service
MMCF	million cubic feet
NAVD 88	North American Vertical Datum of 1988
NLCD	National Land Cover Data
NOAA	National Oceanic and Atmospheric Administration
NRCS	National Resource Conservation Service

O&M	Operations and Maintenance
OPCC	Engineer's Opinion of Probable Construction Cost
Pkwy	Parkway
ROM	Rough order of magnitude
RTA	Regional Transit Authority
SCS	Soil Conservation Service
SDMP	Stormwater Drainage Master Plan
SMS	Stormwater management system
St	Street
sq ft	Square feet
sq mi	square miles
SWBNO	Sewerage and Water Board of New Orleans
SWMM	Storm Water Management Model
SWMP	Stormwater Drainage Master Plan
USEPA	U.S. Environmental Protection Agency
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WSE	water surface elevation





## Executive Summary

The City of New Orleans faces unique stormwater drainage challenges due to its low-lying topography and high impervious surface coverage. This study focused on refining the City's USEPA Stormwater Management Model (SWMM) to assess current stormwater drainage level of service (LOS) performance and simulate the effectiveness of proposed improvements. This report presents the findings and recommendations of the Hydrological and Hydraulic (H&H) Stormwater Drainage Study for the Mid-City, City Park, and Navarre neighborhoods in City of New Orleans which primarily falls within the service zones of Drainage Pump Stations (DPS) 07 and 02. This study was conducted to evaluate existing drainage conditions, identify critical flooding areas, and develop feasible green infrastructure solutions to improve stormwater management and flood resilience.

The project was executed in five major phases:

- **Data Collection and Analysis:** Comprehensive field investigations, desktop reviews, and surveys were conducted to update the City's stormwater drainage system inventory and identify data gaps.
- **System Evaluation and Model Refinement:** The existing SWMM models were updated with new survey data, LiDAR, and land use information, also, the hydraulic and hydrologic parameters were refined.
- **Improvements and Alternatives Evaluation:** A range of green stormwater infrastructure (GSI) and conveyance improvement alternatives were developed and modeled to assess flood reduction benefits.
- **Recommendations and Conceptual Design:** Projects were prioritized based on flood reduction potential, cost-effectiveness, and implementation complexity. Conceptual designs and cost estimates were prepared for selected projects.
- **Implementation Determination:** Phasing strategies, operations and maintenance plans, and funding opportunities were outlined to support project execution.

The study identified four critical flooding areas: South Mid-City (Broad Street area), North Mid-City (Norman C. Francis Parkway area), City Park (Carrollton Avenue area), and the Navarre neighborhood. Flood simulations for 1-, 10-, and 25-year storm events revealed significant inundation, with up to 24.9 miles of streets flooded and depths exceeding 3.7 feet (ft) in some locations. The model showed that flooding is primarily driven by limited storage capacity, undersized infrastructure, and topographic constraints.

The study recommends a suite of GSI and conveyance improvements including:

- **Subsurface Modular Storage Tanks** at key locations such as Comiskey Playground, Warren Easton High School, and Delgado Baseball Fields.
- **Permeable Gutters and Bioswales** along flood-prone corridors like South Lopez Street, Dumaine Street, and Homedale Street.

- Stormwater Parks and pipe upsizing to enhance conveyance and storage.
- Combined Improvements Scenario integrating all proposed projects demonstrated significant flood reduction across all storm events.

Projects were prioritized using flood reduction metrics and the GI Complexity Index. A phased implementation plan was developed, with some projects recommended as stand-alone efforts and others requiring coordination or multi-phase execution. Funding opportunities include the Clean Water State Revolving Fund (CWSRF), Federal Emergency Management Agency (FEMA) grants, and other federal and state programs.

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# 1.0 Background and Purpose

This report summarizes the findings and recommendations of the City of New Orleans's H&H Stormwater Drainage Study; Mid-City, City Park, and Navarre developed for the City of New Orleans stormwater management system (SMS) and is submitted as a draft deliverable for City Project DPW723, *Project Report*.

## 1.1 Introduction

The city of New Orleans, characterized by its nearly complete development and unique low-lying topography, presents a distinctive challenge with over half of the city situated below sea level. Within this context, the present H&H Stormwater drainage study targets three key neighborhoods - Mid-City, City Park, and Navarre with most of the area within Drainage Pump Stations (DPS) 07 service area as well and minor portions within DPS 02 service area. **Figure 1-1** shows the extent of the project area which covers the three neighborhoods of Mid-City, City Park, and Navarre.

## 1.2 Purpose and Objectives

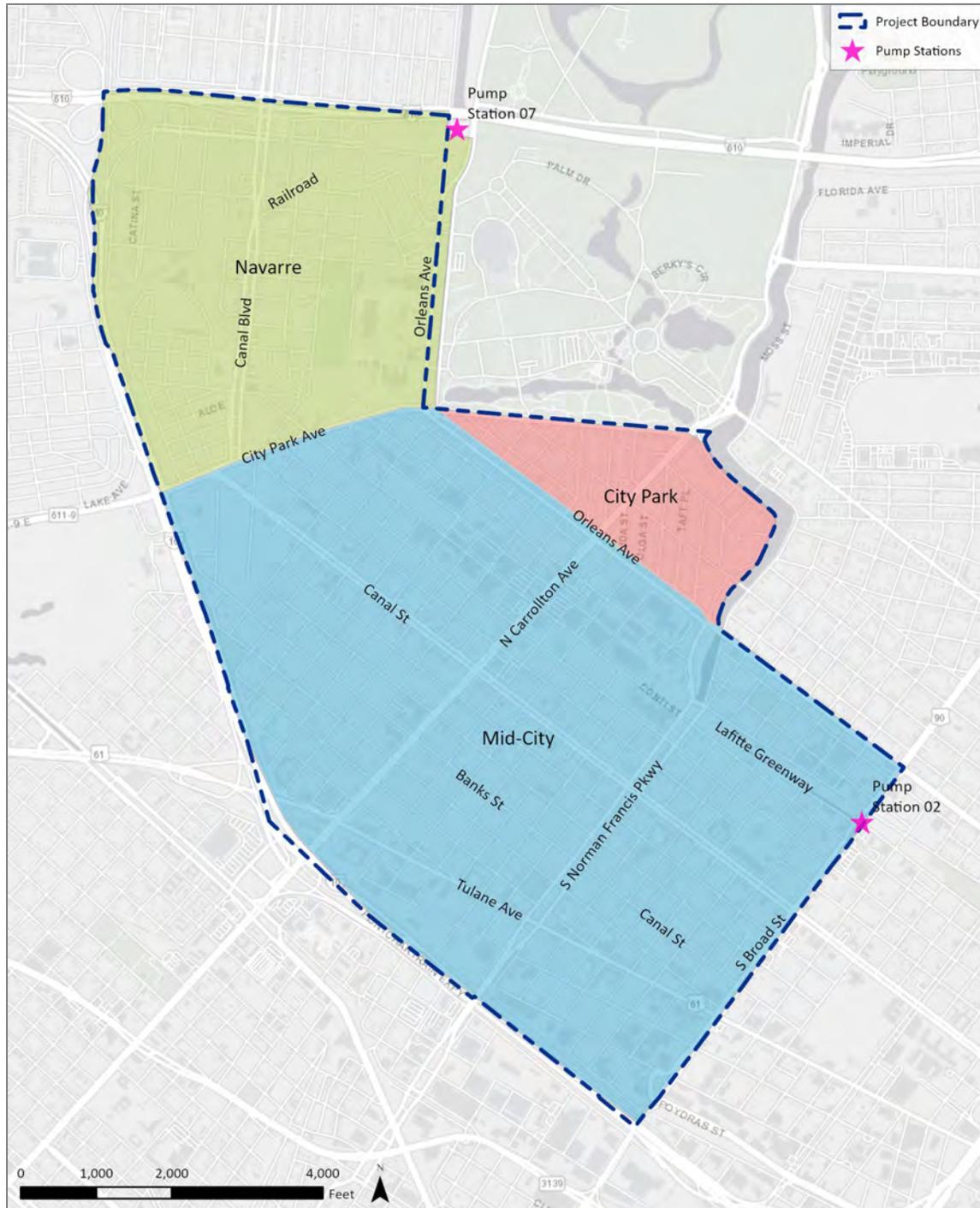
A primary objective for the project was to refine and update the City's U.S. Environmental Protection Agency (USEPA) SWMM models to determine areas of flooding, propose green infrastructure and stormwater management installations and/or improvements, and evaluate flood reduction benefits of proposed projects for the neighborhoods of Mid-City, City Park, and Navarre within 07 and 02 areas.

The City of New Orleans USEPA SWMM was processed using PC SWMM 2D (Version 7.6). The PC SWMM software is an interface for the USEPA SWMM. The H&H Stormwater drainage model was refined for more resolution and updated with recent survey data. The refined and updated model, the existing model, was used as a baseline against which the proposed alternative improvements were evaluated to meet the LOS for flood control under future simulated storms or meet an alternative secondary level of service as a compromise due to practical costs and regulatory constraints. The simulated storms had varying intensity and duration. Proposed capital improvements were tested, prioritized, and balanced with available funding.

The report describes the approach taken to refine and update the H&H Stormwater drainage model for this purpose, in addition to the validation and use of the model for analysis under both simulated existing conditions (available infrastructure and land use data up to Data Year 2024) and proposed alternatives conditions. The report describes the determination of the current LOS, model verification techniques, performance evaluation of the integrated stormwater management systems, as well as proposed improvements to meet the City's desired LOS goals.

## 1.3 Project Work Phases and Report Structure

The project work was divided into four major work phases in the contracted scope of services:



**Figure 1-1. Overview of the Project Area - Mid-City, City Park, and Navarre Neighborhoods**

### *Task 1 - Data Collection and Analysis*

In this phase CDM Smith collected, organized, and analyzed the required information to be used in modeling, surveying, and identification of project opportunities. The collected information described the physical details of the existing stormwater management system including the available City models, available survey information, and available final design and as-builts files. Additionally, the collected

geographical information systems (GIS) based data described the characteristics of the study area including topography, rainfall, soils, land use, flooding problems, and floodplains. When all available data were analyzed, a data gap analysis was conducted during which data availability and efficacy was evaluated, and a survey team was deployed to collect the missing topographic survey data.

The data collection, analysis, and evaluation of Task 1 are covered in Section 2.0, Data Collection and Analysis of this report.

### *Task 2 – Existing System Evaluation and Model Refinement*

This phase focused on the methodology used for the study area stormwater drainage analysis, including model refinement, validation, and design storm modeling for the existing City of New Orleans USEPA SWMM. For this project CDM Smith:

- Refined the hydrologic units and developed stage-area-storage characteristics for significant floodplain areas.
- Updated and developed the hydrologic unit input parameter values such as percent imperviousness, land slope and infiltration rates by evaluating topography, soil characteristics and land use data within each hydrologic unit.
- Developed rainfall hyetographs for the 1-, 10- and 25-year, 24-hour duration rainfall events using National Oceanic and Atmospheric Administration (NOAA) Atlas 14 rainfall totals with a National Resource Conservation Service (NRCS), formerly Soil Conservation Service (SCS), Type III rainfall distribution for water quantity evaluations.
- Updated and developed hydraulic SMS input parameters such as joint invert elevations, pipe cross-section geometry, and pipe, culvert and bridge sizes based on topography and available pipe and structure data.
- Identified problem areas for each neighborhood using simulation results.

The findings and evaluation of Task 2 are covered in Section 3.0, System Evaluation and Model Refinement of this report..

### *Task 3 - Alternatives Evaluations*

CDM Smith defined mitigative alternatives across the study area. This task developed a series of project opportunities to include distributed green stormwater infrastructure (GSI), conveyance improvements as guided by the problem areas identified in Task 2, and opportunities for regional projects that were identified based on available space owned or controlled by the City.

The findings and evaluation of Task 3 are covered in Section 4.0, Improvements and Alternatives Evaluation of this report.

### *Task 4 - Recommendations and Conceptual Design*

CDM Smith created a GSI database of parameters affecting GSI suitability in addition to discussing the prioritization of all proposed projects. CDM Smith developed metrics for assistance with determining projects to recommend and move forward through 10% design. CDM Smith then prepared a 10%

schematic design of the recommended projects which included proposed scope of work and projected construction costs. GSI projects were based on a defined set of metrics that defined whether a given type of project was feasible within a given location. In addition, CDM Smith prepared a rough order of magnitude (ROM) planning level conceptual Opinion of Probable Construction Cost (OPCC) that was developed using City of New Orleans' bid items and unit prices.

The findings and evaluation of Task 3 are covered in Section 5.0, Recommendations and Conceptual Design of this report.

#### *Task 5 - Implementation Determination*

CDM Smith researched and documented a phasing and an operations and maintenance (O&M) plan for the proposed projects. In addition, CDM Smith provided a record of funding opportunities for the types of grants and other financial assistance programs which might be available for each project.

The findings and evaluation of Task 3 are covered in Section 6.0, Implementation Determination of this report.

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## 2.0 Data Collection and Analysis

This Section discusses the techniques, parameters, and input data used to refine the City’s stormwater models implemented in the modeling and analysis phase of the work. CDM Smith conducted a site visit and a desktop investigation to collect available information to support updating the City models with recent data to properly evaluate the neighborhoods’ drainage and size proposed GSI and drainage improvements. The investigation and site visit focused on the Mid-City, City Park, and Navarre neighborhoods. The data describes the physical details of the existing drainage system and the characteristics of the study area including topography, rainfall, soil, and land use. The data were then analyzed, a data gap analysis was performed, and a survey team was deployed to collect missing data from the targeted areas.

### 2.1 Site Investigation

The CDM project team conducted a field visit to visually assess the project area and collect pertinent data to develop a complete project understanding. During the field investigation, the project team documented their observations on existing conditions of roads, green-spaces, and existing stormwater drainage infrastructure to be used later during modeling and design, also, the team captured photos, some of which are shown in **Figure 2-1**.



Orleans Avenue Median Strip



Norman Francis Parkway



Conti Street and St Patrick Street



Homedale Street



Comiskey Playground

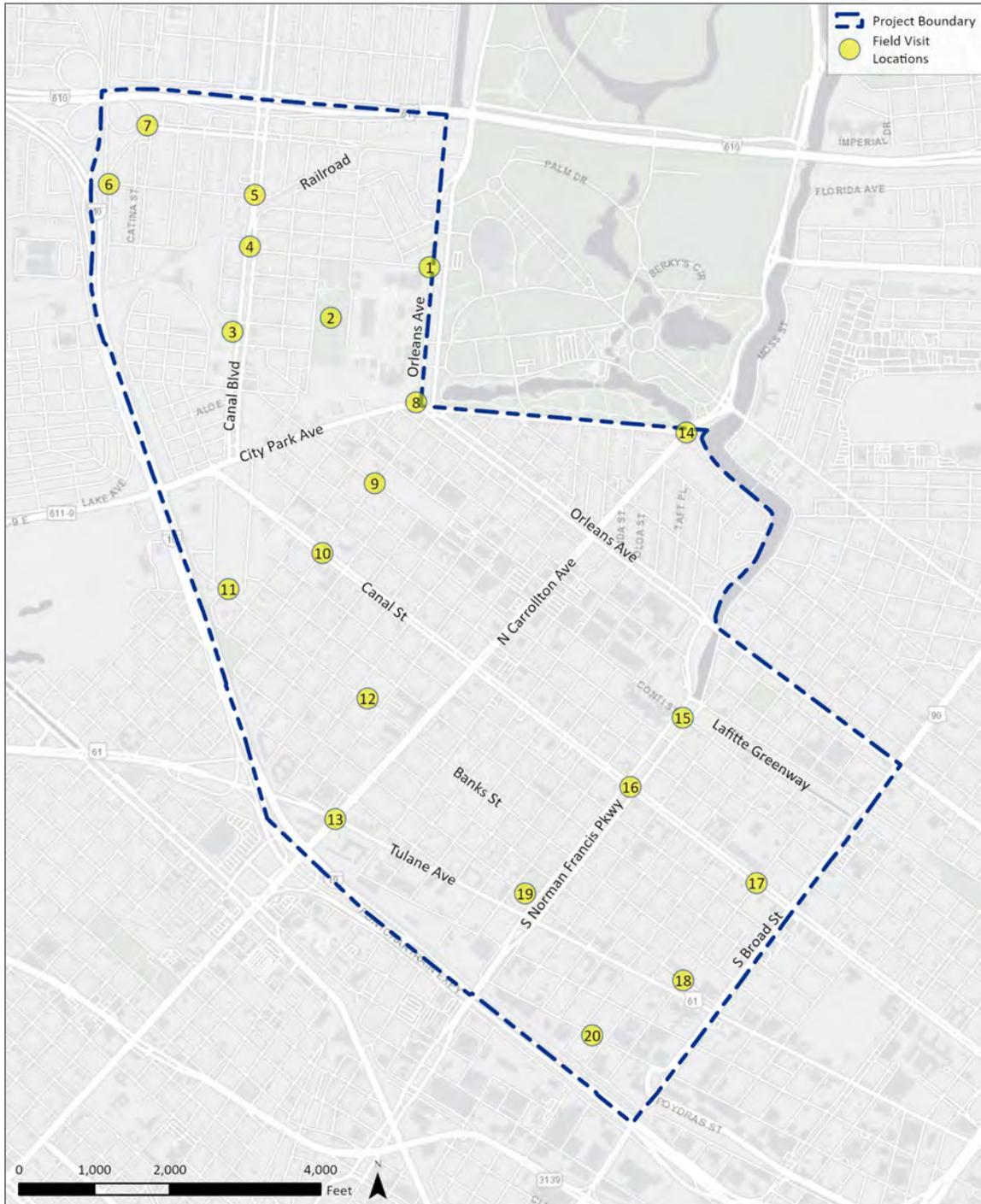


Intersection of S White Street and Banks Street

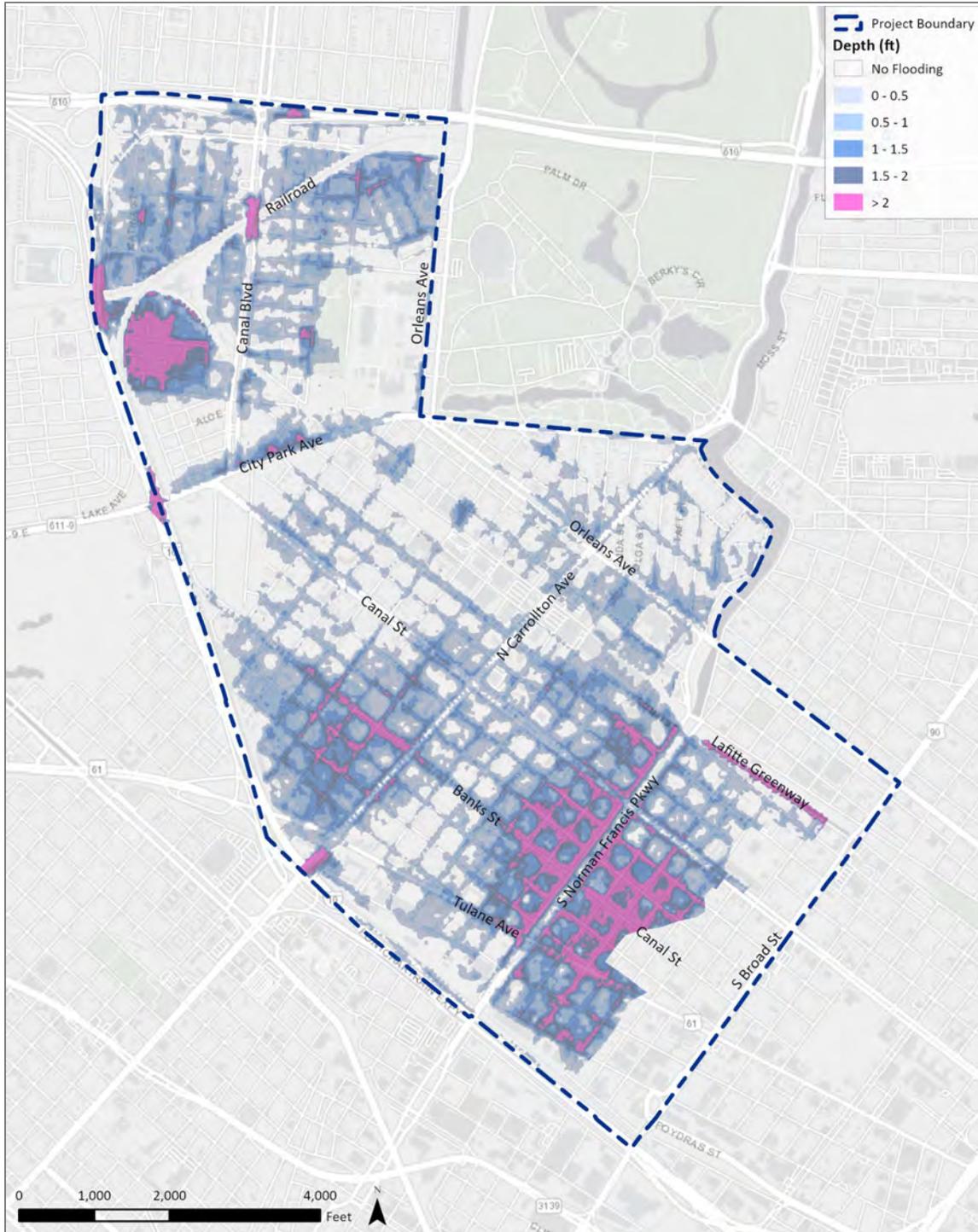
**Figure 2-1. Photos Captured During the Field Visit**

Beyond the windshield assessment, the project team stopped at 20 locations for further inspection, shown in **Figure 2-2**. These stops were selected throughout the project area based on site-specific

information obtained from the flooding concern areas identified using a 10-year flood map delineated using the available City’s SWMM model, shown in **Figure 2-3**.



**Figure 2-2. Field Visit 20 Locations Selected for Further Assessment**



**Figure 2-3. 10-Year Flood Map Delineated Using Available City SWMM Model**

## 2.2 City of New Orleans SWMM Models

The City of New Orleans has a comprehensive SMS that is divided into 13 distinct project areas aligned with the Sewerage and Water Board of New Orleans (SWBNO) pump station service areas. Two City models, DPS 7-12 and DPS 2-3-4-19, were used to model the project area, both created with USEPA

SWMM version 5. The models were created with the North American Vertical Datum of 1988 (NAVD 88), and the geodetic reference system, Louisiana State Plane (NAD 1983, State Plane, Louisiana, South)

In order to check the performance of the City SWMM models and confirm their continuity and validity, the models were used to simulate the 25-, 10-, and 1-year design storms. The simulation parameters were consistently applied across all runs, utilizing the Horton method for soil infiltration with ponding permitted, and the shallow water (St-Venant) equations for hydraulic flow routing. **Figure 2-4** and **Figure 2-5** show the result windows for both models, respectively. All runs were successful with insignificant continuity errors (< 0.2%).



**Figure 2-4. Simulation Results for City Model DPS 7-12**



**Figure 2-5. Simulation Results for City Model DPS 2-3-4-19**

## 2.3 Existing Project Area Inventory

Existing data for the project area was gathered from multiple sources, including the City of New Orleans Department of Public Works, Batture LLC, and the USGS Data Download Center. Data types received include PCSWMM models, recent engineering drawing of projects within the project area, and raster files. This section provides a summary of the data received by CDM Smith.

### 2.3.1 Existing and Proposed Engineering Drawings

The City of New Orleans Department of Public Works (DPW) provided engineering drawings for some existing and proposed roadway projects. The list of these roadway projects is shown in **Table 2-1**. This provided engineering drawings were examined, and relevant information was collected and compiled into an inventory spreadsheet. This inventory was used later in refining and updating the model.

**Table 2-1. Engineering Drawings Provided by the City of New Orleans**

Project ID/Name on Plan Set	Program/Project	Date
RR132	FEMA Recovery Roads Program – Navarre Group A	2022
RR126	Capital Improvement Program	2022
RR125	FEMA Recovery Roads Program	2020
RR025	Capital Improvement Program	2020
RR005	DPW Project – Bayou St John, Fairgrounds, 7 <sup>th</sup> Ward Group C	2022
RR004	FEMA Recovery Roads Program	2020
RR003	FEMA Recovery Roads Program	2020
HMGP 01	DPW Project – Hagan and Lafitte	2018
DPW-2013-B03	DPW Project – S Dupre St and S Gayoso St Improvements	2020
DPW087	DPW Project – 2000 Street Capital Improvement	2022

A list of the locations comprised in the provided drawings is listed in **Table 2-2**. The list describes the comprised road segment, the beginning and the end of the segment, the road name, and the source.

**Table 2-2. Locations of Data Provided by the City of New Orleans**

Source	Street	From	To
RR132	Banks St	S Gayoso St	S White St
	Canal Blvd	Voisin St	Hidalgo St
	Greenwood Dr	Canal Blvd	Vicksburg St
	Hawthorne Place	Hawthorne Place	Canal Blvd
	Marshall Foch St	N Park Place	Pontalba St
	N Park Place	Marshall Foch St	Middle Park Pl
	Navarre Ave	Vicksburg St	General Diaz St
	Pontalba St	Vicksburg St	General Diaz St
	S Dupre St	Tulane Ave	Canal St
	S Gayoso St	Palmyra St	Canal Blvd
	West End Blvd	Homedale St	(End)
RR126	Conti St	N Anthony St	N St. Patrick St
	N Bernadotte St	Canal St	City Park Ave
	N Murat St	Iberville St	Bienville St
RR025	Allard Blvd	Dumaine St	City Park Ave
	St John Ct	Moss St	(End)
RR005	Florida Ave	Moss St	Tunica St
	Leda Ct	Esplanade Ave	St Vincent St
	N Lopez St	Ursulines Ave	Esplanade Ave
	Marie St	Leda Ct	Verna Ct
	St Vincent St	Leda Ct	Verna Ct
	Toulouse St	N White St	N Broad St
DPW087	Homedale Ave	West End Blvd	Canal Blvd

Source	Street	From	To
	Milne Blvd	Homedale Ave	Florida Blvd
	Walker St	Marshall Foch St	Orleans Ave
	Center St	33rd St	Tacoma St
RR125	Banks St	Jane Place	S Broad St
	Banks St	S Genois St	S Telemachus St
	Banks St	S St Patrick St	S Bernadotte St
	Baudin St	S Broad St	S Jefferson Davis Pkwy
	Baudin St	S St Patrick St	S Bernadotte St
	Bienville Ave	N Broad St	N White St
	Canal St	N Anthony St	City Park Ave
	City Park Ave	Pontchartrain Blvd	Canal St
	Cleveland Ave	S Carrollton Ave	S Pierce St
	Cleveland Ave	S St Patrick St	S Olympia St
	Cleveland Ave	S. Bernadotte St	(End)
	Conti St	N Bernadotte St	City Park Ave
	Conti St	N Lopez St	N Cortez St
	Conti St	N Olympia St	N St Patrick St
	D'Hemecourt St	S Murat St	S Olympia St
	D'Hemecourt St	S Telemachus St	S Cortez St
	Gravier St	S Clark St	S Pierce St
	Gravier St	S Gayoso St	S Salcedo St
	Iberville St	N Broad St	N White St
	Iberville St	N Gayoso St	N Salcedo St
	Iberville St	N Murat St	N St Patrick St
	Iberville St	N Pierce St	N Carrollton Ave
	N Alexander St	St Louis St	Toulouse St
	N Anthony St	Bienville Ave	City Park Ave
	N Carrollton Ave	Iberville St	Bienville St
	N Gayoso St	Bienville Ave	Conti St
	N Hennessey St	St Louis St	Toulouse St
	N Lopez St	Iberville St	Bienville St
	N Murat St	St Louis St	Toulouse St
	N Olympia St	Canal St	Bienville Ave
	N Pierce St	Canal St	Conti St
	N Pierce St	Toulouse St	Orleans Ave
	N Rendon St	Canal St	Conti St
N St Patrick St	Canal St	Conti St	
N Scott St	Canal St	Iberville St	
Orleans Ave	N Norman C Francis Pkwy	N Scott St	
Palmyra St	S Lopez St	S Norman C Francis Pkwy	

Source	Street	From	To
	Perdido St	S Lopez St	S Salcedo
	S Bernadotte St	Banks St	Canal St
	S Carrollton Ave	Banks St	Palmyra St
	S Cortez St	Baudin St	D'Hemecourt St
	S Genois St	D'Hemecourt St	Banks St
	S Hennessey St	Banks St	Tulane Ave
	S Lopez St	Gravier St	Perdido St
	S Murat St	Banks St	Palmyra St
	S Pierce St	Gravier St	Tulane Ave
	S Rendon St	Banks St	Palmyra St
	S Rendon St	Gravier St	Tulane Ave
	S St Patrick St	Banks St	D'Hemecourt St
	S Salcedo St	Banks St	Baudin St
	S Salcedo St	Gravier St	Perdido St
	S Scott St	Cleveland Ave	Canal St
	S Scott St	Palmyra St	Banks St
	S Scott St	Tulane Ave	Gravier St
	S Solomon St	Baudin St	Tulane Ave
	S Solomon St	Palmyra St	Banks St
	S White St	Baudin St	Tulane Ave
	S White St	Canal St	Cleveland Ave
	S Gayoso St	Baudin St	Tulane Ave
	S Gayoso St	Gravier St	Perdido St
	St Louis St	N Broad Ave	N Dupre St
	St Peters St	N Hennessey St	N Solomon St
	Toulouse St	City Park Ave	N Bernadotte St
	Toulouse St	N Carrollton Ave	N Scott St
	Toulouse St	N Alexander St	N Hennessey St
	Toulouse St	N Olympia St	N Murat St
	Toulouse St	N Solomon St	David St
	Tulane Ave	S Carrollton Ave	S Pierce St
	Tulane Ave	S Gayoso St	S Dupre St
	Tulane Ave	S Telemachus St	S Genois St
RR004	Allen St	N Galvez St	N Tonti St
	Allen St	N Dorgenois St	Hope St
	Allen St	N Roman St	(End)
	Annette St	Marais St	N Robertson St
	Columbus St	N Robertson St	N Villere St
	Industry St	N Broad St	Allen St
	N Miro	New Orleans St	Allen St

Source	Street	From	To
	N Tonti St	Lapeyrouse St	Onzaga St
	St Anthony St	N Claiborne Ave	N Tonti St
	Touro St	N Claiborne Ave	N Miro St
HMGP 01	N Lopez St	Lafitte Greenway	St Peter St
	Hagan Ave	Lafitte Greenway	St Peter St
	Toulouse St	Hagan Ave	Lopez St
	St Peter St	Moss St	White St
	N Rendon St	Lafitte Greenway	St Peter St
	N Salcedo St	Toulouse St	St Peter St
	N Dupre St	Toulouse St	St Peter St
	N White St	Lafitte Greenway	St Peter St
	N Gayoso St	Lafitte Greenway	St Peter St
DPW-2013-B03	S Dupre St	Banks St	Canal St
	S Gayoso St	Tulane Ave	Canal St
DPW087	Homedale Ave	West End Blvd	Canal Blvd
	Milne Blvd	Homedale Ave	Florida Blvd
	Walker St	Marshall Foch St	Orleans Ave
	Center St	33rd St	Tacoma St

Ave – Avenue  
 Blvd – Boulevard  
 Ct – Court  
 N/A – not available  
 Pl – Place  
 St – Street

### 2.3.2 Available Survey Data

CDM Smith received available survey data from Batture LLC. **Table 2-3** shows the data sets provided, and a list of the locations comprised in the provided data is shown in **Table 2-4**. The list describes the comprised road segment, the beginning and the end of the segment, the road name, and the source. The data sets provided were examined, and relevant information was compiled into the inventory spreadsheet.

**Table 2-3. Survey Data and Drawings Provided by Batture LLC**

Project ID/Name on Plan Set	Program/Project	Date
Edwards Apartments ALTA/NSPS Land Survey of Square 508 2 <sup>nd</sup> District	Land Survey	2022
Edwards Apartments ALTA/NSPS Land Survey of Lot X-1 2 <sup>nd</sup> District	Land Survey	2022
DPW-2016-A01	Capital Improvement Program	2021

**Table 2-4. Locations of Data Provided by Batture LLC**

Source	Street	From	To
EDWARDS_ALTA_X-1	Lafitte Greenway	N Cortez St	Edge of Lot X-1
	N Cortez St	Conti St	Lafitte Greenway
	Conti St	N Cortez St	Edge of Lot X-1
EDWARDS_ALTA_508	Lafitte Greenway	N Scott St	Cortez St
	N Scott St	Conti St	Lafitte Greenway
	N Cortez St	Conti St	Lafitte Greenway
	Conti St	N Scott St	N Cortez St
DPW-2016-A01	Clayton Ave	Vicksburg St	General Diaz St
	Rosedale Dr	Canal Blvd	Virginia St
	Virginia Ct	Memphis St	General Diaz St
	Virginia St	City Park Ave	Virginia Ct

### 2.3.3 City GIS Data

In addition to the engineering drawings, the City provided georeferenced data shapefiles that included the following:

- Adjusted drainage system (2014): The shapefile has about 200-300 inlets and manhole within the project area. The data included depths with rims and invert information; however, the pipe sizes and configuration were not provided.
- Structures (2023): The data included areas of building structures within the project area. The shapefiles were used in the project for flood analysis.
- Catch basins (2024): the data included the depth, rim, and invert elevation for only one manhole within the project area.

## 2.4 Desktop Data Collection

### 2.4.1 Topographic Data

The topography of the two City models, DPS 7-12 and DPS 2-3-4-19, was originally defined using LiDAR data from the Louisiana Statewide LiDAR project. LiDAR was used primarily for dividing the watershed into individual subcatchments, also known as hydrologic units (HU). In addition, LiDAR was used to determine the approximate invert elevations for above-ground drainage features, road elevations, and inlet elevations where survey data was not available.

CDM Smith obtained a newer LiDAR, the 2021 Louisiana Department of Transportation and Development (LaDOTD) LiDAR shown in **Figure 2-6**. Along with the survey data, this LiDAR was used to update and refine the model. This included determining approximate invert elevations for drainage features, road and inlet elevations, storage availability, building areas, developing flood maps, and comparing model results.



Figure 2-6. The 2021 LaDOTD LiDAR

### 2.4.2 Land Use and Imperviousness

The U.S. Geological Survey (USGS) partners with the National Land Cover Data (NLCD) to develop land cover and imperviousness mosaic layers available for public download. Originally, the City utilized the USEPA 2001 NLCD 2001 to develop imperviousness. The NLCD dataset includes imperviousness raster data that has a unique impervious value at each pixel. The percent impervious was developed from the

NLCD 2001 raster data and area weighted by the subcatchment area to develop a homogenous value for total imperviousness for each subcatchment. However, not all of the impervious area is directly connected to the City stormwater system. As a portion will be directed to pervious areas, SWMM has a “ROUTE TO” function to account for this. In the initial setup of the City models, the “ROUTE TO” was set to route 33% of the runoff to the pervious layer, with this value used as a calibration parameter, where applicable.

CDM Smith obtained the 2021 Impervious Cover layer from NLCD and updated the impervious values for each subcatchment. This was accomplished by intersecting the impervious cover layer with the subcatchments to find the average imperviousness over each subcatchment. **Figure 2-7** shows the comparison between the impervious cover values assigned in the existing model (left) and the updated impervious cover values (right). There has been a significant increase in the amount of impervious cover over the project area since 2001, the year represented by the impervious cover in the existing model. In the model, the imperviousness value for a total of 541 subcatchments were updated. **Appendix A** lists the original and the new value for each updated subcatchment.



**Figure 2-7. Comparison Between Existing and Updated Impervious Cover**

### 2.4.3 Soil and Infiltration

For both City models, the infiltration parameters were defined using the Horton soil infiltration method. The soils data (hydrologic soil group (HSG) and soil type) were collected from the U.S. Department of Agriculture (USDA) NRCS. Infiltration parameters were determined by the predominant HSG in each subcatchment. **Table 2-5** displays the soil parameters that were input into each subcatchment for the

dominant HSG. In the model, soil parameters for a total of 541 subcatchments were updated. **Appendix A** lists the original and the new maximum infiltration rate, maximum infiltration volume, and minimum infiltration rate for each updated subcatchment.

**Table 2-5. Global Soil Parameters in the City Models**

Soil HSG	Max. Infiltration Rate (inch/hour)	Min. Infiltration Rate (inch/hour)	Decay Rate (1/sec x 10 <sup>-4</sup> )	Dry Time (days)	Soil Storage (inch)
A	12.0	1.00	5.56	1.0	5.4
B	9.0	0.50	5.56	1.0	4.0
C	6.0	0.25	5.56	1.0	3.0
D	4.0	0.10	5.56	1.0	1.3

#### 2.4.4 Overland Roughness and Depression Storage

For both City models, the overland Manning's roughness values were set to 0.013 for impervious areas and 0.2 for pervious areas. Also, the depression storage values, also known as initial abstraction and defined as the volume of water that does not flow off the surface into the stormwater management system due to ponding, were set to 0.05 inch over impervious areas and 0.1 inch over pervious areas.

#### 2.4.5 Hydrologic Load Points

In the City models, the inlets and smaller connecting pipes (15-inch-diameter and smaller) were considered secondary systems and in most cases were not explicitly modeled. Many areas have two stormwater pipes, one on each side of the street. Consequently, where streets such as these intersect, there are likely four manholes at the intersection of these pipes. Surrounding these manholes, there can be up to 12 inlets. For these intersections, the surface runoff from the surrounding area (estimated from the hydrologic layer of the model) was modeled to load to a single junction (node), hence entering the hydraulic system at a single-entry point.

### 2.5 Available Data Analysis

CDM Smith examined the provided engineering drawings encompassing construction plans, ALTA survey maps, and as-built drawings. The objective was to expand the data inventory spreadsheet by incorporating pertinent details about manholes and conduits. **Figure 2-8** represents a section extracted from the plan and profile views, a pivotal tool in our data gathering process. Our approach included comparing the conduit details extracted from these documents with the City model data. Details obtained for a conduit include location, model conduit name, dimensions, material, and data source.

Similarly, essential manhole details including intersection location, model node name, rim elevation, lowest invert elevation, depth, and data source were obtained. In cases where several manholes were represented by a single node in the model, the team selectively documented the data associated to the node with the lowest invert elevation. **Figure 2-9** provides an example of one of these cases.

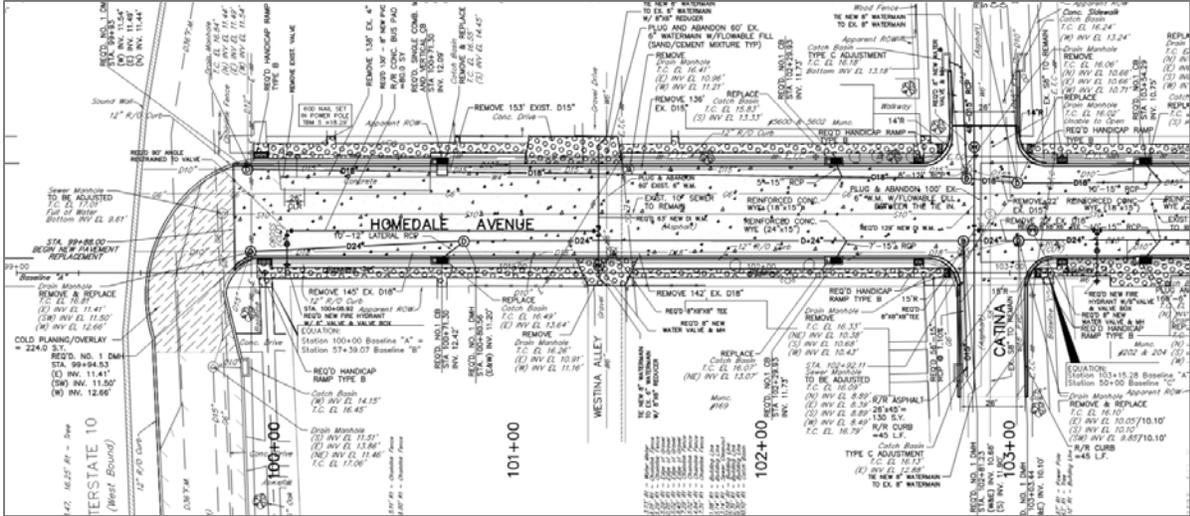


Figure 2-8. Example of a Plan View Examined to Obtain Pertinent Conduit Details

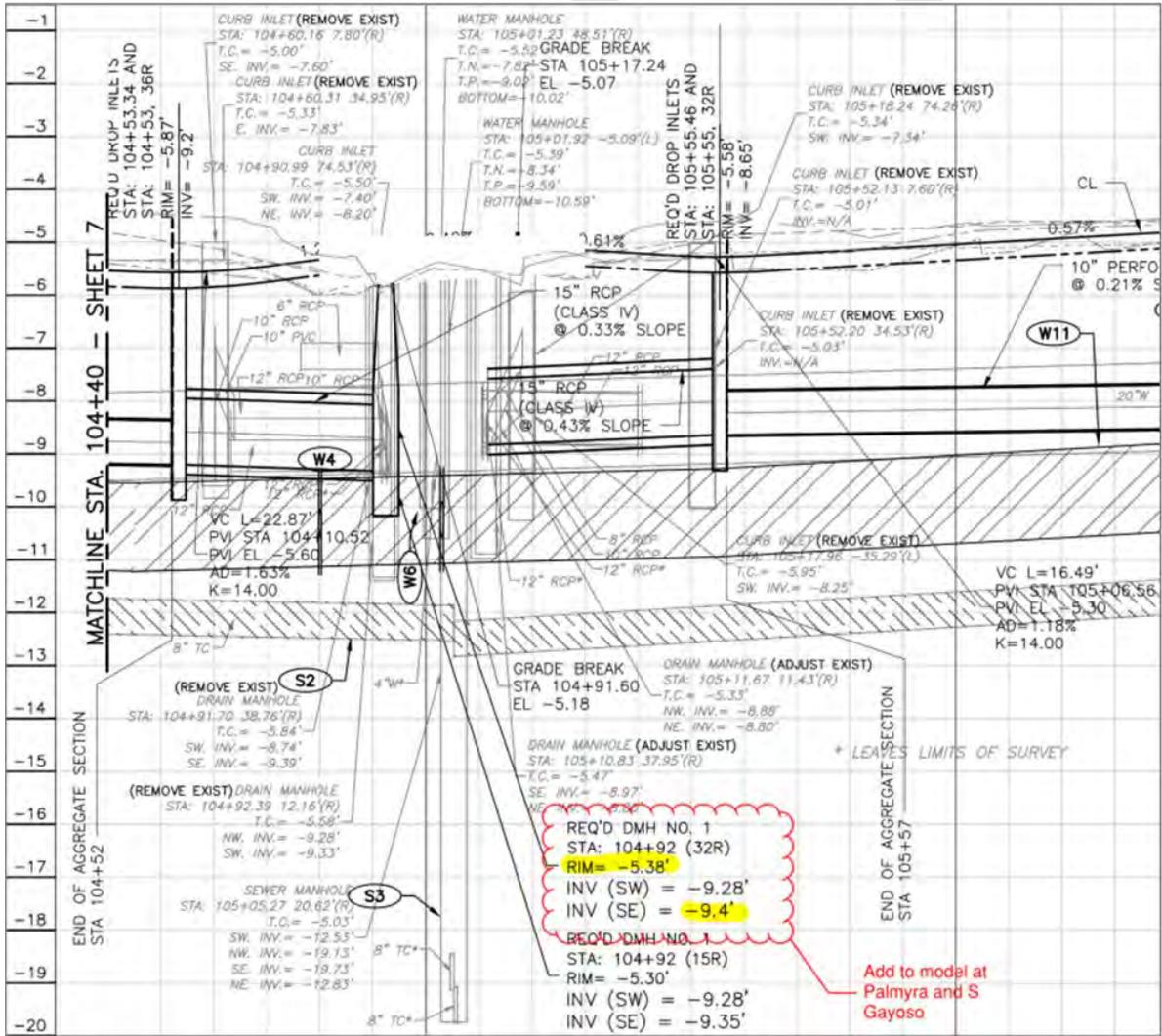


Figure 2-9. Example of Case of Several Manholes Represented by a Single Node in the Model

A comprehensive update of conduits and manholes, already represented in the existing model, are documented. New conduits and manholes were also added to the model. Markups on the source drawings capture all updates to the preexisting conduits and manholes. This systematic approach was implemented to improve the accuracy and integrity of the model.

## 2.6 Data Gaps Identification

A map featuring manholes and large conduits (36-inch or greater) locations throughout the project area was developed. Existing information was added to the map as well. This strategy map was utilized to guide the selection process for survey locations within the project area, encompassing a network of more than 1,000 manhole locations interconnected by pipes of various sizes. In the effort to refine selection, manholes situated along large conduits and areas with incomplete data were selected. This process resulted in approximately 170 locations, illustrated in **Figure 2-10**.

## 2.7 Infrastructure Survey

Team member, Batture LLC was tasked with completing the survey of identified manholes intended for updating the existing model. This section provides examples of the survey data gathered and outlines the anticipated methods through which CDM Smith envisions integrating this data into the existing model.

### 2.7.1 Manhole Inspection Form

During the data gathering process, a thorough assessment of each manhole was conducted at designated locations shown in **Figure 2-10**. Essential details were captured, including manhole location, rim elevation relative to adjacent grade, and whether it was surcharged at the time of the inspection. The inspection form facilitates detailed comments from the surveyors on the condition of the frame, wall, trough, and pipe(s). The compiled data from these forms was reviewed and used as a sample to calculate potential project area cost of future maintenance activities.

The surveyors submitted a comprehensive set of photos for each inspected manhole, presented in PDF format, to provide a thorough visual record together with the corresponding Manhole Inspection Form. These photos include:

- A photo of the closed manhole with embedded GPS data
- A plan view photo of the closed manhole
- A plan view photo of the opened manhole
- Multiple photos capturing the manhole walls, meticulously showcasing each connecting pipe

The photos displayed below represent a manhole inspection conducted on December 12, 2023, at the intersection of Florida Boulevard and Milne Boulevard. **Figure 2-11** illustrates both the open and closed plan views of the same manhole. **Figure 2-12** is the plan view of the manhole with embedded GPS data. Notably, the figure highlights the deteriorated frame of the manhole, consistent with the assessment recorded on the manhole inspection form. **Figure 2-13** provides an inside perspective of the manhole, showcasing connecting pipes. Surveyors thoughtfully include directional context in their field notes, offering insights into the orientation of the captured photos.

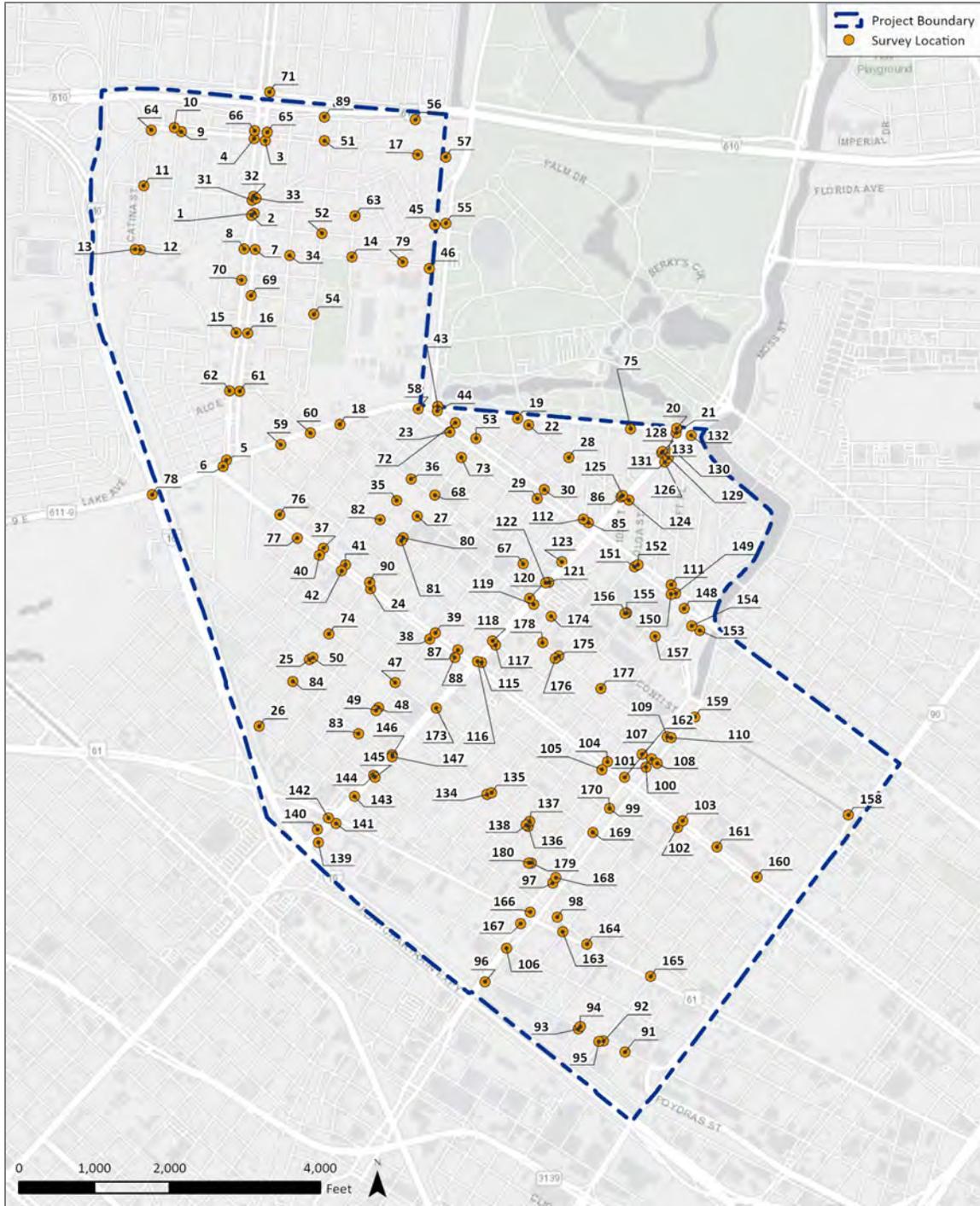


Figure 2-10. Designated Survey Locations



Figure 2-11. Photos of Closed (Left) and Open (Right) Manhole Plan Views



Figure 2-12. Photo of the Closed Manhole with Embedded GPS Data



Figure 2-13. Photos of the Manhole Walls Showcasing Connecting Pipes

The 180 surveyed manholes were cross-checked against the original model and the Drain Link maps provided by the City of New Orleans. Conduits in the model that matched the Drain Link map and survey were left unchanged. Some conduits have been upsized since the Drain Links map and original model were created; these conduits were updated in the model and noted. Additionally, some conduits that were not present in the original model but are shown on the Drain Links map were added to the model. **Figure 2-14** shows a screenshot for a manhole from the CADD files, developed by Batture LLC, displaying the type of data collected. The complete survey dataset is provided in **Appendix B**.



**Figure 2-14. Screenshot from a CADD File Displaying Data Collected for Manholes**

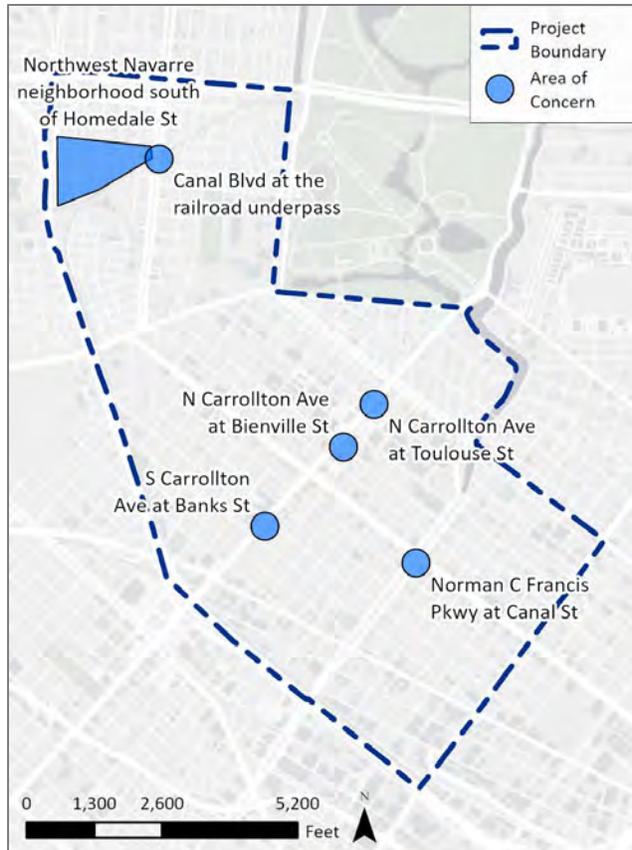
### 2.7.2 Stormwater Drainage Infrastructure Details

Along with the Manhole Inspection Form and associated photos, the number of pipes, pipe sizes, direction, and inverts, top of casting elevations, and GPS coordinates were provided in an AutoCAD format for each identified manhole. The complete survey dataset is provided in **Appendix B**.

## 2.8 Areas of Concern

The City noted several specific areas of concern. These areas are listed below and are illustrated in **Figure 2-15**:

- 1) Northwest Navarre neighborhood south of Homedale Street
- 2) Canal Boulevard at the railroad underpass
- 3) North Carrollton Avenue at Bienville Street
- 4) North Carrollton Avenue at Toulouse Street
- 5) South Carrollton Avenue at Banks Street
- 6) Norman C. Francis Parkway at Canal Street



**Figure 2-15. Critical Areas of Known Flooding Concern**

Each of these areas is a localized topographic low point which naturally collects water but is made worse by other factors including:

- The northwest Navarre neighborhood is bordered to the south by a railroad. This topographic boundary blocks the natural overland flow of stormwater towards the south and exacerbates flooding along Mound Avenue.
- The railroad underpass at Canal Boulevard is an unnatural and significant low point that requires an underpass DPS to drain. The status of this underpass DPS is unknown. An assessment of the required size is suggested to be completed as part of this project.
- The flooding at North Carrollton Avenue at Bienville and Toulouse streets is intensified by the large commercial area between the two streets that drains towards them.
- The area north of South Carrollton Avenue at Banks Street is a large localized low area. South Carrollton Avenue is built higher than the surrounding area and acts as a berm that forces stormwater to pool before being drainage via the underground system.
- Norman C. Francis at Canal Street.







## 3.0 System Evaluation and Model Refinement

Since the City of New Orleans is a nearly completely developed urban area with low-lying, relatively flat topography, the S&WB canal and pumping system is relied on during storms to remove water from the City and pump to outfall canals and Lake Pontchartrain. High intensity rainfalls, low topography, poorly draining soil characteristics, high-water table, high degree of impervious area, and limited available surface storage all contribute to severe flooding potential from precipitation events.

The purpose of the original modeling refinement was to use existing stormwater model to:

- 1) Model the proposed green infrastructure for the project area.
- 2) Determine necessary pipe improvements to convey water to the green infrastructure and alleviate major bottlenecks in the system.
- 3) Show the benefits of green infrastructure and pipe improvements reductions in flood depth and volume.

For the analysis of the project area, the City models were used as a baseline to develop the project area system model.

### 3.1 Methodology

#### 3.1.1 Model Setup

The two City models, DPS 7-12 and DPS 2-3-4-19, were combined to develop the project model. **Figure 3-1** shows parts of the City models that overlay the project area. The project area was mainly covered by the DPS 7-12 model with the remaining parts at the south and east areas covered by the DPS 2-3-4-19 model.

Merging the two City models involved integrating all model elements including junctions, storage junctions, outfalls, conduits, pumps, and subcatchments. DPS 7-12 model was used as the base model, and the needed elements were copied from the DPS 2-3-4-19 model. Some proxy elements, with low level of detail, in the DPS 7-12 model had to be replaced by higher level of detail elements from DPS 2-3-4-19 model. In addition, extraneous elements outside the project boundary were eliminated from the model, retaining only elements that align with and encompass the designated project area.

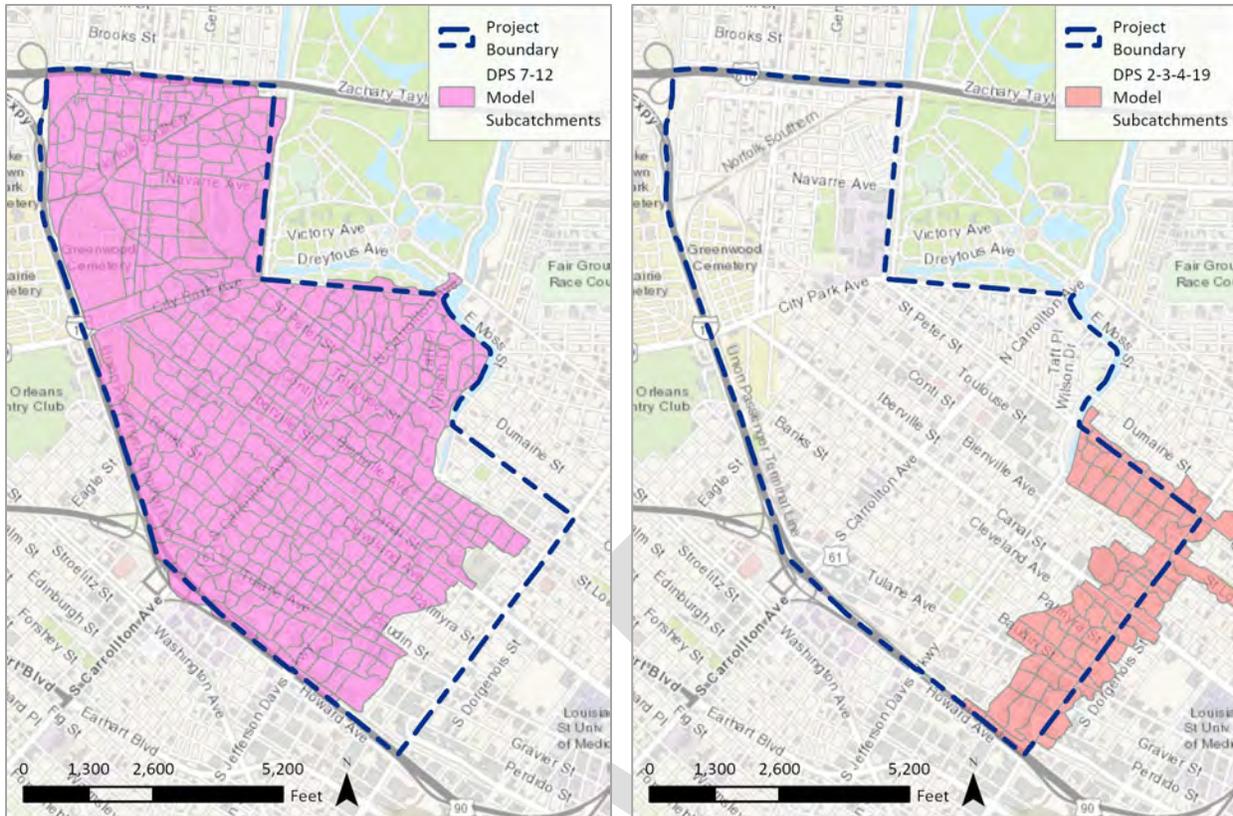


Figure 3-1. City Models Overlaying the Project Area

### 3.1.2 Model Boundary Conditions

Given that some elements were eliminated to detach the project model, time series were developed for the boundary nodes that were previously connected to eliminated elements of the City models. **Figure 3-2** shows the locations of the boundary nodes. The inflow locations were modeled as junctions with defined inflow time series. For the 9 junctions listed below, a unique inflow time series was developed for each design storm, 25-, 10-, and 1-year.

- DPS02\_10188
- DPS03\_40901
- DPS07\_28973\_CDM
- DPS07\_29321\_CDM
- DPS07\_29323\_CDM
- DPS07\_12998\_CDM
- SU20
- SU151
- J8

These inflow time series were used to define the boundary conditions at these locations where floodwaters flow into the project area. The graphical representations of the developed inflow time series are shown in **Appendix C**. Additionally, locations where floodwaters flow out of the project area were simulated as outfall nodes with defined stage time series boundary conditions. For the 3 outfalls listed below, a unique stage time series was developed for each design storm, 25-, 10-, and 1-year.

- J7770
- J12410
- DPS07\_28917\_CDM

The graphical representations of the developed outflow time series are also shown in **Appendix C**.

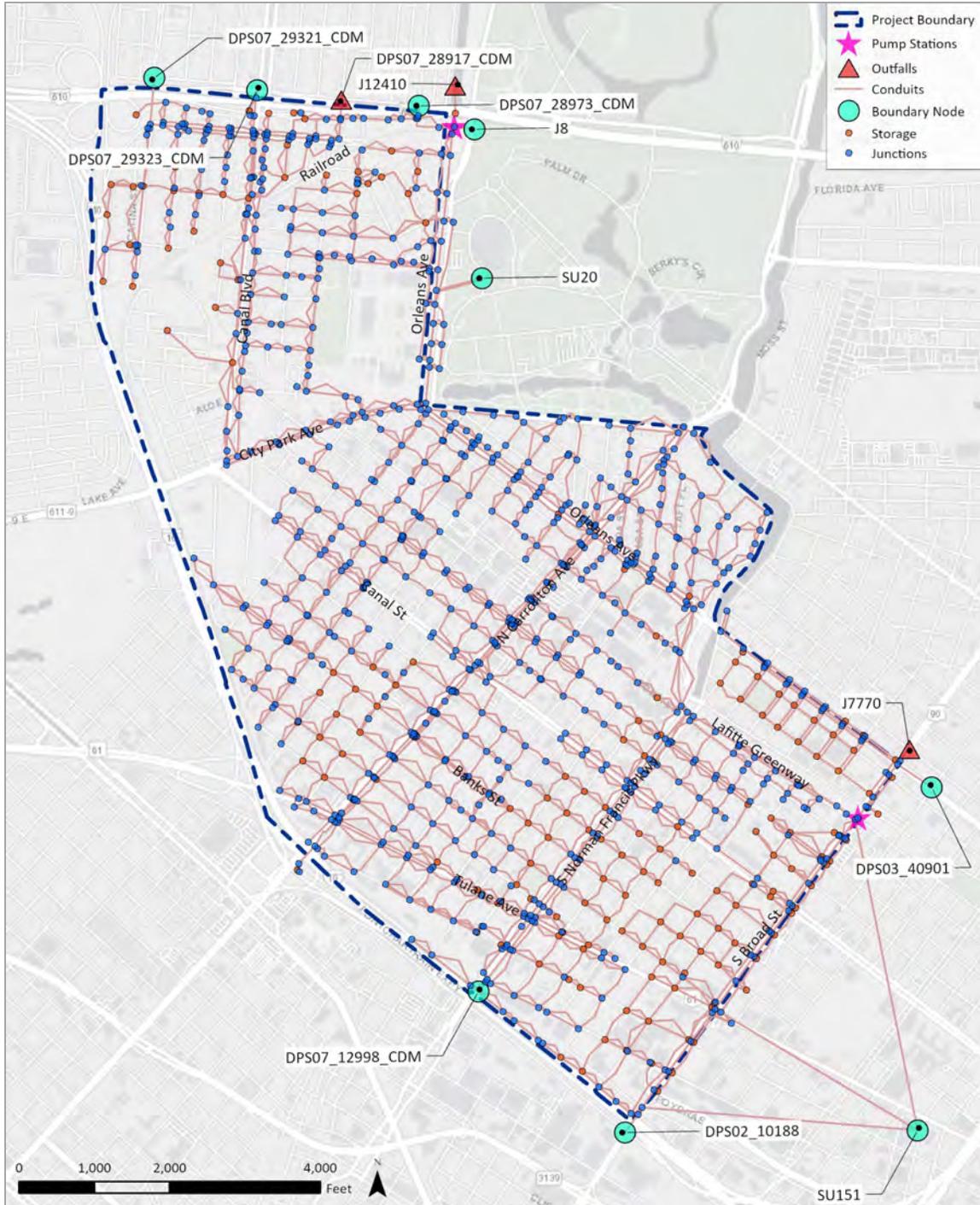


Figure 3-2. Project Model Elements and Boundary Condition Nodes

### 3.1.3 Stormwater Drainage System Assessment

The stormwater drainage system in Mid-City, City Park, and Navarre has been studied to better understand the mechanisms by which stormwater is drained. Major streets serve as collection corridors, while pump stations DPS 07 and DPS 02 facilitate the movement of water to Lake Pontchartrain. Stormwater in these neighborhoods is primarily collected through a network of subsurface and open

canals; storm drains and catch basins. Runoff predominantly flows towards major drainage arteries, including systems on Florida Boulevard (Blvd), City Park Avenue (Ave), N Carrollton Ave, S Norman Francis Parkway (Pkwy), and S Broad Street (St). Water from these streets and surrounding areas is funneled into the Orleans Ave, along Lafitte Greenway and Orleans Ave, which acts as a primary conduit for stormwater. **Figure 3-3** shows these flow paths. Once stormwater enters the canal system, it is directed toward DPS 07 and DPS 02.

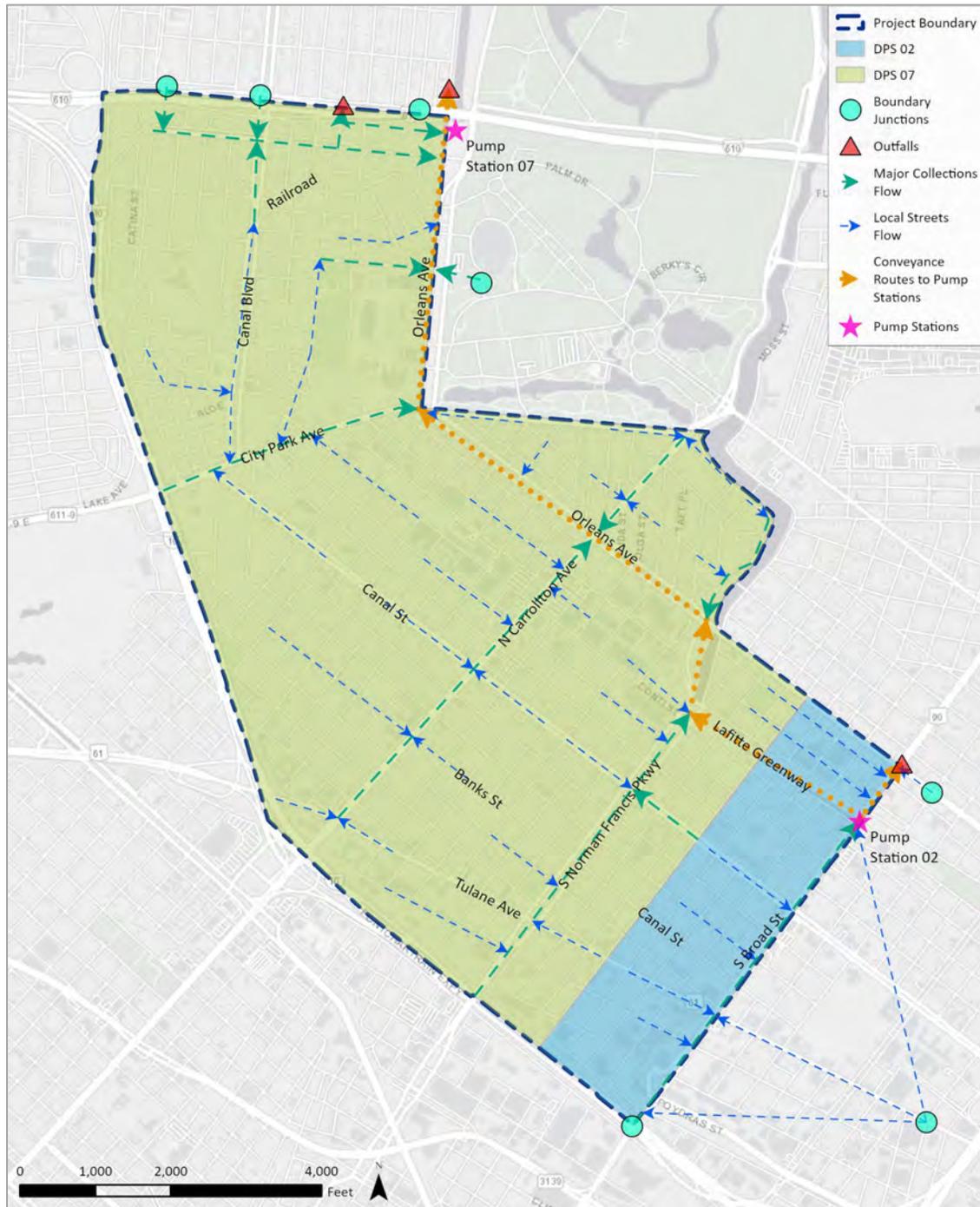


Figure 3-3. Project Area Stormwater Flow Paths

## 3.2 Model Update

The project model was refined, adding more resolution, and updated with recent survey data to properly evaluate neighborhood sized green infrastructure and stormwater drainage improvements.

### 3.2.1 Hydrologic Updates

The hydrologic updates made to the model are discussed in Section 2.4 Desktop Data Collection. All updates were based on publicly available datasets.

### 3.2.2 Hydraulic Updates

#### 3.2.2.1 Nodes and Conduits

The survey data collected by Batture LLC was used to update the existing model. Before updating elevations, all new nodes and conduits were incorporated into the model to ensure accurate topography interpolation. This step was crucial for maximizing confidence in the interpolation process. The project CDM Smith team thoroughly reviewed the survey data and incorporated new nodes and conduits into the model as needed. In total, 66 nodes and 36 conduits were added. All new nodes were included as functional storage nodes to represent manholes. Conduits were added as circular, box, or elliptical cross sections based on the field survey and available data.

Once all the infrastructure was in place, the invert elevations of the conduits were updated. A Python script was developed to identify all conduit paths from upstream to downstream, which were then used to visualize the pipe invert profiles. Pipes added from the survey were assigned to the surveyed pipe invert. If the new conduit invert caused a sudden peak in the profile, the surrounding conduit invert elevations were interpolated. **Figure 3-4** and **Figure 3-5** provide two examples from the model for the attributes of conduits that have been updated.

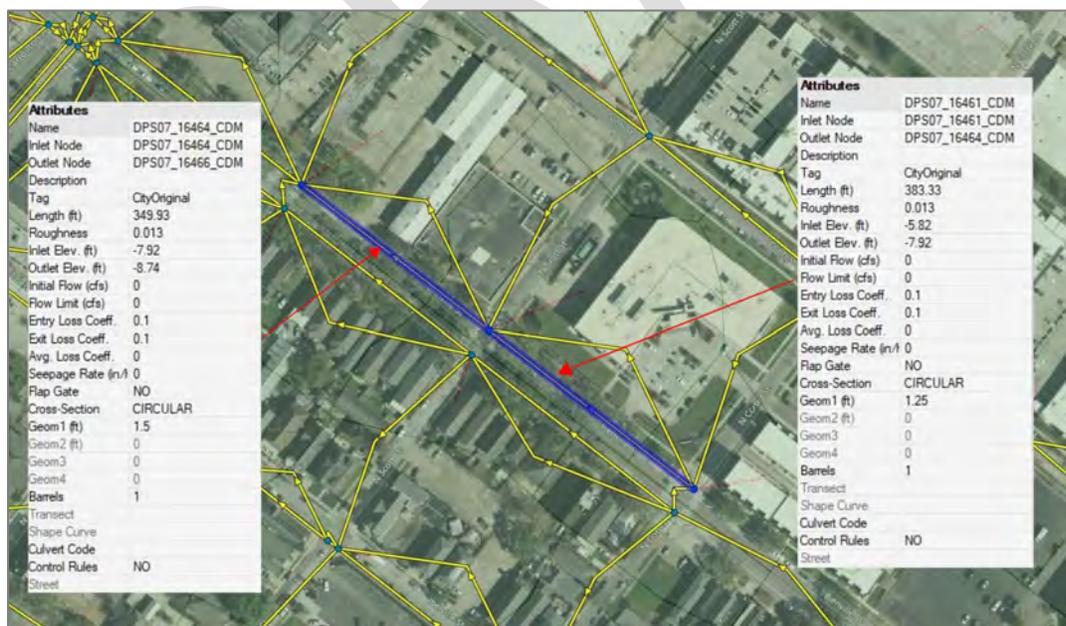


Figure 3-4. Screenshot from the Project Model Prior to Incorporating Survey Data

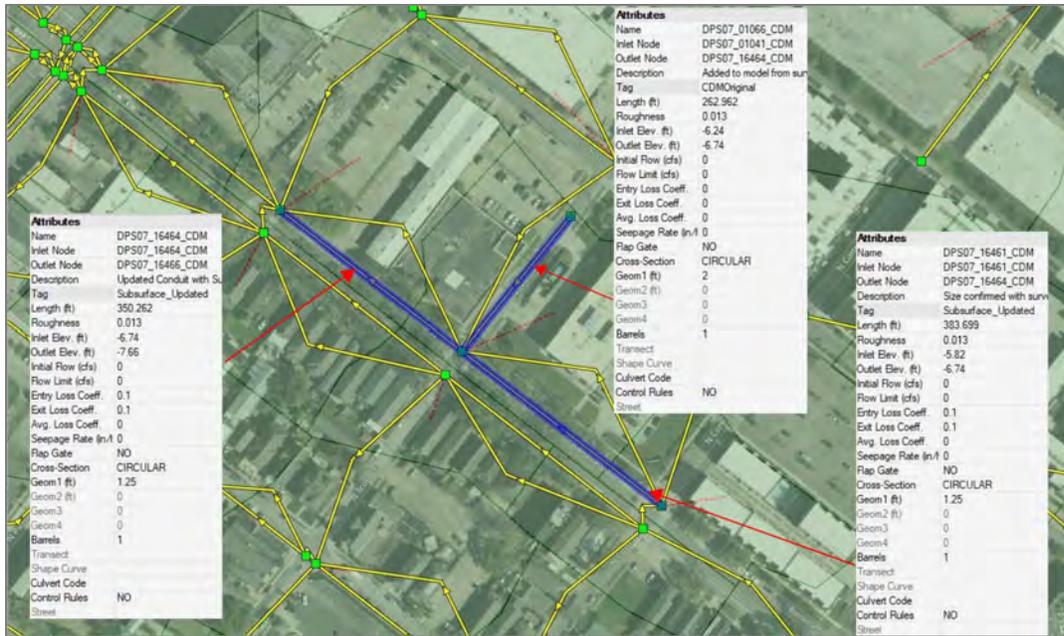


Figure 3-5. Screenshot from the Project Model Post Incorporating Survey Data

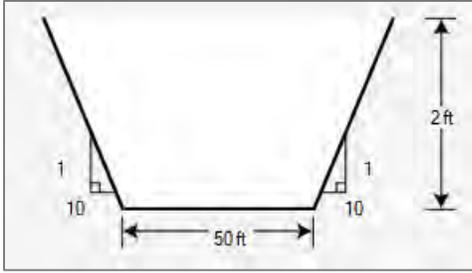
After updating the conduit invert elevations, it was necessary to update the model node invert elevations. This was done by assigning the lowest conduit invert to the node invert to ensure no connecting conduits were lower than the manhole's invert. As an example, if a manhole node invert is at -5.0 feet (ft) below land surface (bls), all connecting conduits must be at -5.0 ft bls or higher for proper drainage into the node. **Appendix D** lists the revised nodes and conduits.

A similar process was used to update the conduit cross sections. Each of the 180 surveyed manholes was cross-checked against the model and the Drain Link Maps provided by the City. The conduit cross-sections were revised to reflect the survey data. Additionally, for consistency, the connecting conduits that were not directly surveyed were also updated to incorporate these changes.

### 3.2.2.2 Overflow Conduits Cross-Section

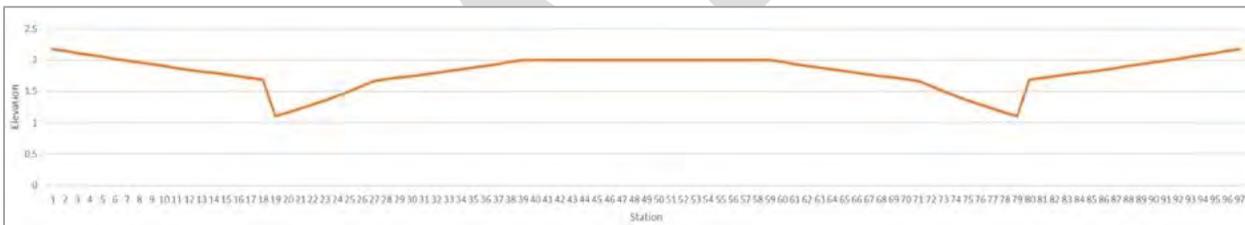
The project model included above-ground conduits to account for roadway runoff, also known as overland flow, to accurately connect flooding between nodes and estimate flood depths. An overflow conduit represented a roadway overflow after storm sewers were surcharged. In the project model, all overflow conduits were trapezoidal cross sections with a maximum depth of 2.0 ft, a bottom width of 50 ft, and side slopes of 1 to 10, horizontal to vertical, as shown in **Figure 3-6**. An analysis was conducted on 11 major streets in the City with medians to determine if the cross section shown in **Figure 3-6** should be updated. These streets are:

- Carrollton Ave
- Banks St
- Orleans Ave
- Canal Blvd
- Florida Blvd
- City Park Ave
- Canal St
- Bienville St
- Tulane Ave
- S Broad St
- Norman C Francis Pkwy



**Figure 3-6. Typical Cross Section of an Overflow Conduit in Project Model**

Various cross sections on each street were defined using transects extracted from the LiDAR data. These cross sections were then compared to determine if a new cross section could be developed to represent streets with medians. An irregular cross section was created, featuring an elevated median, a slight slope for the roads, a steeper slope for the gutters, and a small incline in elevation for sidewalks and the land between roads and buildings. All conduits, with a typical street cross section, along the 11 streets listed above were updated to match the revised cross section shown in **Figure 3-7**. If there were two existing overland flows in the model, one on either side of the median, the irregular cross section shown was split in half and assigned to each respective side.



**Figure 3-7. Revised Cross Section of a Street Overflow Conduit**

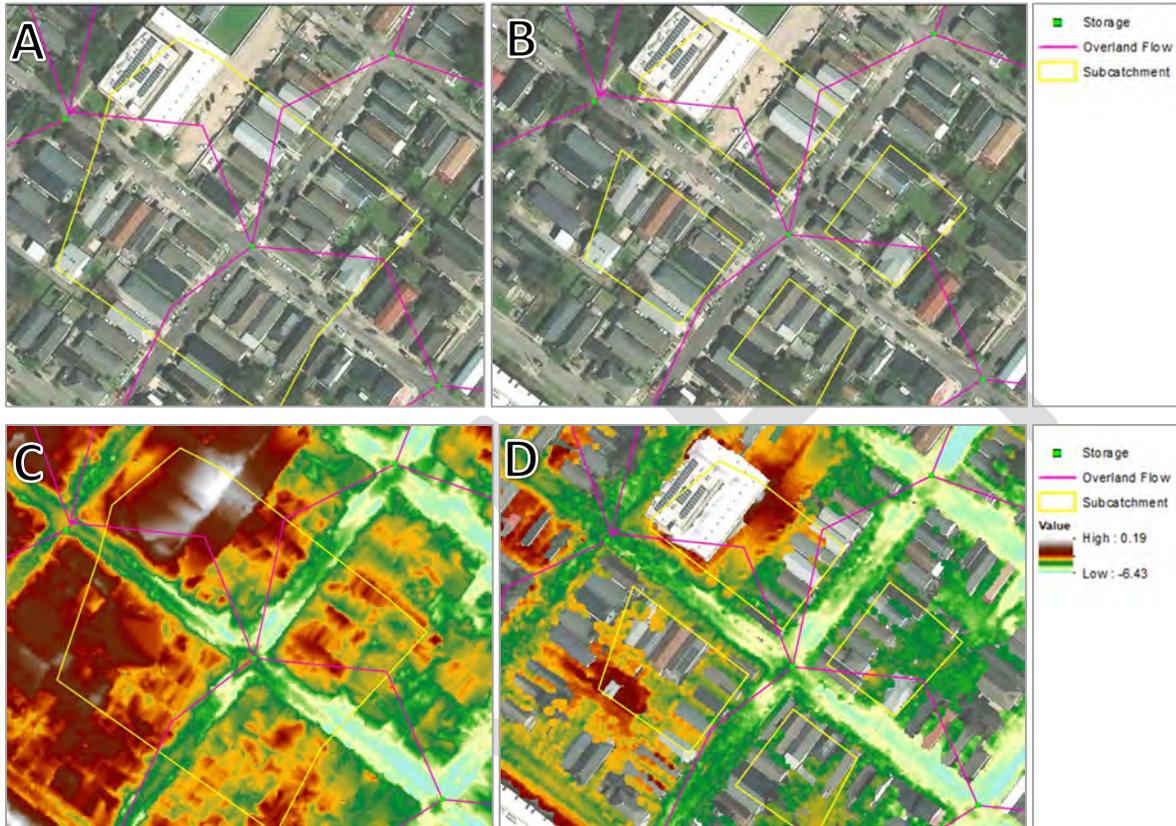
### 3.2.2.3 Updated Stage/Storage Curves

There are various types of nodes in the model, including junctions, storages, and outfalls. The initial step in updating the nodes involved converting all junctions to storage that connect subsurface pipes. The junctions were converted to be a functional storage node with 12.6 square feet (sq ft) of storage space to represent the nominal storage provided in the manhole itself. The storages representing manholes in the model are tagged as “Manhole” while the storages that represent subcatchment storage are tagged as “Stage Storage”.

The stage-storage curves, also known as depth-area curves, were developed using a proprietary CDM Smith Geospatial tool that calculated the volume of a subcatchment at various elevations. The model included 164 storages with depth-area curves, all of which were updated. The updated curves differed significantly from the original curves in the existing model. The original curves encompassed the entire area of the subcatchment, in contrast, the new curves exclude areas inside buildings and within streets if an overland flow conduit already represents that street.

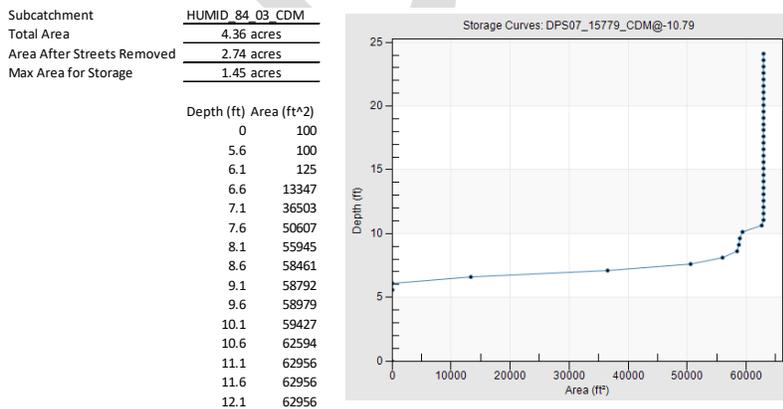
The 2021 LaDOTD LiDAR data was utilized to update the available storage capacity and calculate the area of buildings. **Figure 3-8** highlights different approaches used to develop the stage-storage curves by focusing on one subcatchment, *Subcatchment HUMID\_84\_03\_CDM*. **Figure 3-8A** shows the true

boundary of the subcatchment. **Figure 3-8B** shows the boundary used for calculating stage-storage, where streets were excluded from the subcatchment, ensuring the depth-area curve did not include streets as storage. The streets were accounted for and represented as overland flows. **Figure 3-8C** shows the 2017 USGS DEM that covers the entire subcatchment, while **Figure 3-8D** shows the 2021 LaDOTD LiDAR that was used to calculate stage-storage curves. It was crucial to use the LiDAR that excluded buildings so that the area within the buildings was not considered "accessible" in the storage curve.



**Figure 3-8. Image Showing Different Approaches Used to Develop Stage-Storage Curves**

**Figure 3-9** illustrates the depth-area curve assigned to subcatchment HUMID\_84\_03\_CDM and the difference in the total area of the subcatchment and the total storage in the subcatchment.



**Figure 3-9. Depth-Area Curve Assigned to Subcatchment HUMID\_84\_03\_CDM**

### 3.2.2.4 Conduit and Control Structure Data

Similar to the City models from the 2011 Stormwater Drainage Master Plan (SDMP), all the links in the updated city model are either conduits or pumps. Conduits were either irregular channels, trapezoids, circular pipes, or box culverts. Pipe inlet and outlet inverts were determined through either survey data or interpolation. Approximately 10% of the model elements were surveyed, the rest were interpolated.

The Manning's roughness coefficient values for circular pipes, box culverts, or concrete-lined open channels were uniformly set to 0.013 representing clean, well-maintained concrete surface. Road conduits were represented with irregular and trapezoids cross sections with an estimated Manning's roughness coefficient value set to 0.02. Entrance and exit losses were uniformly set to 0.2 and 0.3, respectively, for circular conduits except for conduits flowing into bodies of water and creeks, the exit losses were set to 1.0, since the velocity head goes to zero. For large box culverts, both entrance and exit losses were set to 0.1. For irregular and trapezoids conduits, no entrance and exit losses were accounted for, since the pressure head goes to zero.

### 3.2.2.5 Refine/Develop Hydraulic Units

In addition to updating imperviousness, overland roughness, depression storage, subcatchment were thoroughly examined. Consequently, some subcatchments were either divided or redefined where necessary. This process entailed a detailed evaluation of the existing subcatchment to identify any irregularities in size, shape, or spatial alignment with adjacent infrastructure. In total, 26 subcatchments were updated. These subcatchments are listed below, with their locations highlighted in **Figure 3-10**.

■ HUCPK_01_06_CDM_1	■ HUMID_104_10	■ HUMID_104_10
■ HUCPK_01_06_CDM_4	■ HUMID_13_04_CDM_1	■ HUMID_45_03_CDM_1
■ HUCPK_12_06_CDM_1	■ HUMID_13_07_CDM_1	■ HUMID_45_03_CDM_5
■ HUCPK_13_07_CDM_3	■ HUMID_26_01_CDM_1	■ HUMID_45_04_CDM_3
■ HUMID_104_4	■ HUMID_26_01_CDM_2	■ HUMID_45_04_CDM_4
■ HUMID_104_5	■ HUMID_45_01_CDM_3	■ HUNAV_26_07_CDM_2
■ HUMID_104_7	■ HUMID_45_01_CDM_6	■ HUNAV_26_07_CDM_3
■ HUMID_104_8	■ HUMID_45_02_CDM_5	■ S2
■ HUMID_104_9	■ HUMID_45_02_CDM_6	■ S3
■ HUCPK_01_06_CDM_1		

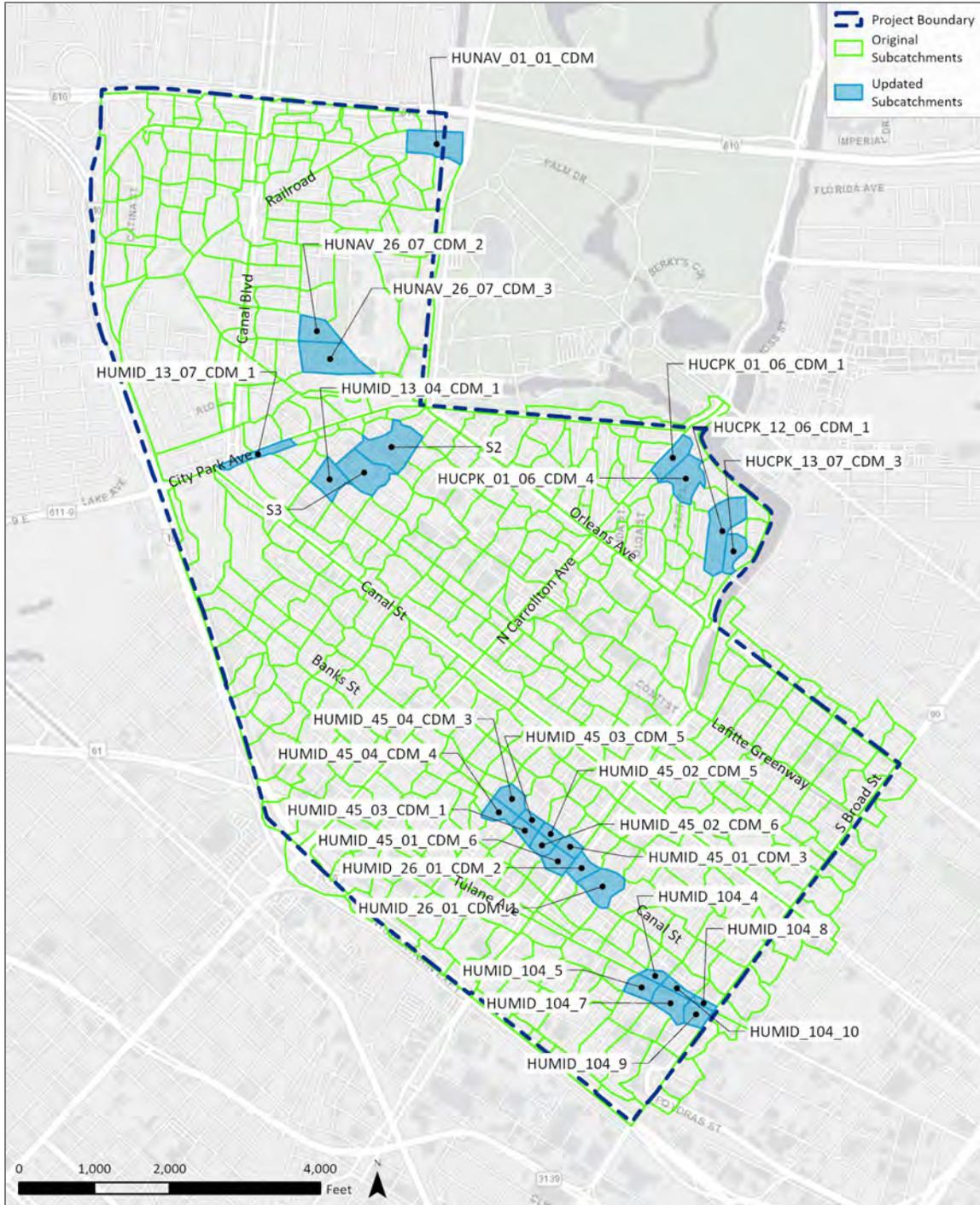


Figure 3-10. Location of the Updated Subcatchments

### 3.2.3 Pump Stations

Central New Orleans is almost surrounded by water: Lake Pontchartrain to the north, Lake Borgne to the east, wetlands to the east and west, and the Mississippi River to the south. Most of this area is at or below sea level, and without natural drainage, flooding poses a major risk. Consequently, rainwater must be pumped out into outfall canals and to Lake Pontchartrain using a stormwater pump system.

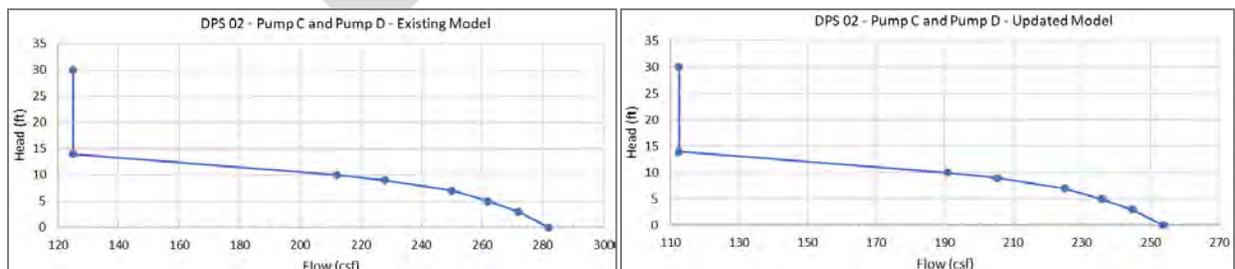
SWBNO operates the drainage pump system which comprises 22 DPSs. As previously noted, this H&H stormwater drainage study focuses on three key neighborhoods: Mid-City, City Park, and Navarre, with most of the area falling within DPS 07 and smaller sections within DPS 02 service areas. DPS 02 and DPS 07 are located within the project area and are part of the project Model.

The pumps in the model were updated to operate at their full nameplate capacities, ensuring 100% utilization. The pump curves were adjusted based on the nameplates while maintaining the same heads as in the existing model. Additionally, both the startup and the shutoff depths remained unchanged. This approach was taken due to the absence of a standard operation procedure for these drainage pump stations, coupled with inconsistencies in available depths in historic pumping data. The pump stations updates were validated using pumping data of two historic rainfall events, September 4, 2023, and April 10, 2024. Maintaining the same startup and shutoff depths matched the expected pump station capacities during modeling these historic rainfall events.

### 3.2.3.1 Drainage Pump Station 02

DPS 02 is located on N Broad St at the intersection with St Louis St. It conveys stormwater runoff using four large multistage pumps (A, B, C, and D) in addition to two constant duty (CD) pumps No. 2 and No. 3. Pump A and Pump B convey stormwater runoff along N Broad St, each having a nameplate capacity of 550 cubic feet per second (CFS). Pump C and Pump D convey stormwater runoff to St Louis St, each having a nameplate capacity of 1,000 CFS. The two CD pumps, No. 2 and No. 3, also convey runoff to St Louis St, with a nameplate capacity of 25 CFS each. DPS 02 was updated in the model to operate at its full nameplate capacities, ensuring 100% utilization. **Figure 3-11** illustrates the existing and updated pump curves applied in the model for Pump A and Pump B, where the pump curves for both pumps were adjusted so that the flows were decreased by 11.5% while maintaining the same heads as in the existing model. **Figure 3-12** shows the existing and updated pump curves for Pump C and Pump D applied in the model, where the pump curves for both pumps were adjusted so that the flows were decreased by 10% while maintaining the same heads as in the existing model.

DPS 02 lacked a defined standard operating procedure. According to feedback from the operators, during a rainfall event, Pump A and Pump B were activated first when the upstream water elevation level reaches 9.5 ft. Subsequently, either Pump C or Pump D was started when the upstream water elevation level reaches 11 ft. Despite all pumps functional, only one Pump C or Pump D operated at a time. During heavy rainfall, when multiple pumps were engaged at various pumps stations, Pump C faced power issues, causing it to become inoperative during significant storm events.



**Figure 3-11. Existing and Updated Pump Curves for DPS 02 Pump A and Pump B**

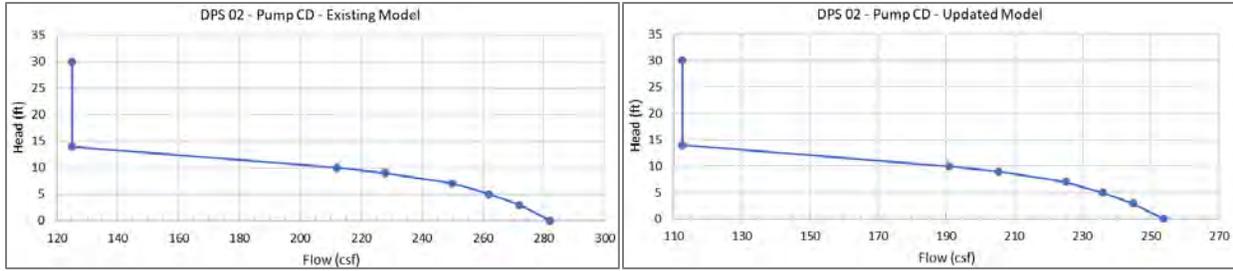


Figure 3-12. Existing and Updated Pump Curves for DPS 02 Pump C and Pump D

### 3.2.3.2 Drainage Pump Station 07

DPS 07 is located along the Orleans Canal, downstream of the railroad and upstream of US Interstate 610. It conveys stormwater runoff using three large multistage pumps (A, C, and D) in addition to two CD pumps, No. 1 and No. 2. All three pumps convey stormwater runoff to the Orleans Canal which runs from the pump station to Lake Pontchartrain. Pump A is a single stage pump that has a nameplate capacity of 550 CFS whereas Pump C and Pump D are multistage pumps, each having a nameplate capacity of 1000 CFS. The two CD pumps have a nameplate capacity of 70 CFS each.

DPS 07 lacked a defined standard operating procedure. According to feedback from the operators, during a rainfall event Pump A was activated first, then Pump C followed by Pump D. DPS 07 was updated in the model to operate at its full nameplate capacities, ensuring 100% utilization. **Figure 3-13** illustrates the existing and updated pump curves applied in the model for Pump A, where the pump curve was adjusted so that the flows were increased by 32% while maintaining the same heads as in the existing model. **Figure 3-14** shows the existing and updated pump curves for Pump C and Pump D applied in the model, where the pump curves for both pumps were adjusted so that the flows were increased by 42.5% while maintaining the same heads as in the existing model.

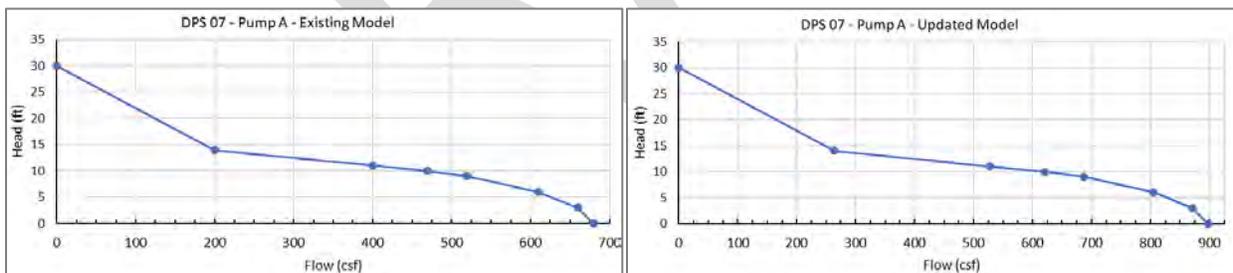


Figure 3-13. Existing and Updated DPS 07 Pump Curves for Pump A

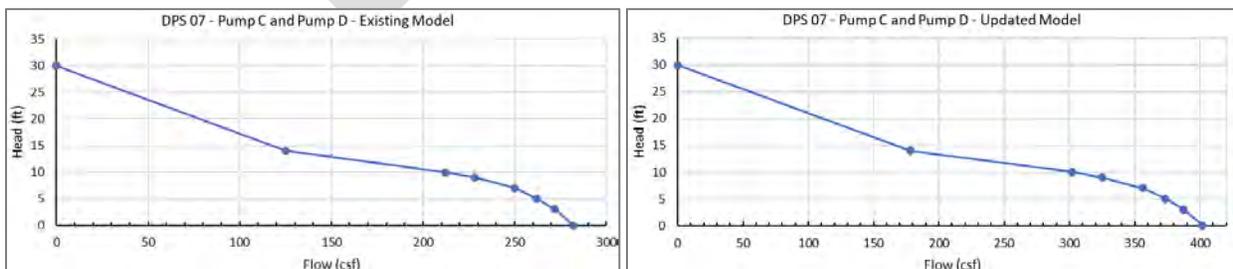


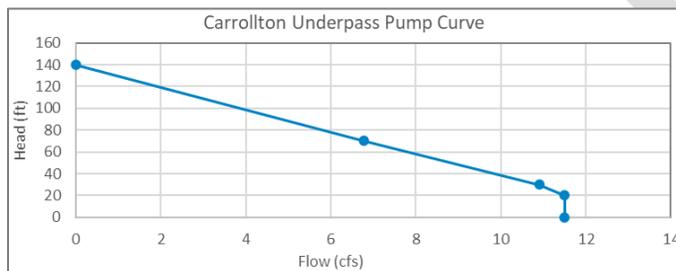
Figure 3-14. Existing and Updated Pump Curves for DPS 07 Pump C and Pump D

### 3.2.3.3 S Carrollton Avenue and Interstate-10 Underpass

The pump station at the intersection of S Carrollton Ave and Interstate-10 (I-10) was not included in the original model for undetermined reasons. Drain link maps and discussions with SWBNO verified that there is an active pump station at this underpass that needed to be added to the model.

To correctly model the underpass and pump at S Carrollton Ave, a storage and pump link needed to be added. First, a storage curve was developed to simulate the underpass detention area. This was done by removing the highway pavement from the underpass subcatchments since the highway would not be used for storage. Then, GIS was used to calculate the surface area at half-foot increments to develop a stage-area relationship.

A type three pump was added to the underpass in the model. Using the pump curve provided by SWBNO (Curve Number JD6F-E43-2), a pump curve with 5 control points was added to the model. The pump curve in the model is double the curve received from the City because it is assumed that there are two pumps at this pump station. **Figure 3-15** shows the new pump curve that was applied to the Carrollton Underpass in the model.



**Figure 3-15. S Carrollton Avenue and Interstate-10 Underpass Pump Curve**

## 3.3 Sensitivity Analysis

A sensitivity analysis was performed on selected hydrologic and hydraulic parameters using the existing conditions model. The analysis was conducted on the 10-year mean annual 24-hour design storm. The results of this analysis were presented in **Table 3-1**. While the 10-year design storm determined service levels, the model showed greater sensitivity to parameter changes during smaller storms. This was due to small runoff changes significantly affecting peak stage when the system was near capacity. Small changes in runoff could greatly affect peak stage when the system neared capacity. Since little volume existed above a pipe until water reached ground level and spread out, stage rose quickly where runoff entered upstream pipes. Consequently, maximum or minimum differences at some locations might be several feet if they were close to surcharge, despite a small average change overall.

**Table 3-1. Model Sensitivity to Selected Hydrologic and Hydraulic Parameters**

Hydrology	Annual 24-Hour Storm Differences (ft)				10-Year, 24-Hour Storm Differences (ft)			
	Ave	STD	Max	Min	Ave	STD	Max	Min
Impervious / 2	-0.64	-0.18	-0.81	0.09	-0.22	0.00	-0.28	-0.14
DCIA Route to 50%	0.24	-0.13	0.05	0.24	-1.28	0.35	-0.48	-0.34
DCIA Route to 15%	0.25	-0.14	-0.02	0.25	0.00	0.00	0.00	0.02
Width x 2	0.42	-0.16	0.05	0.30	0.08	0.00	0.08	0.08

Hydrology	Annual 24-Hour Storm Differences (ft)				10-Year, 24-Hour Storm Differences (ft)			
	Ave	STD	Max	Min	Ave	STD	Max	Min
Width / 2	0.22	-0.14	0.00	0.25	-0.09	0.01	-0.12	-0.11
Slope x 2	0.33	-0.15	0.02	0.28	0.04	0.00	0.04	0.04
Slope / 2	0.11	-0.14	-0.03	0.20	-0.05	0.00	-0.05	-0.05
Overland x 2	0.03	-0.12	-0.06	0.16	-0.09	0.02	-0.09	-0.09
Overland / 2	0.39	-0.16	0.04	0.30	0.06	0.00	0.06	0.07
Soil Storage x 2	0.09	-0.09	0.00	0.17	-0.03	0.01	-0.03	-0.03
Soil Storage / 2	0.36	-0.10	0.12	0.27	0.02	0.00	0.01	0.00
Hydraulics	Annual 24-hour Storm (4.2 inches)				10-year, 24-hour Storm (7.9 inches)			
	Ave	STD	Max	Min	Ave	STD	Max	Min
Zero Entrance Losses	0.16	-0.13	0.00	0.17	-0.04	0.01	-0.01	-0.09
Zero Exit Losses	0.11	-0.12	0.00	0.18	-0.06	0.01	-0.01	-0.06
Zero Entrance/Exit Losses	0.03	-0.10	-0.01	0.2	-0.12	0.04	-0.01	-0.12
(Lack of) Maintenance	1.59	-0.37	0.54	0.21	0.21	0.03	0.06	-0.4
No Initial Depths	0.23	-0.14	0.00	0.25	0.00	0.00	0.00	0.00

Ave: Average of 535 loading nodes – peak stage deltas between scenarios versus base model  
 STD: Standard deviation of same

It is important to note that while increased runoff and/or increased pipe flows raise stages in one area, they may simultaneously lower stages in another, and vice versa. This is particularly evident in hydraulic parameters, where increased flows tend to reduce stages upstream while potentially raising them downstream. This dynamic can skew the averages closer to zero. Therefore, the standard deviation has been included for clarity. A low average with a relatively high standard deviation indicates more sensitivity compared to the same average with a low standard deviation.

### 3.3.1 Hydrologic Parameters

Nearly all the hydrologic parameters input into the model were tested for sensitivity. However, soil infiltration rates and decay rates were not tested, as previous projects had shown that models were more sensitive to soil storage than to the maximum and minimum rates within reasonable value ranges. Additionally, the overland roughness and depression storage parameters were combined, based on previous sensitivity analyses performed by CDM Smith.

Efforts were made to keep the variations uniform and within physical limits, though, the physical range of the parameters varies significantly. For example, doubling the slope of a catchment is not a considerable variation, whereas doubling the roughness of the overland flow is. Although the slope may locally vary beyond this range, it is not expected that the model-wide physical range exceeds this limit, so the range was not expanded. For impervious areas, we are able to half the impervious area but doubling the parameter value would result in values exceeding 100%; so only the former was tested. The model input for pervious areas was directly connected impervious area (DCIA), as some impervious precipitation ran off to pervious areas before reaching the drainage system. Since the portion of the basin that is directly connected was unknown, 33% of the impervious areas were routed to pervious areas in the base condition. This “route to” adjustment was tested at 15% and 50% in this analysis, with little effect on results.

The sensitivity analysis indicates that the model was most sensitive to changes in impervious areas, followed by overland parameters, DCIA routing, soil storage, Subcatchment width, and slope. These findings are typical, although it was generally observed that overland parameters exhibited less sensitivity. The range of these parameters is extreme and likely causes this result.

### 3.3.2 Hydraulic Parameters

The hydraulic parameters tested included entrance and exit losses, initial depths, and a maintenance condition. Typically, entry and exit losses vary throughout a project area and highly dependent on the pipes present at each connection. However, determining losses on a case-by-case basis for over 2,000 pipes would require effort beyond the scope and budget for this project. Therefore, entrance and exit losses were assigned to pipes in the model based on their shape, size, and general connectivity with other pipes.

The sensitivity analysis aimed to determine whether it was necessary to perform an individual analysis on each pipe to assign entry and exit losses. The model was tested for sensitivity to three scenarios: zero entry losses, zero exit losses, and zero entry or exit losses. In all simulations, the averages and standard deviations indicated that the model is not sensitive to entry and exit losses. Consequently, a more detailed assessment is not required to reassign entry and exit losses in the model.

The maintenance condition was tested because the model is based on a well-maintained system with low roughness values (0.013 for concrete) and full capacity. This test evaluates a scenario where pipes are silted to 30% of the diameter and the roughness is increased to 0.025. The model is more sensitive to this condition than for any other for the mean annual storm. This test highlights the importance of routine maintenance, as stages may rise by as much as 1.3 ft during a design storm if the system is not properly maintained. In cases where pipes and/or inlets are completely clogged, the increases could be significantly worse.

The model was also tested for sensitivity to initial depths. Twenty-eight storage nodes and four junctions have an initial depth to provide an even starting surface for the model. These initial depths were taken directly from the existing City model, so an analysis was necessary to determine if the model was sensitive to this parameter and if it needed updating. The sensitivity analysis tested the model with zero initial depths and determined that the model is not sensitive to initial depths for current managed groundwater conditions.

The sensitivity analysis indicates that the model exhibits some sensitivity to maintenance conditions during the annual storm and to DCIA values in the 10-year storm. However, it is not overly sensitive to any single parameter. Much of the model area experiences surcharged pipes and street flooding. Accordingly, minor hydraulic changes have minimal impact on peak stages.

### 3.3.3 Hydraulic Scenarios

A few hydraulic scenarios were tested to identify the model's sensitivity to boundary conditions and general infrastructure improvements. The two infrastructure scenarios tested were doubling the subsurface box network and upsizing all subsurface pipes to have a minimum diameter of 15 inches. The two boundary conditions scenarios tested were no inflows and free outfalls. The results of this analysis are presented in **Table 3-2**.

**Table 3-2. Model Sensitivity to Hydraulic Scenarios**

Hydraulic Scenarios	Annual 24-hour Storm (4.2 inches)				10-year, 24-hour Storm (7.9 inches)			
	Ave	STD	Max	Min	Ave	STD	Max	Min
General Infrastructure: Double Boxes	-0.21	0.07	0.00	-0.06	-0.24	0.15	0.00	-0.51
General Infrastructure: 15" Minimum Subsurface	0.00	-0.01	-0.10	0.00	-0.01	0.00	-0.02	0.00
Boundary Condition: No Inflows	-0.41	0.27	-0.11	0.00	-0.19	0.12	-2.10	0.00
Boundary Condition: Free Outfall	-0.22	0.14	-2.88	0.00	-0.41	0.37	-0.08	0.00

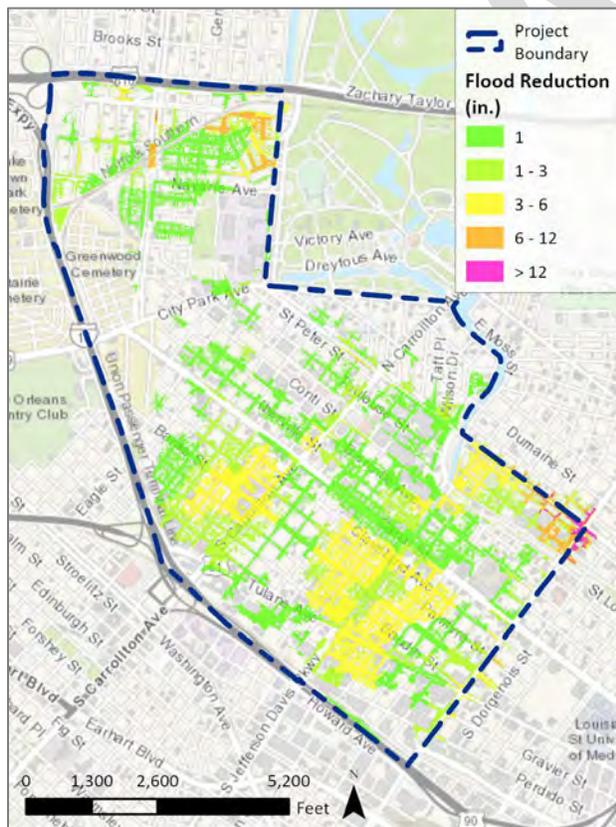
The model was evaluated for its sensitivity to doubling the boxes within the project area to assess the effect of increased system capacity on flooding. In this scenario, 33,235 ft of trunklines, equivalent to 5.4 million cubic feet (MMCF), were added to the model. **Figure 3-16** illustrates which boxes were doubled for this simulation and which are already double-barreled in the existing system. The analysis revealed that increasing the trunkline capacity does not have a significant impact on flooding which resulted in only a minor reduction in average flood depth for both the 1-year and 10-year storms, with a decrease of approximately 0.2 ft. These results suggest that flooding within the project area is not primarily due to insufficient conduit capacity. To further explore system sensitivity, the model was tested by upsizing small conduits to the City’s new minimum diameter of 15 inches, upsizing 86 pipes, totaling 20,808 ft were upsized. Notably, many existing 10-inch pipes within the project area were not included in the model.



**Figure 3-16. Existing and Upgraded Double Barrel Conduits**

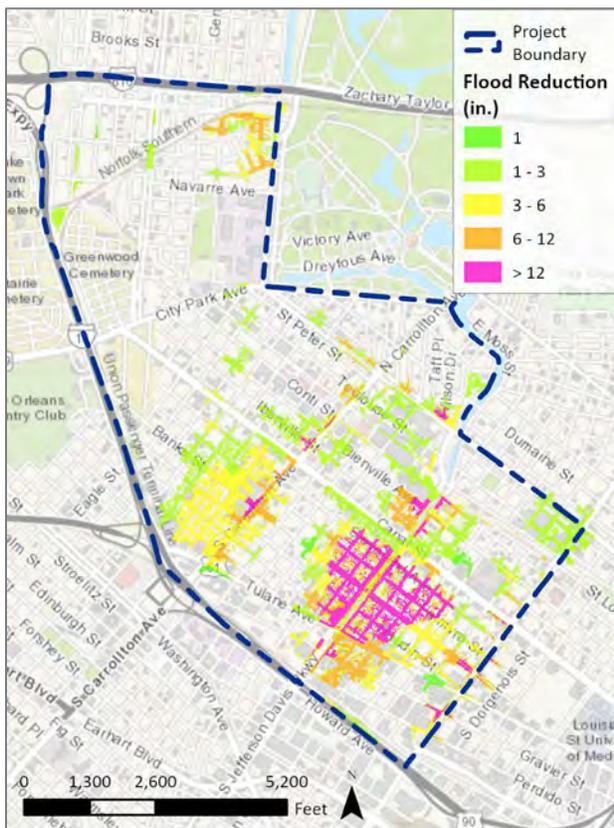
While upsizing conduits can improve conditions at upstream locations, the results indicate that increasing pipe size alone does not significantly reduce overall flooding. This is because downstream infrastructure, such as larger boxes and SWBNO pump stations, has fixed capacity limits. Additional upstream flow may exceed these limits, potentially shifting or intensifying flooding downstream. Therefore, upsizing should be considered as part of a broader, integrated stormwater strategy rather than a standalone solution. Pipes under 15 inches should be addressed within future comprehensive designs to ensure system-wide effectiveness and avoid unintended consequences.

Additionally, the model was assessed for its sensitivity to boundary condition inflows by disabling them in the simulation. A time-series inflow curve representing contributions from neighboring areas was applied at nine storage nodes and junctions, resulting in lateral inflows of 201 MG during the 1-year storm and 493 MG during the 10-year storm. Sensitivity analysis revealed that these boundary inflows had a notable impact on the model results. When the inflows were removed, the average HGL dropped by approximately 0.4 ft for the 1-year storm and 0.2 ft for the 10-year storm. **Figure 3-17** illustrates the reduction in flood depths for the 10-year event when inflows from adjacent areas are removed. These reductions reflect flooding that is independent of direct rainfall. In some locations, such as the Navarre neighborhood and the intersection of Broad St and Orleans Ave, neighboring inflows contributed over one foot of flooding. If surrounding communities can lower their runoff into the project area, a substantial decrease in flood severity can be expected.



**Figure 3-17. Flood Reduction for 10-Year Storm Under No Inflows Scenario**

Finally, The model was evaluated for its sensitivity to allowing all outfalls to drain freely. In the existing model, outfalls have dynamic conditions with discharge rates governed by downstream water levels. This sensitivity analysis aimed to quantify the extent to which downstream constraints contribute to localized flooding. The analysis results indicated that configuring the outfalls as free flowing significantly impact the simulation results. When unrestricted drainage was permitted, the average HGL decreased by approximately 0.2 ft during the 1-year storm and 0.4 ft during the 10-year storm. **Figure 3-18** illustrates the corresponding reduction in flood depths for the 10-year event under these conditions. These reductions represent flooding levels independent of direct rainfall. In some locations, such as Mid-City near Norman C Francis Pkwy, downstream conveyance restrictions contributed to more than one foot of flooding. If storage were incorporated into neighboring communities to lower downstream stage elevations at major outfalls, the project area would experience a notable reduction in flood severity.



**Figure 3-18. Flood Reduction for 10-Year Storm Under Free Outfalls Scenario**

## 3.4 Model Simulations – Existing System

### 3.4.1 Rainfall Events Simulation

The existing conditions model, provided in **Appendix G**, was used to simulate flooding extents. **Table 3-3** presents depth-duration-frequency statistics for three return periods based on NOAA Atlas 14. The depth for each storm event was distributed over 24 hours using a Type III NRCS (SCS) distribution.

**Table 3-3. Design Storm Depths**

Return Interval (Years)	Precipitation for 24-hr Duration (inch)	Peak Intensity (inch/hour)
1-Year	4.65	1.88
10-Year	8.30	3.35
25-Year	10.40	4.24

Flood extent files were developed using GIS tools in conjunction with PCSWMM model inputs and outputs for each city domain across the three design storm scenarios. The flood extents were developed using subcatchments and loading nodes defined in the model. The modeled maximum HGL values, representing peak water surface elevations (WSE) for each subcatchment, were compared against the DEM to delineate areas of inundation. The resulting flood extent was produced as GIS raster, which consisted of uniform-sized grid cells containing elevation or depth values. **Figure 3-19** through **Figure 3-21** display the predicted flood extents for each design storm, with inundation depths discretized in 0.5-foot intervals from 0 to 2 ft, and an additional category for depths exceeding 2 ft. For estimating flooded street lengths in the Mid-City, City Park, and Navarre Study area, streets were considered inundated if at least 50 linear ft were covered by a minimum depth of 6 inches.

#### 3.4.1.1 1-Year Rainfall Event

For this storm, 246 out of 964 model storage nodes are simulated to be flooded six inches or greater than the estimated ground surface elevation. **Figure 3-19** shows an estimated flood map of the existing conditions model built using the predicted peak flood stages and the LiDAR topography. This map, in conjunction with the aerial photography has been used to estimate that 12.88 miles of streets are flooded in the Mid-City, City Park, and Navarre study area during the 1-year rainfall event. The volume of flooding in this case is 10.54 MMCF or 242.4 acre-feet (ac-ft). The deepest flooding is 2.1 ft at Greenwood Cemetery. The deepest flooding that impacts streets and residents is 1.7 ft at the intersection of Canal St and S Genois St.

#### 3.4.1.2 10-Year Rainfall Event

For this storm, 576 out of 964 model storage nodes are simulated to be flooded six inches or greater than the estimated ground surface elevation. **Figure 3-20** shows an estimated flood map of the existing conditions model built using the predicted peak flood stages and LiDAR topography. This map, in conjunction with the aerial photography, has been used to estimate that 14.5 miles of streets are flooded in the Mid-City, City Park, and Navarre study area during the 10-year rainfall event. The volume of flooding in this case is 31.41 MMCF or 718.1 ac-ft. The deepest flooding is 3.4 ft at the intersection of Banks St and S Solomon St near Jesuit High School of New Orleans.

#### 3.4.1.3 25-Year Rainfall Event

For this storm, 755 out of 964 model storage nodes are simulated to be flooded six inches or greater than the estimated ground surface elevation. **Figure 3-21** shows an estimated flood map of the existing conditions model built using the predicted peak flood stages and the LiDAR topography. This map, in conjunction with the aerial photography, has been used to estimate that 24.9 miles of streets are flooded in the Mid-City, City Park, and Navarre study area during the 25-year rainfall event. The volume

of flooding in this case is 46.34 MMCF or 1,064.9 ac-ft. The deepest flooding is 3.77 ft at the intersection of Palmyra St and S Lopez St near Morris Jeff Community School - Lopez campus.

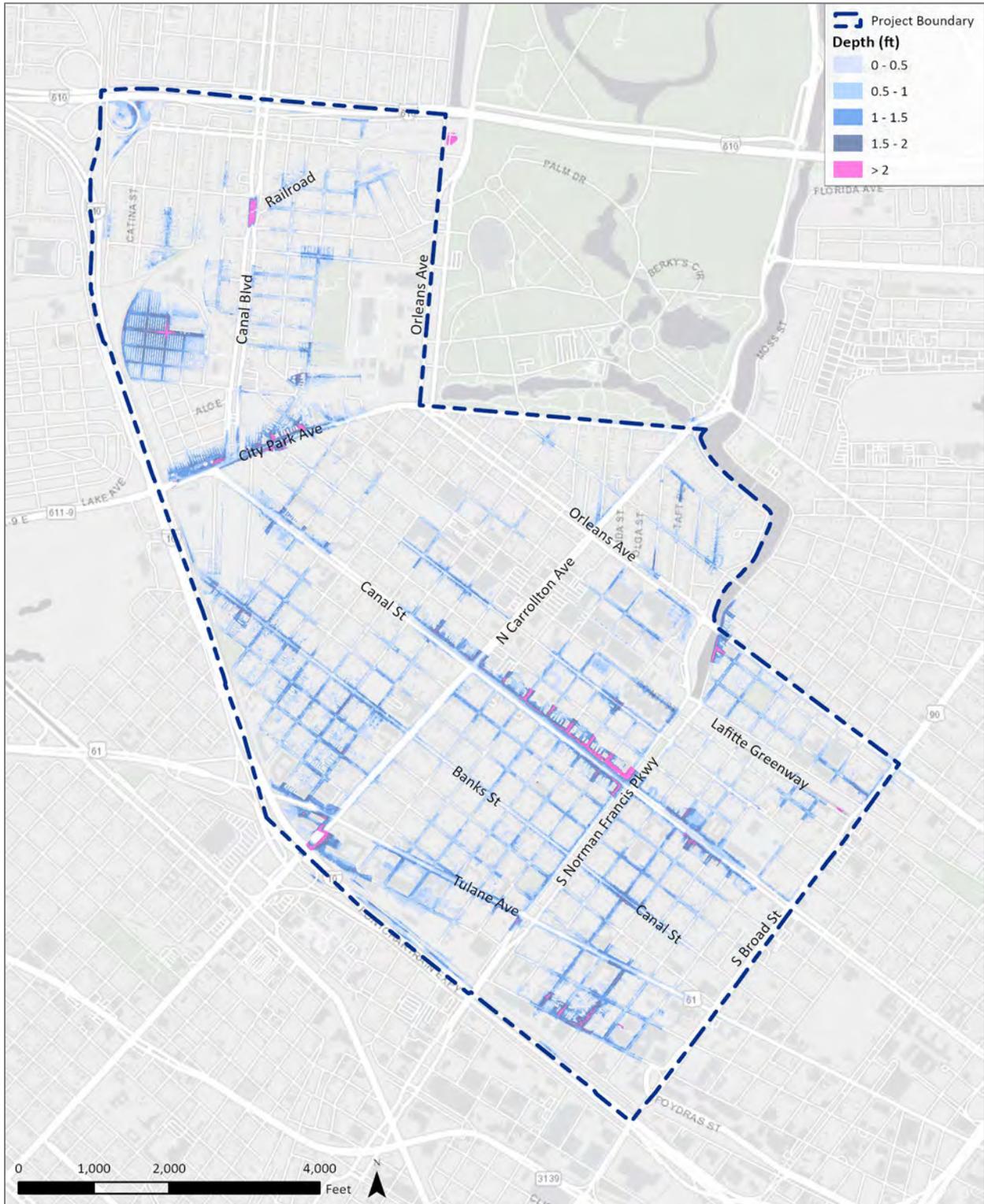


Figure 3-19. Flooding Extent at NRCS Type III 1-Year 24-Hour Design Storm

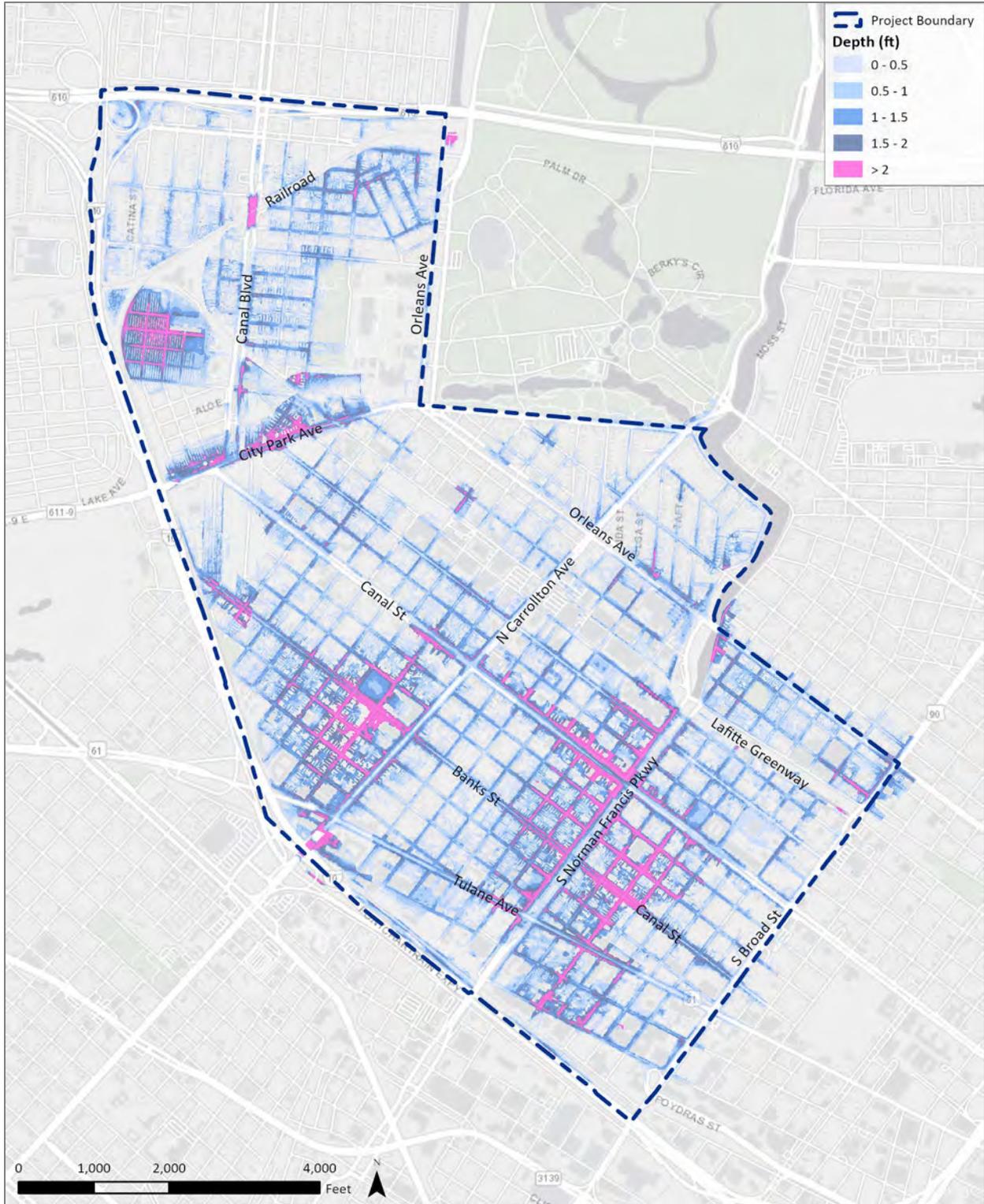


Figure 3-20 Flooding Extent at NRCS Type III 10-Year 24-Hour Design Storm

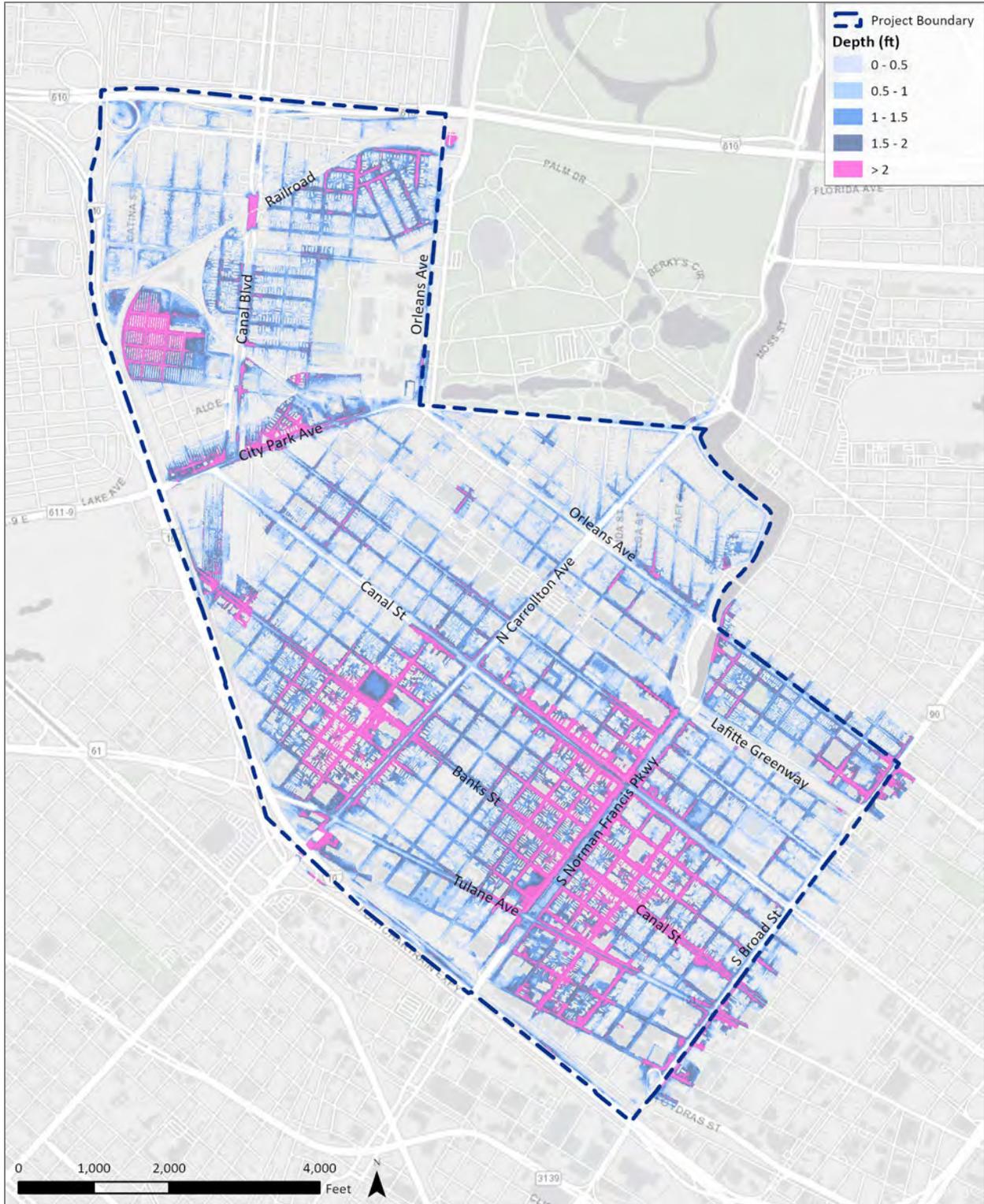


Figure 3-21. Flooding Extent at NRCS Type III 25-Year 24-Hour Design Storm

## 3.4.2 Flooding Assessment and Level of Service

### 3.4.2.1 Flooding Summary

The flood inundation raster of the existing conditions model was utilized to identify critical areas of flooding. The LOS criterion is based on the NRCS type III 10-year 24-hour storm event. The results of this analysis were divided into four areas for convenience of discussion, within the Mid-City, City Park, and Navarre neighborhood. These areas are:

- 1) South Mid-City – Broad St Area
- 2) North Mid-City – Norman C Francis Pkwy Area
- 3) City Park – Carrollton Ave Area
- 4) Navarre Neighborhood

**Table 3-4** shows a summary of the ten nodes and intersections with the deepest flooding as estimated by the model.

**Table 3-4. Summary of Locations of Deepest Flooding**

Rank	Model Node ID	Location	Fooding Depth (ft)
1	DPS07_17293_CDM	Intersection of Banks St and S Solomon St	3.4
2	DPS07_9995_CDM	Intersection of Palmyra St and S Lopez St	3.1
3	DPS07_9979_CDM	Intersection of Palmyra St and S Rendon St	3.0
4	DPS07_10011_CDM	Intersection of Banks St and S Lopez St	3.0
5	DPS07_14713_CDM	On D’Hemecourt St near intersection of D’Hemecourt St and S Jefferson Davis Pkwy	2.9
6	STOR_02_CDM	In the Greenwood Cemetery	2.8
7	DPS07_10036_CDM	Intersection of Baudin St and S Lopez St	2.8
8	DPS07_15781_CDM	Intersection of D’Hemecourt St and S Solomon St	2.8
9	DPS07_16588_CDM	Intersection of Canal St and S Genois St	2.7
10	DPS07_17276_CDM	Intersection of D’Hemecourt St and S Carrollton Ave	2.7

**Table 3-5** provides a summary of the longest 5 flooded street segments as determined by predicted peak flood stages and LiDAR topography. **Appendix E** provides a list of the flooded streets during the 10-year storm at existing conditions.

**Table 3-5. Summary of Longest Segments Street Flooding**

Rank	Street	Length of Flooding (ft)	Average Flooding Depth (ft)	Peak Flooding Depth (ft)
1	Bienville Ave	9,461	1.1	2.5
2	Orleans Ave	8,340	0.9	2.2
3	Canal St	6,725	1.0	2.5
4	Tulane Ave	5,813	0.9	2.1
5	Toulouse St	5,487	1.1	3.0

### 3.4.2.2 Flood Profiles

CDM Smith plotted hydraulic grade profiles for 8 conduits for existing conditions. These are all provided in **Appendix F**.

### 3.4.3 Critical Flooding Areas

The results of the analysis showed four critical areas throughout the study area, within the Mid-City, City Park, and Navarre neighborhood.

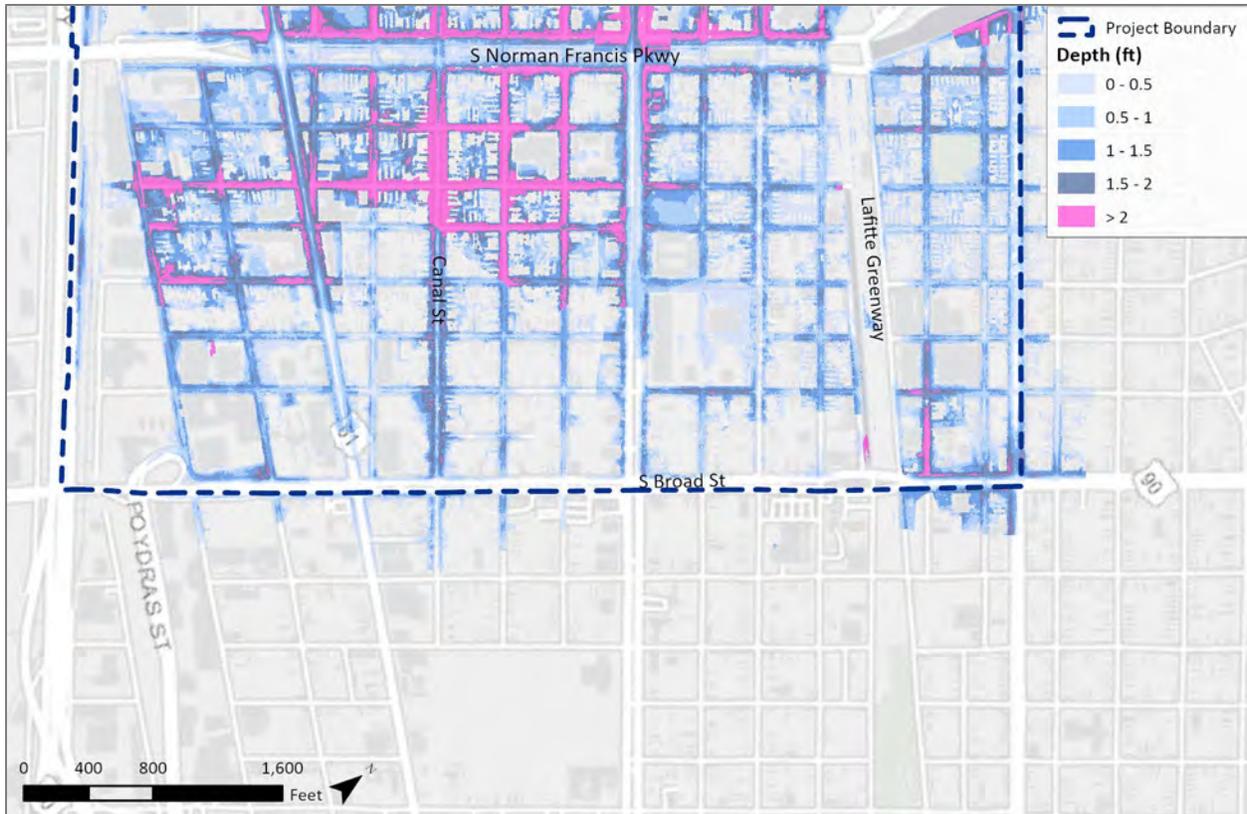
#### 3.4.3.1 South Mid-City – Broad St Critical Flooding Areas

The south Mid-City area, Broad St and its surroundings encompassed 0.44 square miles (sq mi) of the project area and included four areas identified as flood critical: Warren Easton High School area, Perdido St, S Lopez St area, and Banks St area. Neighborhoods adjacent to S Lopez St, Banks St, and Palmyra St exhibited substantial flooding impacts. Model predictions showed flood depths exceeding 2 ft in these areas, with depths reaching up to 3.7 ft near Banks St and S Lopez St. Additional streets, including S Gayoso St, S Salcedo St, Canal St, and Broad St, were also expected to experience notable flooding, though these impacts were less widespread than in the previously mentioned corridors. Flood depths on Canal St ranged from under 0.5 ft to 2.7 ft, while Broad St showed variable conditions from no flooding to depths of 2.7 ft. Some of the flooding observed along Broad St might be influenced by the existing boundary conditions and model configuration, and these results could be refined with future updates to input data and modeling parameters.

Canal St exhibits a downward slope from Broad St to Norman C. Francis Pkwy, contributing to increasing flood depths along its length. As shown in **Figure 3-22**, flood depths increased from under 0.5 ft to approximately 2 ft as Canal St approached Norman C. Francis Pkwy. Notably, Warren Easton High School and the adjacent Regional Transit Authority (RTA) center experienced flood depths of around 1.6 ft, which might pose risks to residents and potentially hinder safe evacuation of students and staff during severe storm events.

In addition, the Orleans Parish Prison, located on Perdido St, experienced critical flooding. The model predicted flood depths reaching 2 ft directly in front of the facility, with peak inundation on Perdido St rising to 2.5 ft. This highly developed area, including both the prison and an adjacent residential apartment complex, experienced increased runoff and accelerated water accumulation due to impervious surfaces. Perdido St was topographically low, with nearby streets sloping downward toward it, intensifying the flooding. Such conditions present a potential hazard during major storm events, as inmates and staff might become trapped if evacuation measures were required.

Moreover, S Lopez St was a major flood-prone corridor, with model projections showing flood depths ranging between 2.1 and 3.7 ft along its entire length. Like Perdido St, S Lopez St lies at a topographic low point, consistently the lowest elevation at each intersection, while connecting streets increased in elevation as they extended away, intensifying runoff accumulation. The street's average elevation was -6.0 ft NAVD88, notably lower than adjacent roads such as Baudin St, which averaged -5.0 ft NAVD88 on both ends where it intersected S Lopez.



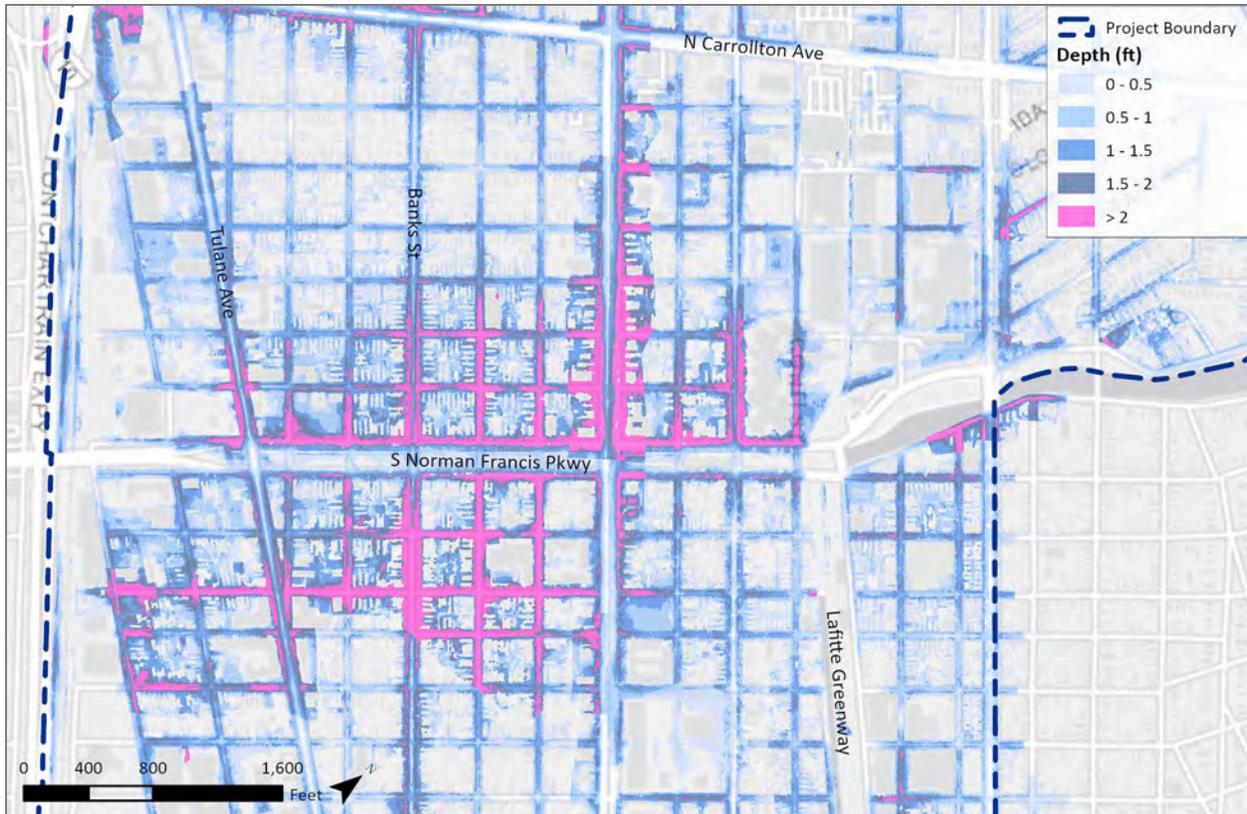
**Figure 3-22. South Mid-City – Broad Street Critical Flooding Area**

Finally, Banks St experiences significant flooding, particularly between S Rendon St and S Lopez St. The intersection with S Lopez St saw the deepest flooding, reaching 3.8 ft. Topographically, Banks St forms a bowl-shaped depression, bordered by higher elevations at Norman C. Francis Pkwy and S Salcedo St.

### 3.4.3.2 North Mid-City – Norman C Francis Parkway Critical Flooding Area

The S Norman C Francis Pkwy and surrounding neighborhood covered 0.64 sq mi of the project area and included three areas identified as flood critical: along S Norman C Francis Pkwy, Canal St area, and Banks St area. Surrounding these major streets, the model predicted significant flooding impacts, with depths exceeding 2 ft on several streets including Palmyra St, Cleveland Ave, S and N Genois St, S and North Clark St, Iberville St, and S and North Telemachus St. Near Canal St, depths ranged from under 1 foot to as much as 2.9 ft. In general, the model estimated an average flood depth of 1.7 ft within this neighborhood, peaking at 3.5 ft in a 10-year storm event.

**Figure 3-23** shows substantial flooding along Canal St, particularly from N Carrollton Ave to S Norman C. Francis Pkwy, posing a critical concern for broader Mid-City neighborhood. Water accumulation on Canal St was aggravated by runoff from adjacent local streets, including N Genois St, N Clark St, and N Cortez St. The model predicted average flood depths of 1.3 ft along Canal St, with localized peaks reaching 2.9 ft during the 10-year storm.



**Figure 3-23. North Mid-City – Norman C Francis Parkway Critical Flooding Area**

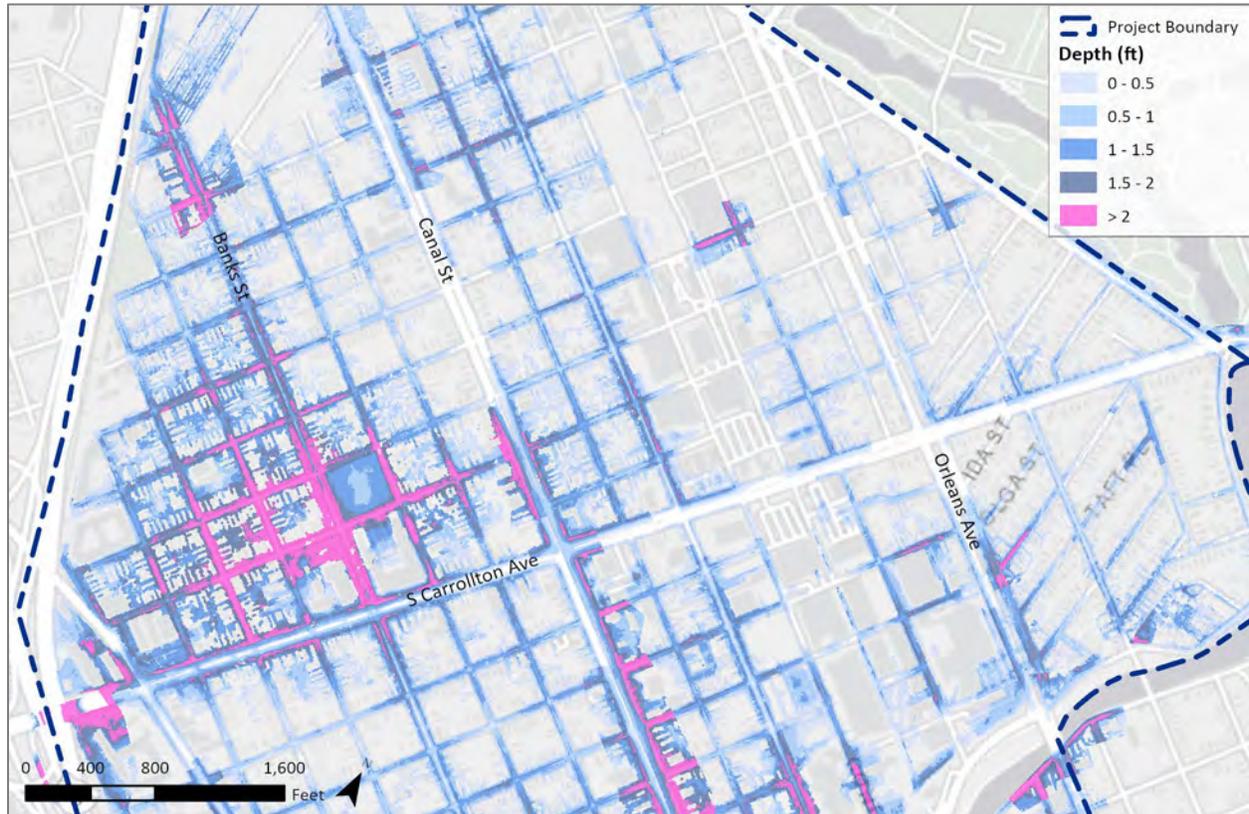
Another area of concern identified in the model was located along S Norman C. Francis Pkwy. Ground elevation at the intersection of Canal St and N Carrollton Ave began at approximately -2.1 ft NAVD88 and gradually sloped downward to -3.3 ft NAVD88 along S Norman C. Francis Pkwy. The subsurface drainage infrastructure serving major streets, such as Canal St, Banks St, Bienville St, and Tulane Ave in the Mid-City neighborhood, consisted of pipes ranging in diameter from 10 inches to 3 ft. These pipes ultimately connected to a series of box culverts, transitioning from a 72-inch circular pipe to a 54-inch by 88-inch box, then to a 10 ft box, and finally into a larger culvert beneath S Norman C. Francis Pkwy that extended from Perdido St to Conti St. Model results indicated an average flood depth of 1.7 ft in this area during a 10-year storm event, with water depths reaching up to 3.7 ft along S Norman C. Francis Pkwy.

### 3.4.3.3 City Park – Carrollton Ave Critical Flooding Areas

The Carrollton Ave area covered 0.73 sq mi of the project area and included three areas identified as flood critical: Banks St near S Bernadotte St, the I-10 underpass on S Carrollton Ave, and the S Solomon St area.

As shown in **Figure 3-24**, Banks St experienced severe flooding between the railroad and Bernadotte St. The elevation at the railroad end was approximately 0.0 ft NAVD88, and over the short 800-foot stretch to Bernadotte St, the ground dropped nearly 2.5 ft. This sharp slope directed all runoff from both the residential area and Cypress Grove Cemetery toward Bernadotte St. Contributing to the flooding was the limited drainage capacity of the subsurface infrastructure where the storm pipes in this segment of

Banks St were only 12 inches in diameter. The combination of steep topography, concentrated runoff, and undersized pipes results in critical flooding conditions. The model estimated an average flood depth of 1.0 foot in the Banks/Bernadotte area, with depths reaching up to 2.9 ft at their intersection during a 10-year storm event.



**Figure 3-24. Carrollton Ave Critical Flooding Areas**

The underpass at I-10 and S Carrollton Ave presented a significant flooding hazard within the City Park/Carrollton Ave area. Over a 400-foot stretch, S Carrollton Ave experienced a 10-foot elevation change, forming a topographic bowl that collected stormwater runoff. Model simulations indicated that flood depths in this underpass could reach up to 3.15 ft during a 10-year storm event. Given its role as a major exit from I-10 and high traffic volume, this location posed a substantial safety risk. It was a frequent site of vehicular entrapment during flood events due to poor visibility of water depth. Although a flood gauge was installed in 2018 following Hurricane Harvey, driver awareness remained a concern, with many continuing to underestimate flood severity and becoming stranded during major storms.

Several streets surrounding Jesuit High School of New Orleans and Esperanza Charter School including Banks St, Baudin St, S Hennessey St, S Solomon St, Palmyra St, D'Hemecourt St, and Ulloa St were identified as critically flood prone. The model predicted an average flood depth of 2.5 ft across this area, with peak depths reaching 3.8 ft along Banks St between S Hennessey and S Solomon during a 10-year storm event. These narrower residential streets served as collection points for runoff attempting to discharge into the broader drainage system along Carrollton Ave. As a result, flooding in this area posed

risks to nearby homes and creates hazardous conditions that could trap students and staff during major storm events.

#### 3.4.3.4 Navarre Neighborhood Critical Flooding Areas

The Navarre neighborhood covered 0.68 sq mi of the project area and included four critical flooding areas: north of Delgado Community College area, the underpass at Canal Blvd and the railroad, Greenwood Cemetery, and City Park Ave area.

The elevated terrain of Delgado Community College's campus and the adjacent railroad corridor formed a berm-like barrier relative to the surrounding Navarre neighborhood. This topographic feature increased flood risk by redirecting runoff toward lower-lying residential streets. Model results forecasted an average flood depth of 1.2 ft across the area, with peak depths reaching 2.4 ft along General Haig St during a 10-year storm event. These inundation levels resulted in complete submersion of neighborhood streets, rendering them impassable and potentially isolating residents without access to emergency routes.

The underpass at Canal Blvd and the railroad was a critical flooding concern within the Navarre neighborhood. Over a 600-foot segment, Canal Boulevard dipped and rose by approximately 10 ft, forming a bowl-shaped depression that trapped stormwater during heavy rainfall. The model predicted flood depths reaching up to 7 ft at this location during a 10-year storm event. This posed a severe safety risk, especially given the underpass's role as a vital access linking Mid-City and Lakeview. The site was notorious for vehicles becoming stranded during flood events, as water depth was often difficult to assess. Although a flood gauge was installed in 2018 following Hurricane Harvey, driver awareness remained a concern, and the underpass continued to be a frequent location for flood-related vehicular incidents.

As shown in **Figure 3-25**, Greenwood Cemetery faced significant flooding during storm events, with model projections indicating water depths of up to 2.8 ft during a 10-year storm. The cemetery's average ground elevation was approximately -3.0 ft NAVD88, in contrast to the surrounding topography which included Canal Blvd at roughly 0.0 ft NAVD88 and the nearby railroad at around 3.0 ft NAVD88. This elevation disparity created a berm-like effect that trapped water within the cemetery grounds. Compounding the issue, Greenwood Cemetery lacked subsurface drainage connections to New Orleans' broader stormwater network. As a result, water that accumulated in the cemetery during storms could only exit via overland flow or infiltration, leaving the site highly susceptible to prolonged inundation and restricted drainage.

City Park Ave served as the primary drainage corridor for runoff originating from Greenwood Cemetery St, Patrick Cemetery, and Holt Cemetery. These cemeteries were largely paved, contributing to substantial stormwater volumes. It already had subsurface drainage infrastructure on both sides over a stretch of approximately 2,700 ft. On the south side, pipe diameters ranged from 1.0 to 1.5 ft, discharging into the box culverts beneath Orleans Ave. On the north side, pipe diameters ranged from 1.5 to 2.25 ft. However, these drainage lines were undersized and already operated at full capacity during a 1-year storm event, offering limited additional conveyance during more severe storms. The

model forecasted an average flood depth of 1.5 ft along City Park Ave, with maximum depths reaching up to 3.9 ft during a 10-year storm making it vulnerable to recurring, high-volume flooding.



Figure 3-25. Navarre Neighborhood Critical Flooding Area



## 4.0 Improvements and Alternatives Evaluation

A comprehensive evaluation of potential improvements and alternatives aimed at mitigating flooding and enhancing stormwater management within the Mid-City, City Park, and Navarre neighborhoods. Building on the findings from the system evaluation and model refinement, this section outlines the methodology for developing a range of GSI and conveyance alternatives. The objective is to identify feasible solutions that address critical flooding areas, maximize flood reduction benefits, and support long-term resilience. The section provides an overview of the modeling approach for GSI, followed by detailed descriptions and analyses of each alternative considered. Storage volumes, hydraulic connectivity, and implementation constraints are discussed for each alternative, providing a clear basis for comparison and prioritization. This evaluation serves as the foundation for the recommendations and conceptual designs presented in the subsequent section.

### 4.1 Modeling Approach for Green Infrastructure Alternatives

Although SWMM contains Low-Impact Development (LID) modules that allow for the modeling of several types of GSI, these modules were not used for this project. The LID modules in SWMM apply to the hydrologic layer in the model, which makes it difficult to model the dynamics of how GSI for this project would interact with the hydraulic system. The benefit of GSI for this analysis is how the additional storage can decrease peak depths and durations of predicted flooding. This requires modeling the GSI in the hydraulic layer of the model with approximations of how the stormwater flows into and out of the storage available. To do this, the following hydraulic components were used:

- Storage nodes represented the total volume of storage available for each type of GSI at a resolution similar to that of the model (typically per city block), accounting for both open storage (100% void space) and media-filled storage (less than 100% void space).
- Conduits represented inlet or outlet pipes linking GSI to the pipe system and the modeled street sections where stormwater flowed from the surface into GSI.
- Weirs represented curb inlets directing surface flow to storage components.
- Orifices modeled standpipes in storage zones, gradually draining surface water into the pipe system.

Some terminology, general assumptions, or approximations regarding the modeling of the GSI are listed below:

- Due to the limited infiltration rates of soil and the height of the wet season water table, no infiltration is included for the storage nodes representing GSI. This was a conservative approach that was used although preliminary tests had shown that some infiltration did occur. Infiltration might be included in the future.
- Volume of storage is not a direct input in the model. Instead, an area-depth curve is used. The void space for all subsurface storage is considered as 92%. For GSI that has rectangular storage (i.e. constant area over the depth of storage), the total storage area is multiplied by the void space percentage to get an effective area that only represents the void space. If the storage is

rectangular and includes both surface and subsurface storage, an equivalent void space is calculated based on the depth of each type of storage and then applied to the area to get the effective area for storage.

- Per each storage node, a single weir element was used to represent the sum of the length of all curb inlets to a storage component.
- Inlet and outlet pipes were assumed HDPE pipes with a Manning roughness coefficient of 0.01.

An approach to modeling each specific type of GSI was developed. This includes how each storage, inlet, and outlet element was represented in the model. Some parameter values are the same for each GSI type, but others are specific to the location. Each GSI type is listed in **Table 4-1** with a description of the modeling approach and schematics. The table also provides a summary of specific parameters.

**Table 4-1. Parameter Values Used in Modeling of Green Infrastructure**

Type	Storage(s)	Storage Depth (ft)	Equivalent Void Space	Inlets	Outlets
Modular Storage	Surface	4.5 ft	92%	<ul style="list-style-type: none"> <li>▪ Pipe: varying diameter</li> <li>▪ Curb: 3-foot openings spaced every 20 ft around the perimeter</li> </ul>	<ul style="list-style-type: none"> <li>▪ Drain: 6-inch diameter</li> <li>▪ Orifice: 2 ft by 1 ft</li> </ul>
Stormwater Park	Surface and Subsurface	2.0 ft with 3:1 side slope	92%	<ul style="list-style-type: none"> <li>▪ Pipe: varying diameter</li> <li>▪ Curb: 3-foot openings spaced every 20 ft around the perimeter</li> </ul>	<ul style="list-style-type: none"> <li>▪ Drain: 6-inch diameter</li> <li>▪ Orifice: 2 ft by 1 ft</li> </ul>
		4.5 ft			
Permeable Gutters	Surface	3.5 ft	92%	<ul style="list-style-type: none"> <li>▪ Orifice: 10 ft by 10 ft</li> </ul>	<ul style="list-style-type: none"> <li>▪ Drain: 6-inch diameter</li> </ul>
Bioswale	Surface and Subsurface	3.0 ft	N/A	N/A	N/A
		Varies			

### 4.1.1 Pipe Improvements

Targeted pipe improvements have been proposed to direct stormwater toward designated GSI sites. These locations were selected to enhance connectivity across the primary stormwater conveyance zones, facilitating more efficient runoff distribution. The upgraded system features cross-connecting pipes that integrate with existing large-scale drainage infrastructure, forming a cohesive network. This interconnected system enables stormwater to balance and redistribute within the network, improving overall hydraulic performance and reducing localized flooding.

### 4.1.2 Modular Storage Tank

A modular storage tank is a highly adaptable system designed to manage stormwater runoff in space-constrained urban environments. These tanks consist of interlocking, lightweight units, typically made from recycled polypropylene or other durable plastics, that can be customized to fit specific site layouts and volumes. Engineered with a high void ratio, they provide maximum water storage capacity while supporting structural loads, making them suitable for installation beneath roads or parking lots. Common applications include stormwater detention to prevent flooding, infiltration to recharge groundwater (where soil and water table allow), and rainwater harvesting for non-potable reuse.

Integrated into larger GSI systems like bioswales, modular tanks help reduce the burden on municipal drainage networks, limit erosion, and promote sustainable water use. **Figure 4-1** shows a schematic configuration of modular storage tank.



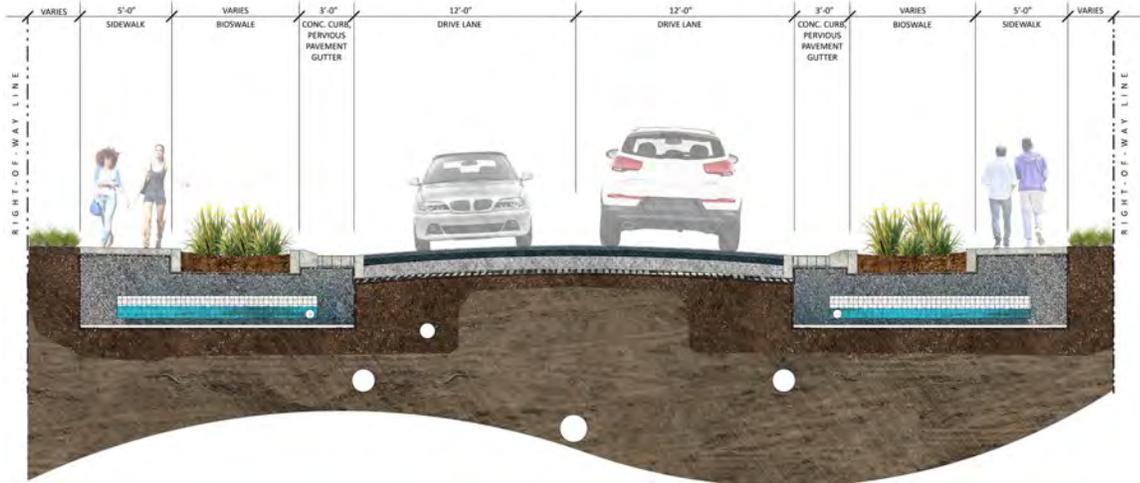
**Figure 4-1. Schematic Configuration of Modular Storage Tank**

#### 4.1.3 Stormwater Park

Stormwater parks function similarly to detention ponds, providing both surface and subsurface storage to manage runoff. Surface storage typically consists of a basin 2 ft deep with 3:1 side slope, while subsurface storage is composed of modular storage tanks approximately 4.5 ft deep. Each location is modeled as a single storage node, with a depth-area curve that accounts for surface slope geometry and subsurface void space. Inlet configurations include curb inlets with 3 ft openings spaced every 20 ft, along with a dedicated pipe inlet. Outflow is managed via a standpipe modeled as an orifice, featuring a rectangular opening 2 ft high by 1 foot wide, as well as a 6-inch diameter drainage pipe.

#### 4.1.4 Permeable Gutters

A permeable gutter is a sustainable stormwater management feature designed to allow rainwater to infiltrate through the sidewalk and curb surface rather than flowing directly into storm drains. Unlike traditional concrete or asphalt gutters, permeable gutters are constructed using porous materials, such as permeable pavers or specially designed concrete blocks, that enable water to pass through into an underlying storage or infiltration layer helping reduce runoff volume. Permeable gutters are especially effective in urban areas with limited green space, where they can be integrated along roadways, alleys, or parking lots to slow, capture, and treat stormwater at its source. By mimicking natural hydrology, they contribute to flood mitigation, improved water quality, and enhanced resilience of urban infrastructure. **Figure 4-2** shows a schematic configuration of permeable gutters.



**Figure 4-2. Schematic Configuration of Permeable Gutter**

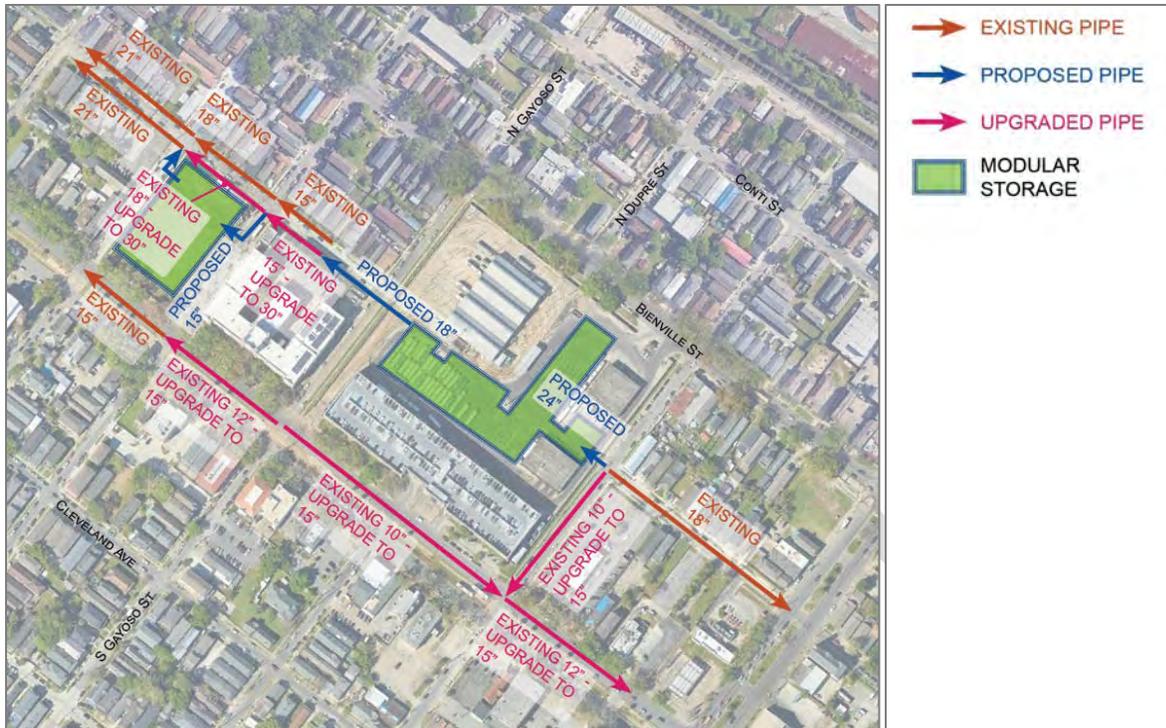
### 4.1.5 Bioswales

A bioswale is a vegetated shallow channel with surface and subsurface storage. It slows, filters, and absorbs rainwater as it flows across impervious surfaces like roads and parking lots. Unlike traditional storm drains that rapidly convey water away, bioswales mimic natural hydrology by allowing water to infiltrate into the ground, reducing runoff volume and improving water quality. Bioswales recharge groundwater, reduce erosion, and enhance urban aesthetics making them a multifunctional solution for sustainable stormwater management in both residential and commercial landscapes. Different designs cover different areas and depths of storage. The total storage for each block is represented by one storage node with a constant effective area.

## 4.2 South Mid-City – Broad Street Area Improvements

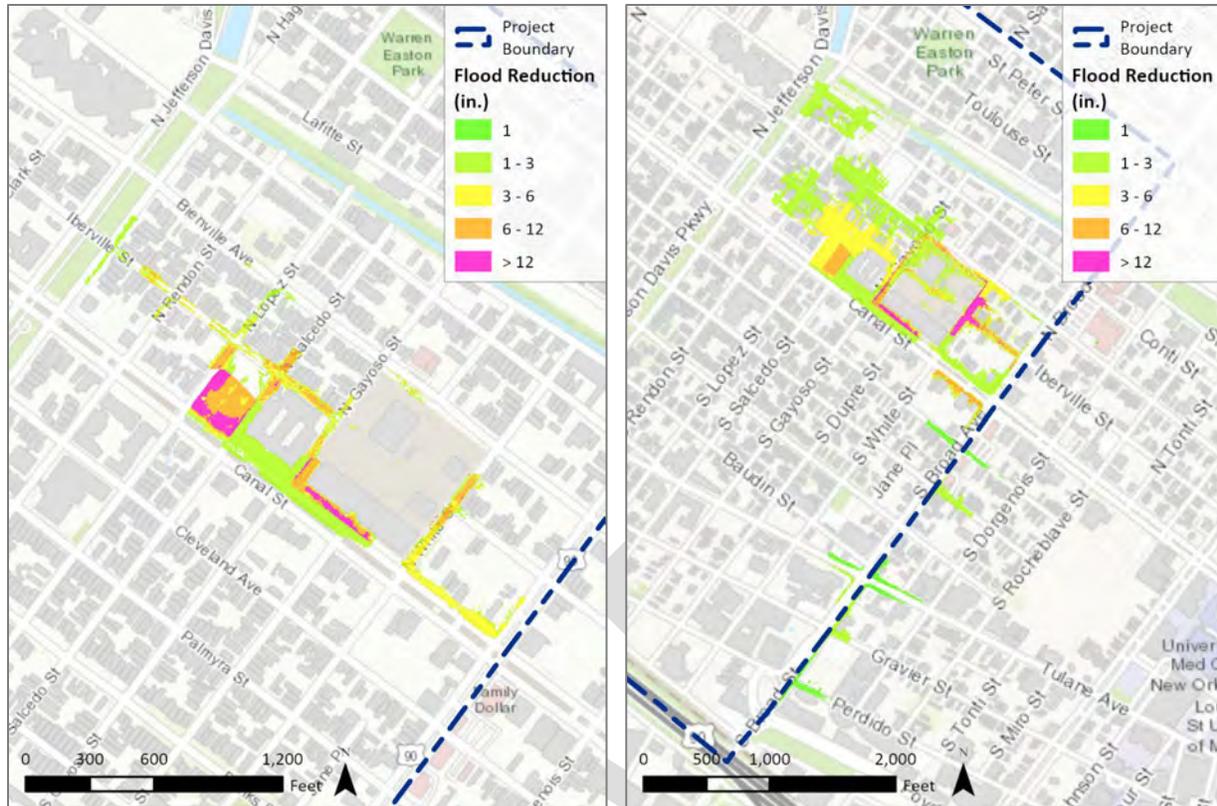
### 4.2.1 Warren Easton/Regional Transit Authority Alternative

Two subsurface modular storage tanks can be installed near Warren Easton Jr High School, one at the RTA and the other at the school's athletic field. The RTA tank will feature an irregular footprint totaling 76,869 sq ft, with a depth of 4.5 ft and 92% void space, installed with 1-foot cover beneath the paved surface. Water will enter the tank through a 2-foot HDPE pipe, connected to the existing stormwater system. The athletic field tank will be rectangular, measuring 144 ft wide by 222 ft long and 4.5 ft deep with 92% void space. It will be installed with 3.5 ft cover and receive stormwater through a 1.25-foot HDPE pipe, supplemented by open curb cuts surrounding the field. In addition to the subsurface tank, the athletic field will support surface storage with dimensions of 228 ft wide by 150 ft long and a depth of 2 ft. The volume of storage added from this project is about 519,000 cubic feet (cu ft). Both systems will discharge through a ground-level orifice and drain into the existing stormwater network via a 6-inch pipe. To facilitate proper drainage into the system, the pipes and manholes along a 1,200-foot segment of Iberville St will require lowering. **Figure 4-3** shows the graphic representation of the alternative subsurface modular storage tanks and surface storage. **Appendix H** provides the PC SWMM model for this alternative.



**Figure 4-3. Modular Storage and Surface Storage at Warren Easton/Regional Transit Authority**

During a 10-year storm event, the intersection of N White St and Iberville St experiences peak flood depths of approximately 1.5 ft, with water ponding for up to two hours before draining. The alternative modular storage tanks work synergistically to reduce both flood depth and duration. **Figure 4-4** shows the flood reduction maps for the 1-year and the 10-year storm events, or the difference in flood depth between the existing conditions and alternative conditions for each design storm. The flood reduction maps for the 25-year storm events are provided in **Appendix I**. The largest reduction in flooding peak due to the project will occur at N White St and Iberville St.



**Figure 4-4. Warren Easton/Regional Transit Authority Subsurface Modular Storage and Surface Storage Flood Reduction for 1-Year (Right) and 10-Year (Left) Storm Events**

### 4.2.2 Gravier Park Alternative

A modular storage tank can be installed under Gravier Park, located at the intersection of Perdido St and S Gayoso St. The tank will be rectangular, measuring 60 ft in width, 130 ft in length, and 4.5 ft deep, with 92% void space for optimal water retention. It will be installed with one foot cover below the Gravier Park's surface and positioned on the north side to avoid interference with tree roots on the southern side. Stormwater will enter the tank via a 1.25-foot HDPE pipe and through open curb cuts along the park's northern edge. Complementing the subsurface system, the park will also serve as a surface storage area that will measure 116 ft in width and 136 ft in length at the top, with a storage depth of 2 ft. The volume of storage added from this project is about 58,000 cu ft. Stormwater captured in the surface basin will discharge through an orifice at ground level and exit via a 6-inch pipe connecting to the existing drainage system. **Figure 4-5** shows the graphical representation of the subsurface modular storage tank. **Appendix H** provides the PC SWMM model for this alternative.

At the intersection of Perdido St and S Gayoso St, the model predicts peak flooding depths of approximately 1.1 ft during a 10-year storm event. Stormwater accumulates and remains ponded at this location for up to 5 hours at the height of the storm before draining. The implementation of the modular storage tank is projected to reduce peak flood depths by 0.13 ft and shorten the ponding duration by 30 minutes. **Figure 4-6** shows the flood reduction maps for the 1-Year and the 10-year storm events. The flood reduction map for the 25-year storm event is provided in **Appendix I**.



Figure 4-5. Subsurface Modular Storage at Gravier Park

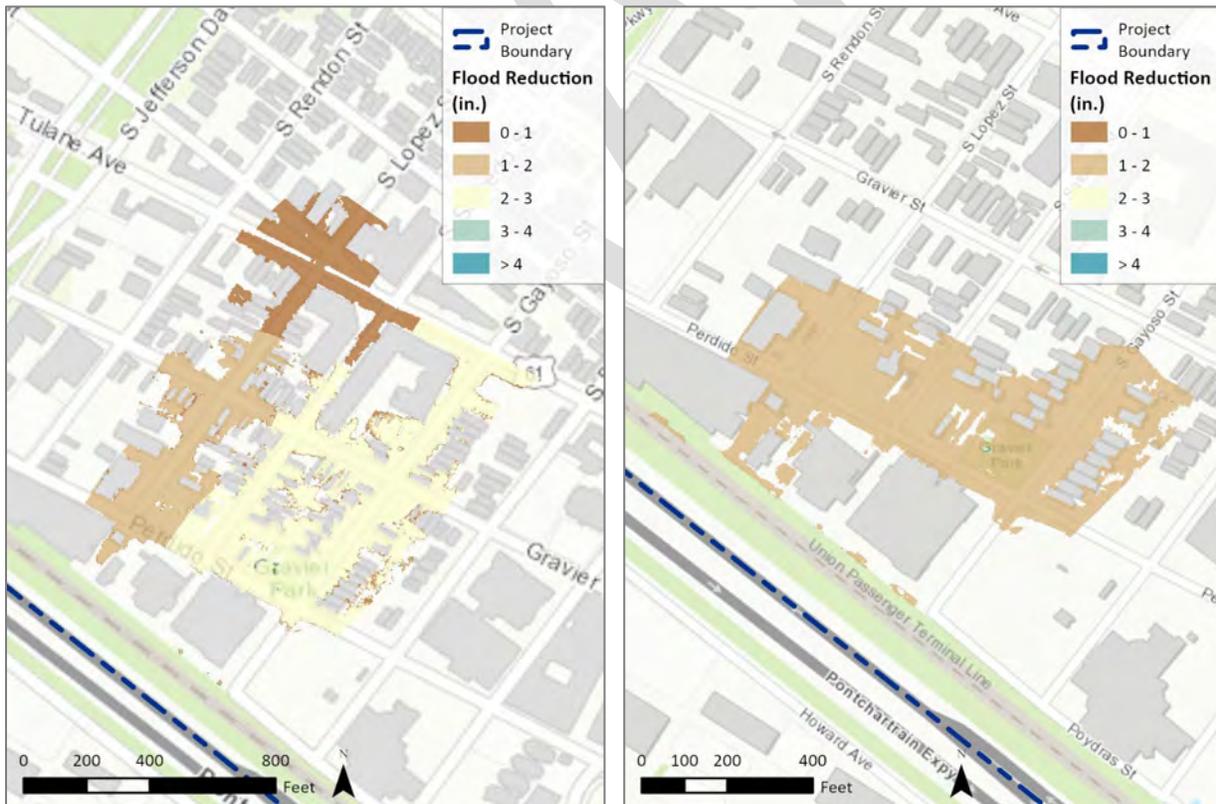
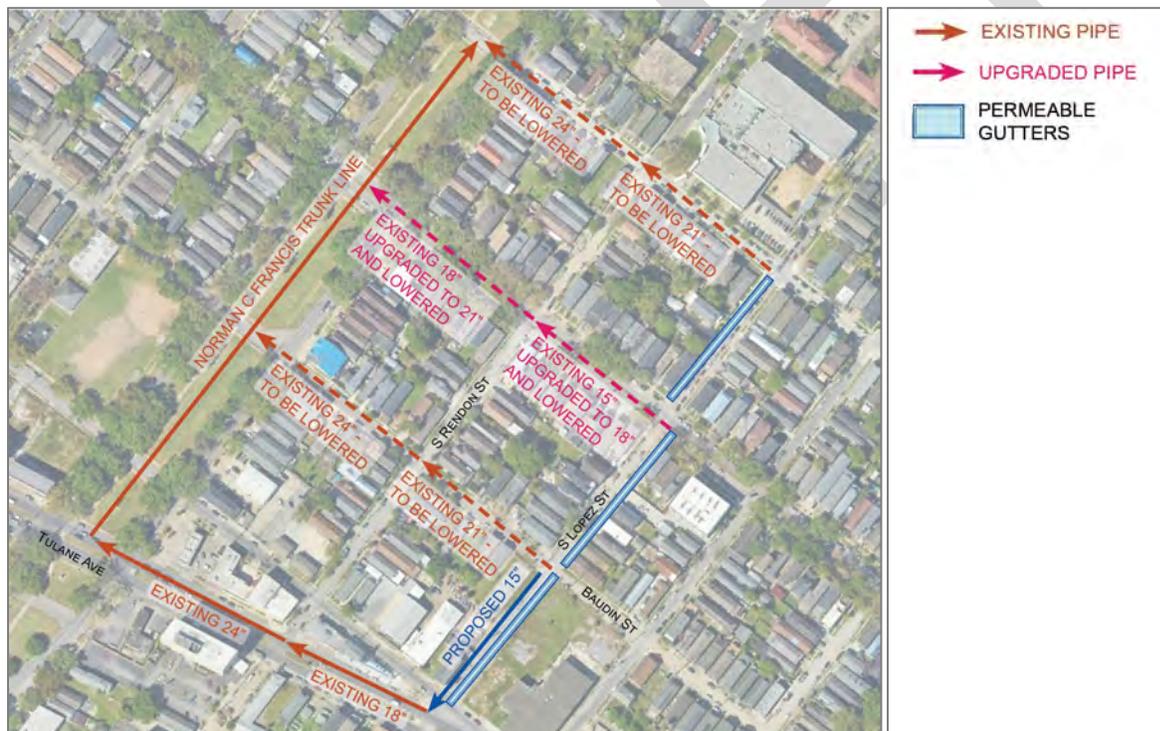


Figure 4-6. Gravier Park Subsurface Modular Storage Flood Reduction for 1-Year (Right) and 10-Year (Left) Storm Events

### 4.2.3 South Lopez Street Alternative

Permeable gutters can be installed along S Lopez St from D’Hemecourt St to Palmyra St to alleviate flooding. **Figure 4-7** shows the graphic representation of the permeable gutter segments. Along S Lopez, permeable gutter segments will be installed on the East side of the street with a length of 350 ft, width of 10.5 ft, and depth of 3.5 ft between each intersection. The volume of storage added from this project is about 10,000 cu ft. The tree roots on the west side of the street restrict our ability to propose subsurface permeable gutter storage on that side. The permeable gutters will extend from the edge of the right of way to the edge of the on-street parking. The permeable gutter segments will each flow into a subsurface storage tank that is 3.5 ft deep and has 92% void space. The depth of cover for each tank varies between 1.5 through 2 ft deep. The storage tanks drain through a 6-inch diameter pipe back into the existing system. For the GSI storage to drain into the existing system, the pipes and manholes along Baudin St, Banks St, and Palmyra St need to be lowered over a 750-foot span. The pipes along Banks St from S Lopez St to Norman C Francis should not only be lowered, also, they should also be upsized from the existing 1.25 and 1.5 ft to 1.5 and 1.75 ft respectively. Lastly, it is also recommended that a new 15-inch pipe be added along both sides of S Lopez St from Baudin to D’Hemecourt. **Appendix H** provides the PC SWMM model for this alternative.



**Figure 4-7. Permeable Gutters at South Lopez Street**

In this area, the deepest flooding in the 10-year storm is about 3 ft at the intersection of S Lopez St and Palmyra St. According to the existing model, water ponds in this intersection for 6.5 hours during the peak of the storm before it can drain away. **Figure 4-8** shows the flood reduction maps for the 1-year and the 10-year storm events. The flood reduction map for the 25-year storm event is in **Appendix I**.

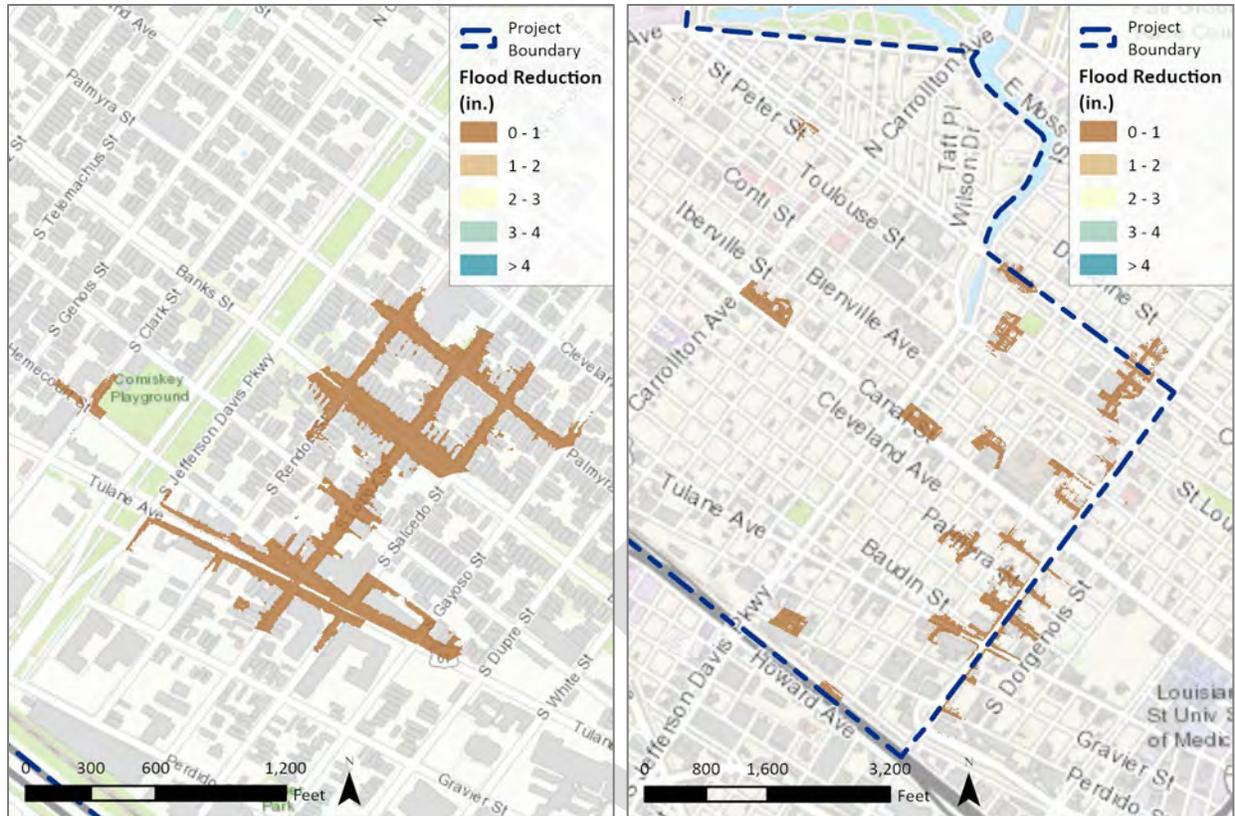


Figure 4-8. South Lopez Street Permeable Gutters Flood Reduction for 1-Year (Right) and 10-Year (Left) Storm Events

#### 4.2.4 Toulouse Street Alternative

Permeable gutters can be installed along Toulouse St from N Dupre St to Hagan Ave to alleviate flooding. **Figure 4-9** shows the graphic representation of the permeable gutter segments that will be installed on either side of the street, avoiding tree roots, and will have varying lengths, a width of 10.5 ft, and depth of 3.5 ft between each intersection. The volume of storage added from this project is about 28,000 cu ft. The permeable gutters will extend from the edge of the Right of Way to the edge of the on-street parking. The permeable gutter segments will each flow into a subsurface storage tank that is 3.5 ft deep and has 92% void space. The depth of cover for each tank varies between 1 through 1.8 ft deep. The storage tanks drain through a 6-inch diameter pipe back into the existing system. **Appendix H** provides the PC SWMM model for this alternative.

In this area, the deepest flooding in the 10-year storm is about 1.5 ft at the intersection of N Rendon St and Toulouse St. According to the existing model, water ponds in this intersection for about 5 hours during the peak of the storm before it can drain away. **Figure 4-10** shows the flood reduction maps for the 1-year and the 10-year storm events. The flood reduction map for the 25-year storm event is in **Appendix I**.

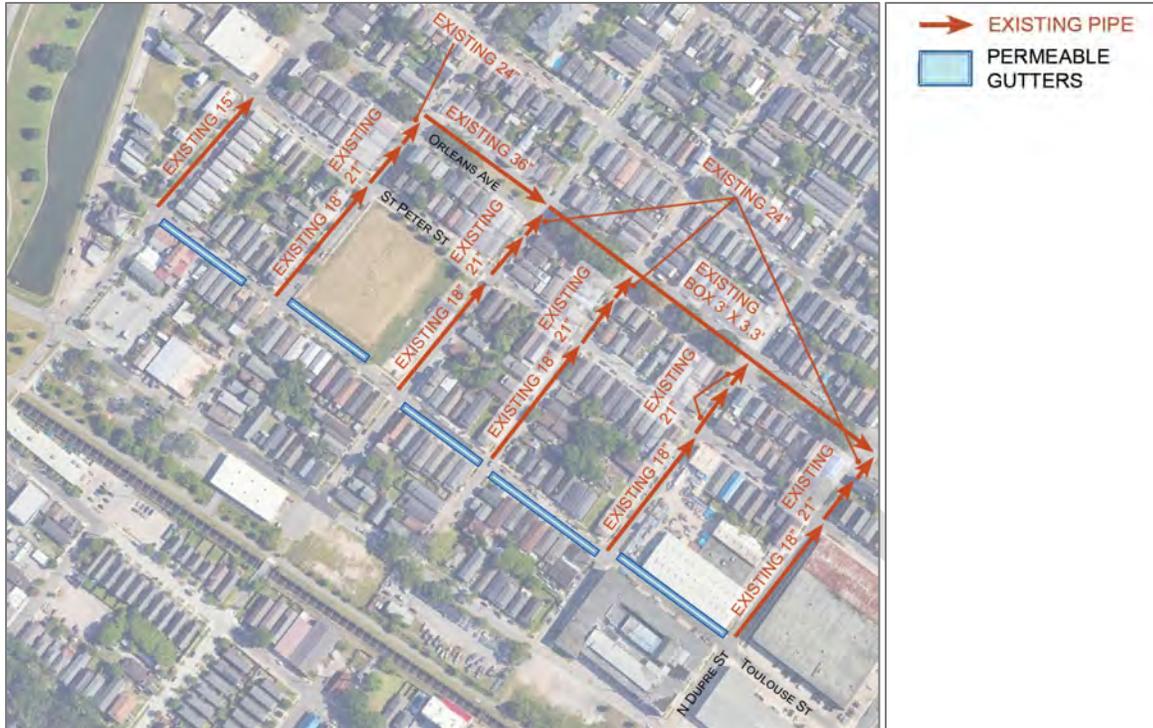


Figure 4-9. Permeable Gutters at Toulouse Street

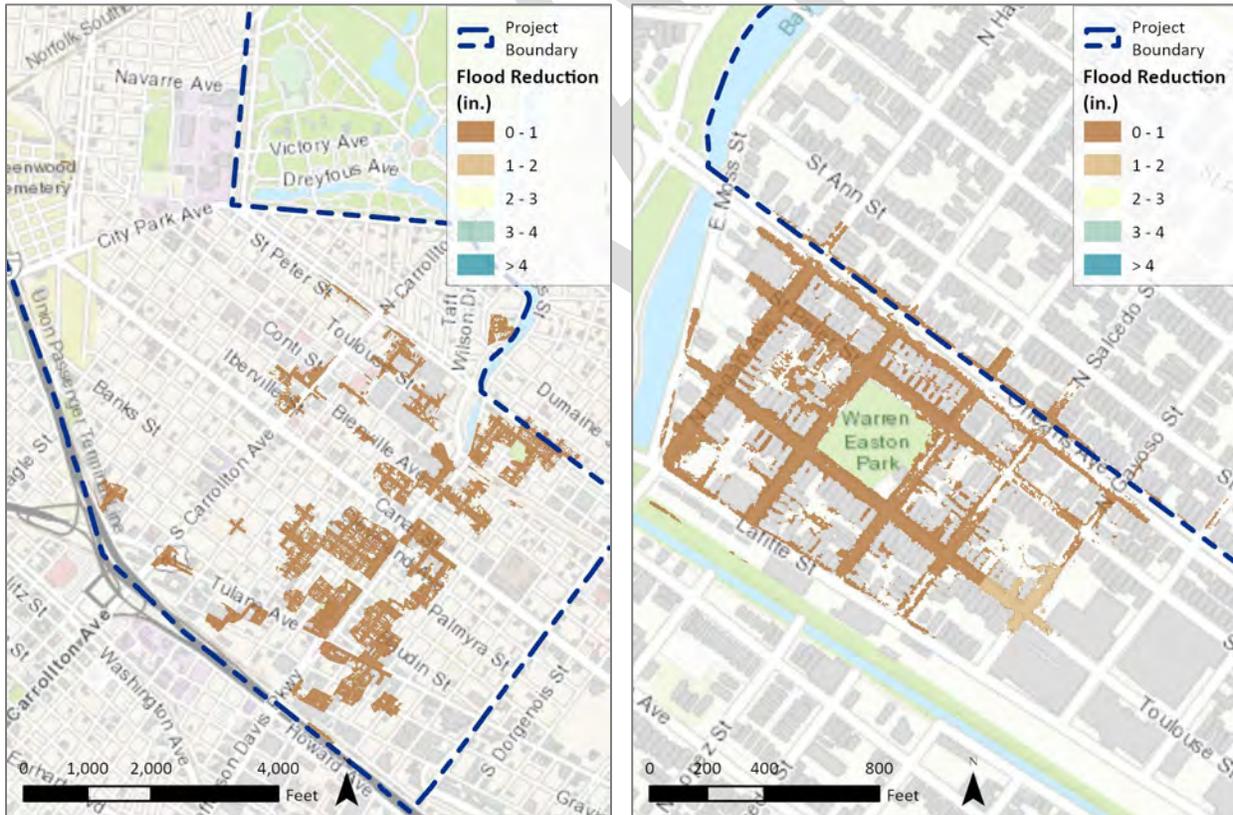


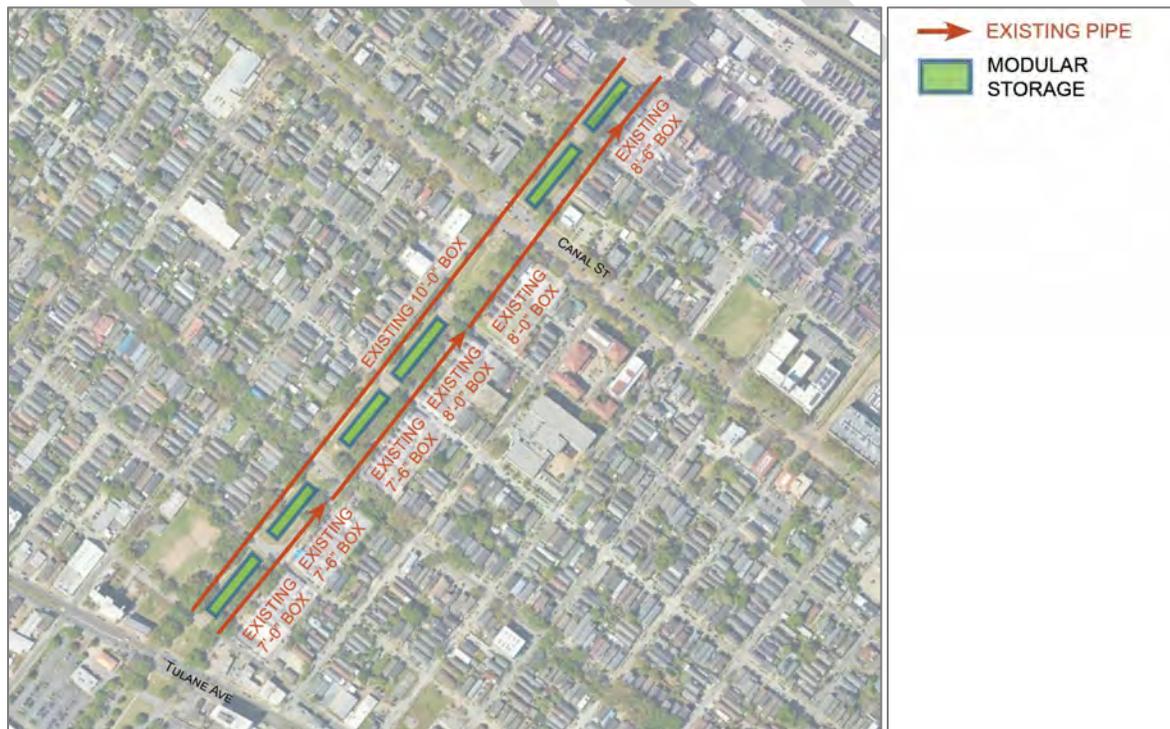
Figure 4-10. Toulouse Street Permeable Gutters Flood Reduction for 1-Year (Right) and 10-Year (Left) Storm Events

## 4.3 North Mid-City – Norman C Francis Area Improvements

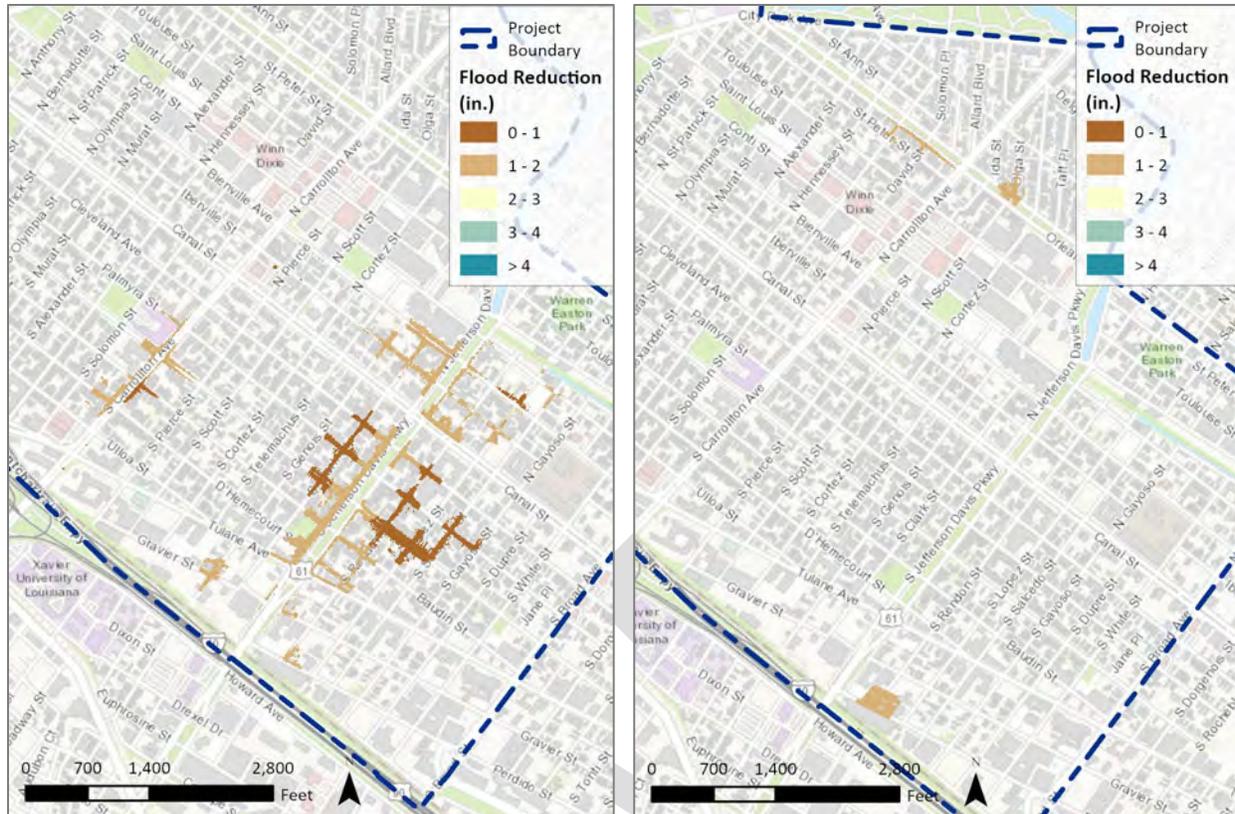
### 4.3.1 Norman C Francis Alternative

Flooding occurs along Norman C Francis Parkway from Tulane Ave to Conti St. Surrounding streets such as Canal St and Banks St typically experience flooding depths up to 3.5 ft. To address this issue, a subsurface modular storage tank can be installed beneath the median along Norman C Francis. The tank will cover a total area of 70,552 sq ft, have a depth of 4.5 ft, and feature a 92% void ratio for water storage. The volume of storage added from this project is about 923,000 cu ft. It will be installed underground with 3 ft of soil cover above it. Stormwater will enter the tank through a 2-foot diameter pipe. Water will then discharge through a 6-inch pipe fitted with an orifice at ground level, ultimately draining back into the existing subsurface drainage system. To ensure proper flow from the GSI system into the existing drainage network, the existing manholes along Norman C Francis will need to be lowered. **Figure 4-11** shows the graphical representation of the subsurface modular storage tank. **Appendix H** provides the PC SWMM model for this alternative.

In this area, the deepest flooding in the 10-year storm is about 3.5 ft at the intersection of S Norman C Francis Pkwy and Canal St. According to the existing model, water ponds in this intersection for about 4 hours during the peak of the storm before it can drain away. **Figure 4-12** shows the flood reduction maps for the 1-year and the 10-year storm events. The flood reduction map for the 25-year storm event is in **Appendix I**.



**Figure 4-11. Subsurface Modular Storage at Norman C Francis Parkway**



**Figure 4-12. Norman C Francis Parkway Subsurface Modular Storage Flood Reduction for 1-Year (Right) and 10-Year (Left) Storm Events**

### 4.3.2 Tulane Street Alternative

Permeable gutters can be installed along Tulane Ave from S Pierce St. to S Salcedo St. **Figure 4-13** shows the graphical representation of the permeable gutter segments which will be installed on both sides of the street. Permeable gutters are proposed along Tulane Ave from S Dupre St to S White St. Segments will be installed on the north side of the street and will be designed to be approximately 228 ft long, 10.5 ft wide, and 3.5 ft deep between each intersection. The volume of storage added from this project is about 35,000 cu ft. On some sides of the street, existing tree roots limit the ability to install subsurface permeable gutter storage, so installation is restricted to the opposite side. These permeable gutters will extend from the edge of the right-of-way to the boundary of on-street parking. Each segment will direct stormwater into an underground storage tank that is 3.5 ft deep with 92% void space. The depth cover above each tank will range from 1.5 to 2 ft. The storage tanks will drain back into the existing stormwater system through a 6-inch diameter pipe. **Appendix H** provides the PC SWMM model for this alternative.

In this area, the deepest flooding in the 10-year storm is about 2.4 ft at the intersection of Tulane Ave and S Norman C Francis Pkwy. According to the model, water ponds in this intersection for about 2.5 hours during the peak of the storm before it can drain away. **Figure 4-14** shows the flood reduction maps for the 1-year and the 10-year storm events. The flood reduction map for the 25-year storm event is in **Appendix I**.

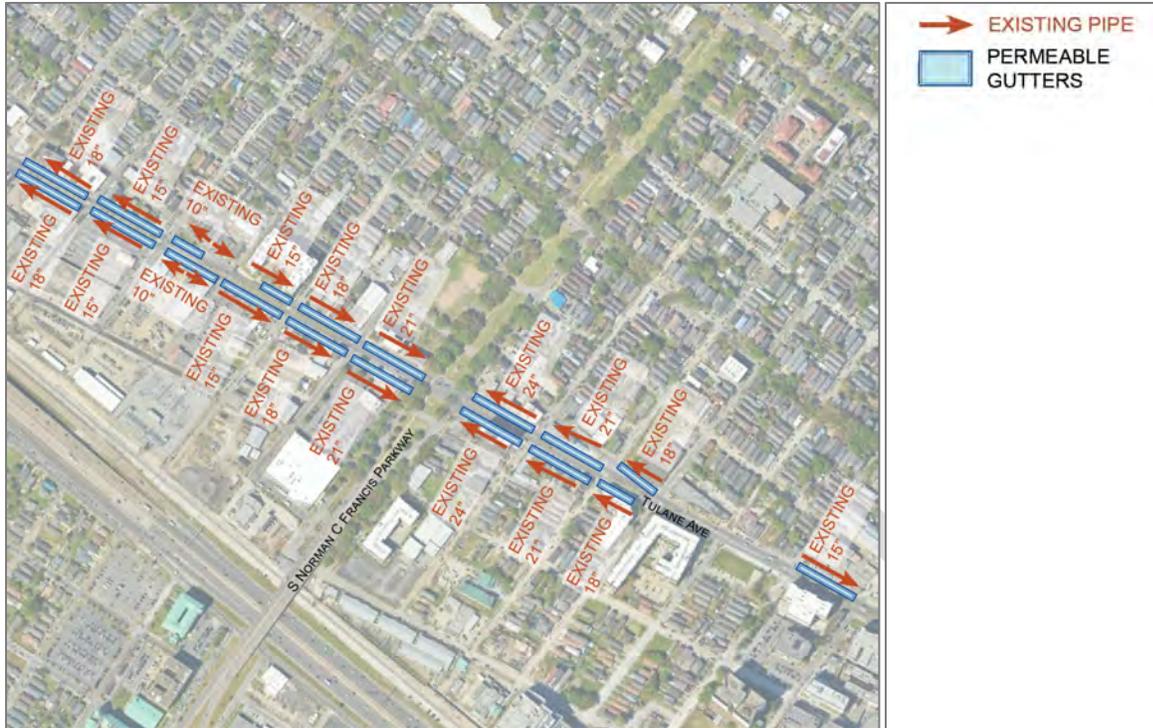


Figure 4-13. Permeable Gutters on Tulane Street

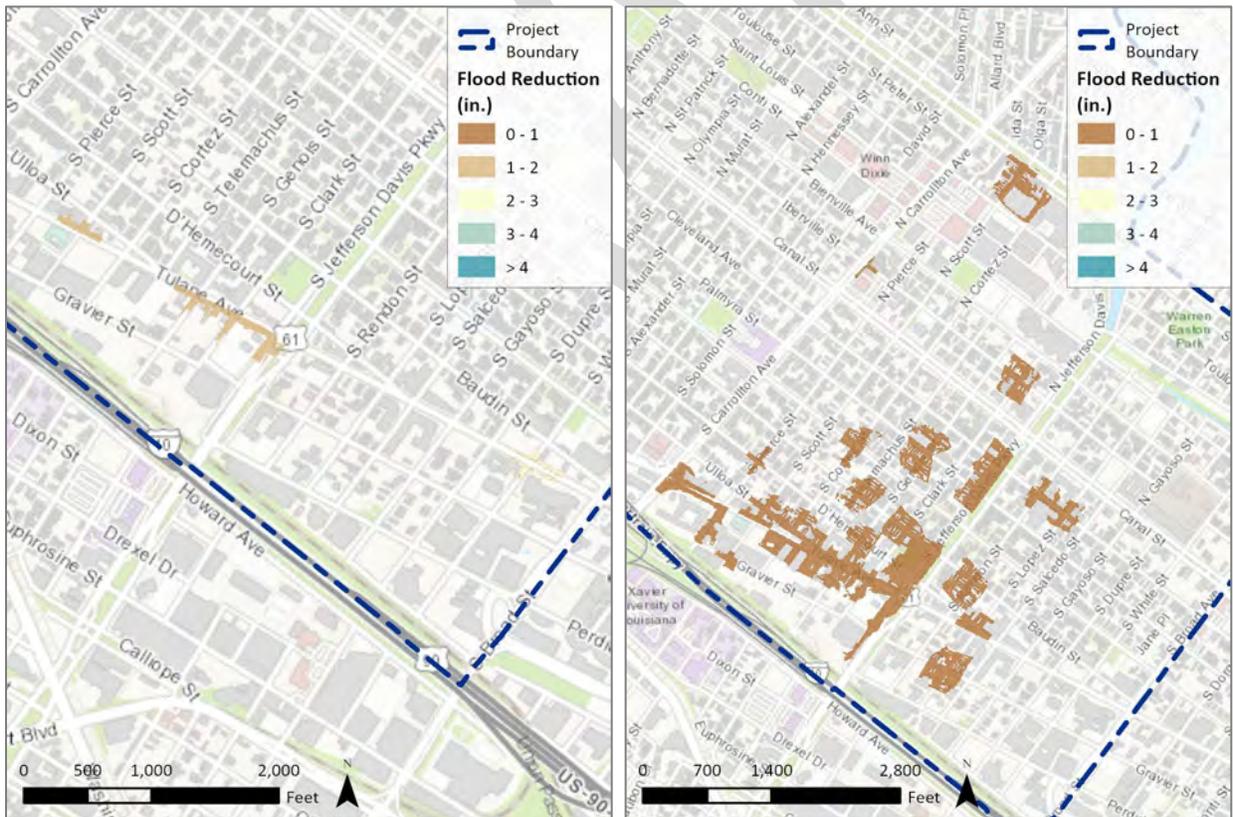


Figure 4-14. Tulane Street Permeable Gutters Flood Reduction for 1-Year (Right) and 10-Year (Left) Storm Events

### 4.3.3 Dumaine Street Alternative

Permeable gutters can be installed along Dumaine St from Moss St to Carrollton St to alleviate flooding. **Figure 4-15** shows the graphical representation of the permeable gutter segments. Along Dumaine St, permeable gutter segments will be installed on either side of the street, avoiding tree roots, with a length of 218 ft, width of 10.5 ft, and depth of 3.5 ft between each intersection. The volume of storage added from this project is about 41,000 cu ft. The permeable gutters will extend from the edge of the right of way to the edge of the on-street parking. The permeable gutter segments will each flow into a subsurface storage tank that is 3.5 ft deep and has 92% void space. The depth of cover for each tank varies between 1.4 and 1.8 ft deep. The storage tanks drain through a 6-inch diameter pipe back into the existing system. In order for the GSI storage to drain into the existing system, the manhole at Taft Pl and Dumaine St needs to be lowered as well as the pipe connected to it. **Appendix H** provides the PC SWMM model for this alternative.

In this area, the deepest flooding in the 10-year storm is about 1.2 ft at the intersection of Harding St and Dumaine St. According to the existing model, water ponds in this intersection for about 4.5 hours during the peak of the storm before it can drain away. **Figure 4-16** shows the flood reduction maps for the 1-year and the 10-year storm events. The flood reduction map for the 25-year storm event is in **Appendix I**.



**Figure 4-15. Permeable Gutters at Dumaine Street**



**Figure 4-16. Dumaine Street Permeable Gutters Flood Reduction for 1-Year (Right) and 10-Year (Left) Storm Events**

#### 4.3.4 Comiskey Playground Alternative

Flooding occurs at Comiskey Playground and the adjacent streets during a 10-year storm event. Surrounding streets such as S Clark St, Baudin St, D’Hemecourt St and S Jefferson Davis Pkwy typically experience flooding depths up to 2.75 ft. To address this issue, a subsurface modular storage tank can be installed beneath Comiskey Playground. The tank will cover an area of 39,800 sq ft, have a depth of 4.5 ft, and feature a 92% void ratio for water storage. The volume of storage added from this project is about 107,000 cu ft. It will be installed underground with 3 ft of soil cover above it. Stormwater will enter the tank through a 2-foot diameter pipe. Water will then discharge through a 6-inch pipe fitted with an orifice at ground level, ultimately draining back into the existing subsurface drainage system. To ensure proper flow from the GSI system into the existing drainage network, an existing manhole will need to be lowered. **Figure 4-17** shows the graphical representation of the subsurface modular storage tank. **Appendix H** provides the PC SWMM model for this alternative.

In this area, the deepest flooding in the 10-year storm is about 2.6 ft on Baudin St running along Comiskey Playground. According to the existing model, water ponds in this intersection for about 4.5 hours during the peak of the storm before it can drain away. **Figure 4-18** shows the flood reduction maps for the 1-year and the 10-year storm events. The flood reduction map for the 25-year storm event is in **Appendix I**.



Figure 4-17. Subsurface Modular Storage Tank at Comiskey Playground

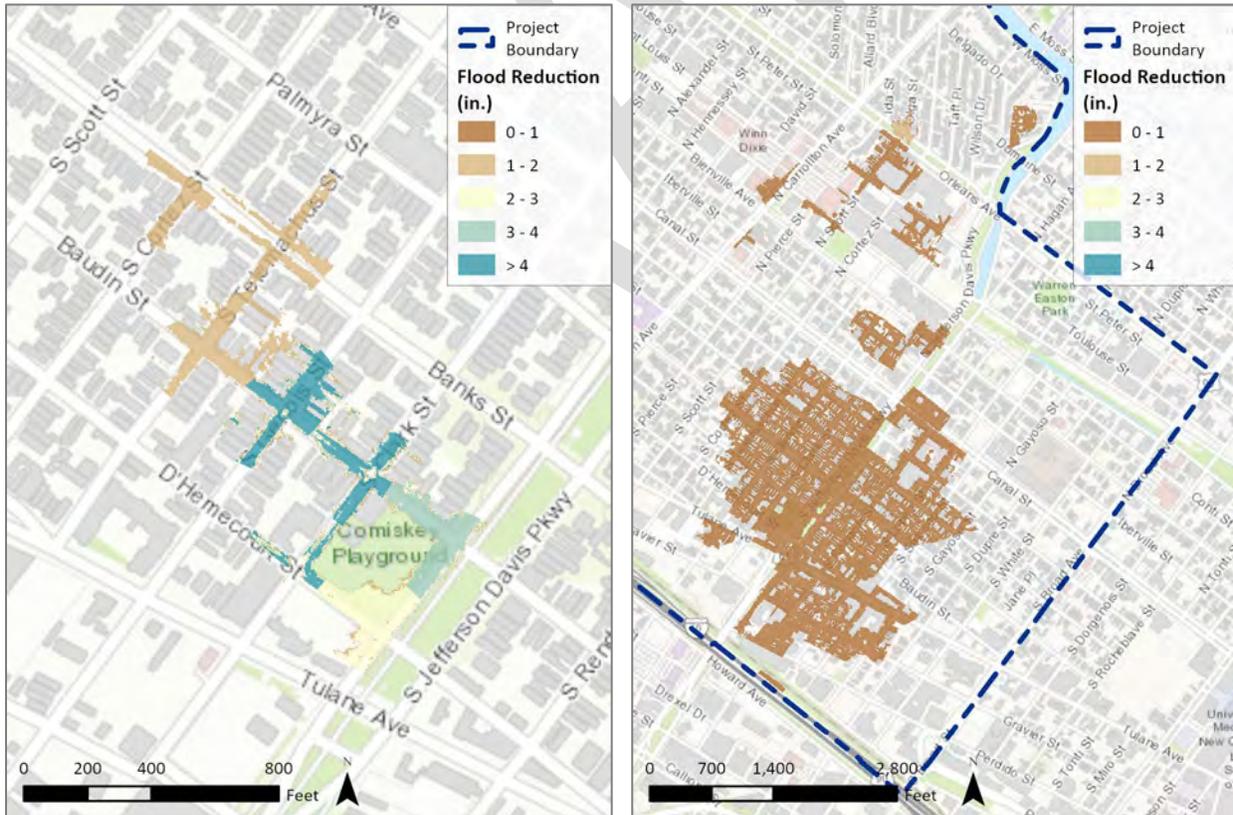


Figure 4-18. Comiskey Playground Subsurface Modular Storage Tank Flood Reduction for 1-Year (Right) and 10-Year (Left) Storm Events

## 4.4 City Park – Carrollton Avenue Area Improvements

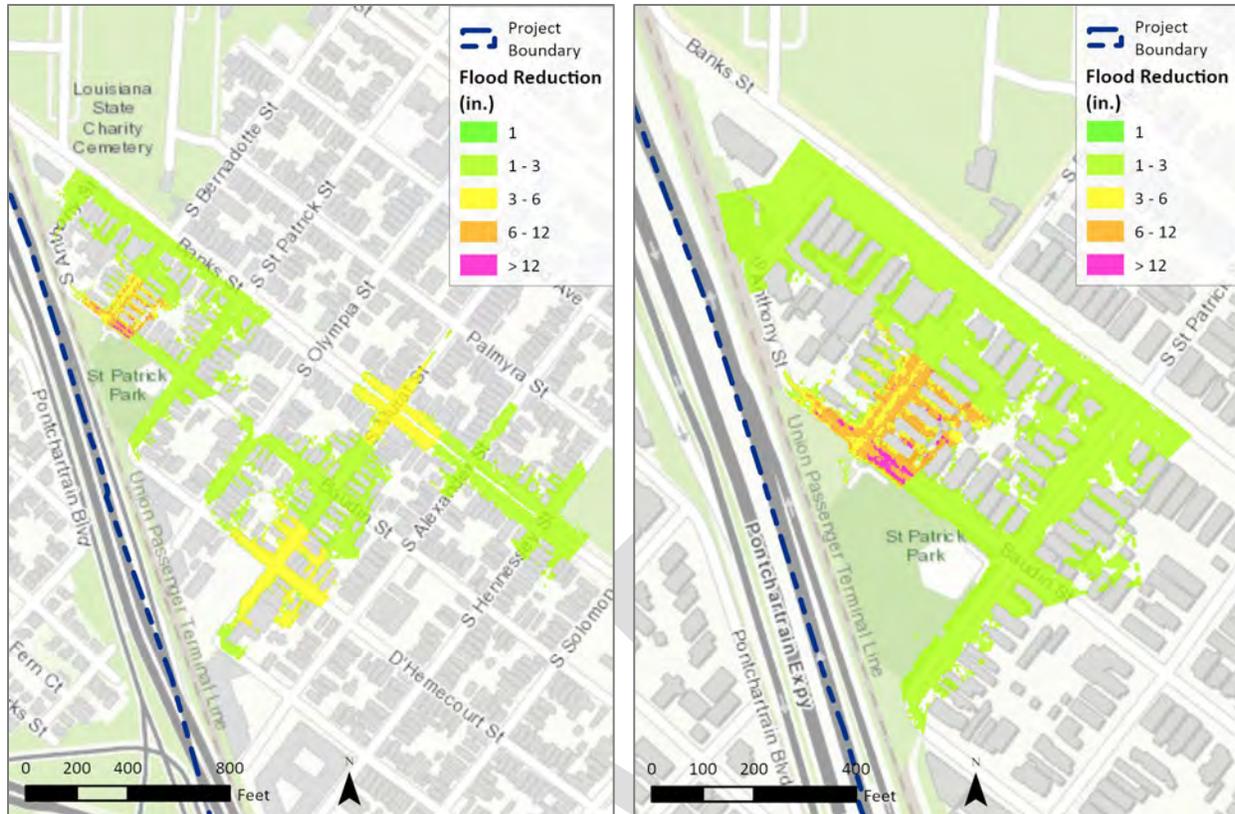
### 4.4.1 St. Patrick Playground Alternative

Flooding occurs at St. Patrick Playground and the adjacent streets during a 10-year storm event. Streets such as Baudin St and S St Patrick St typically experience flooding depths of at least 1.5 ft. Additionally, nearby streets experience flooding, with depths ranging from 0.5 to 2.8 ft. To address this issue, a subsurface modular storage tank can be installed beneath St. Patrick Playground. Figure 4-19 shows the graphical representation of the subsurface modular storage tank. The proposed tank will cover an area of 55,950 sq ft, have a depth of 4.5 ft, and feature a 92% void ratio for water storage. The volume of storage added from this project is about 152,000 cu ft. It will be installed underground with 3 ft of soil cover above it. Stormwater will enter the tank through a 2-foot-diameter pipe. Water will then discharge through a 6-inch pipe fitted with an orifice at ground level, ultimately draining back into the existing subsurface drainage system. To ensure proper flow from the GSI system into the existing drainage network, approximately 1,100 ft of existing pipes and manholes will need to be lowered, from S St Patrick St down D’Hemecourt St. **Appendix H** provides the PC SWMM model for this alternative.

In this area, the deepest flooding in the 10-year storm is about 2.5 ft on Baudin St along St Patrick Playground. According to the model, water ponds in this intersection for about 5 hours during the peak of the storm before it can drain away. **Figure 4-20** shows the flood reduction maps for the 1-year and the 10-year storm events. The flood reduction map for the 25-year storm event is in **Appendix I**.



**Figure 4-19. Subsurface Modular Storage at St. Patrick Playground**



**Figure 4-20. St. Patrick Playground Subsurface Modular Storage Flood Reduction for 1-Year (Right) and 10-Year (Left) Storm Events**

#### 4.4.2 Baudin Street Area Alternative

Permeable gutters can be installed along the Baudin St area, north of S Carrollton Ave. **Figure 4-21** shows the graphic representation of the segments including segments along Baudin St on the east side from Carrollton Ave to S Solomon St, and on the west side from S Solomon St to S Hennessey St. Also, along D'Hemecourt St on both sides between Carrollton Ave and So Murat St, as well as on the east side from S Olympia St to S St Patrick St. On Ulloa St, gutters are proposed along the west side from Carrollton Ave to S Solomon St and then on both sides until S Hennessey St. In addition, they are proposed on both sides of S Murat St between D'Hemecourt St and Banks St, on both sides of S Olympia St between D'Hemecourt St and Baudin St, and along south side of S St Patrick St from Baudin St to D'Hemecourt St. Each segment spans approximately 350 ft in length and 10.5 ft in width between street intersections. Installation is limited to one side of the roadways due to presence mature tree roots on some sides. Gutters extend from the edge of the public right-of-way to the boundary of on-street parking and are designed to convey stormwater into underground modular tanks, each is 3.5 ft deep with 92% void space and a soil cover ranging from 1.5 to 2 ft thick. The volume of storage added from this project is about 60,000 cu ft. Stored runoff is routed back into the existing stormwater network through a 6-inch diameter discharge pipe. **Appendix H** provides the PC SWMM model for this alternative. In this area, the deepest flooding in the 10-year storm is about 3.1 ft at the intersection of Baudin St and S Solomon St. Water ponds in this intersection for about 5 hours during the peak of the storm before it can drain away. **Figure 4-22** shows the flood reduction maps for the 1-year and the 10-year storm events. The flood reduction map for the 25-year storm event is in **Appendix I**.

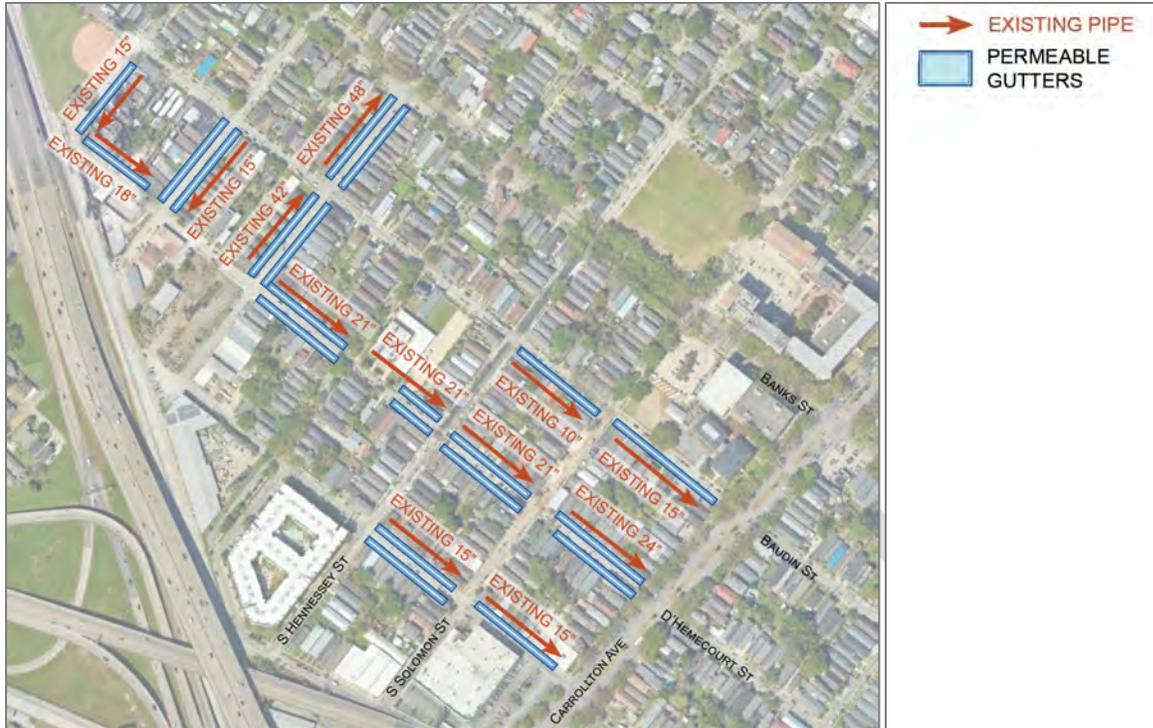


Figure 4-21. Permeable Gutters at Baudin Street Area

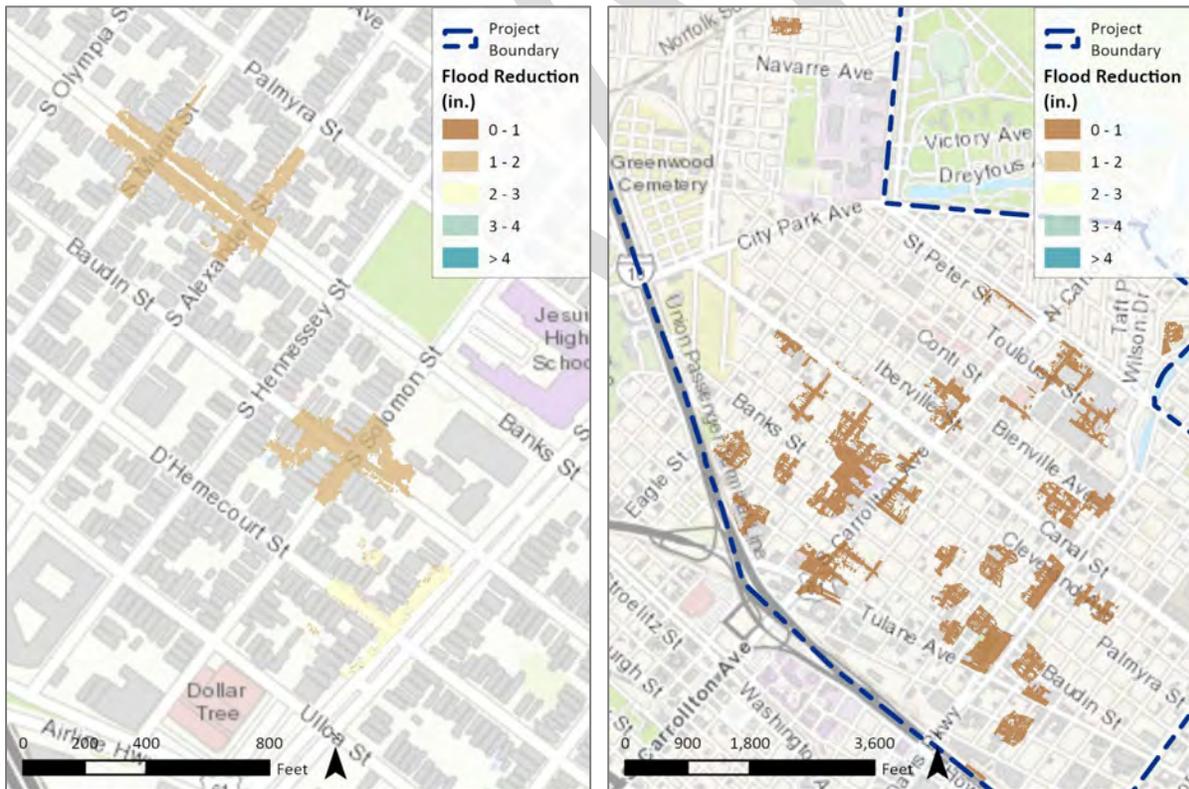
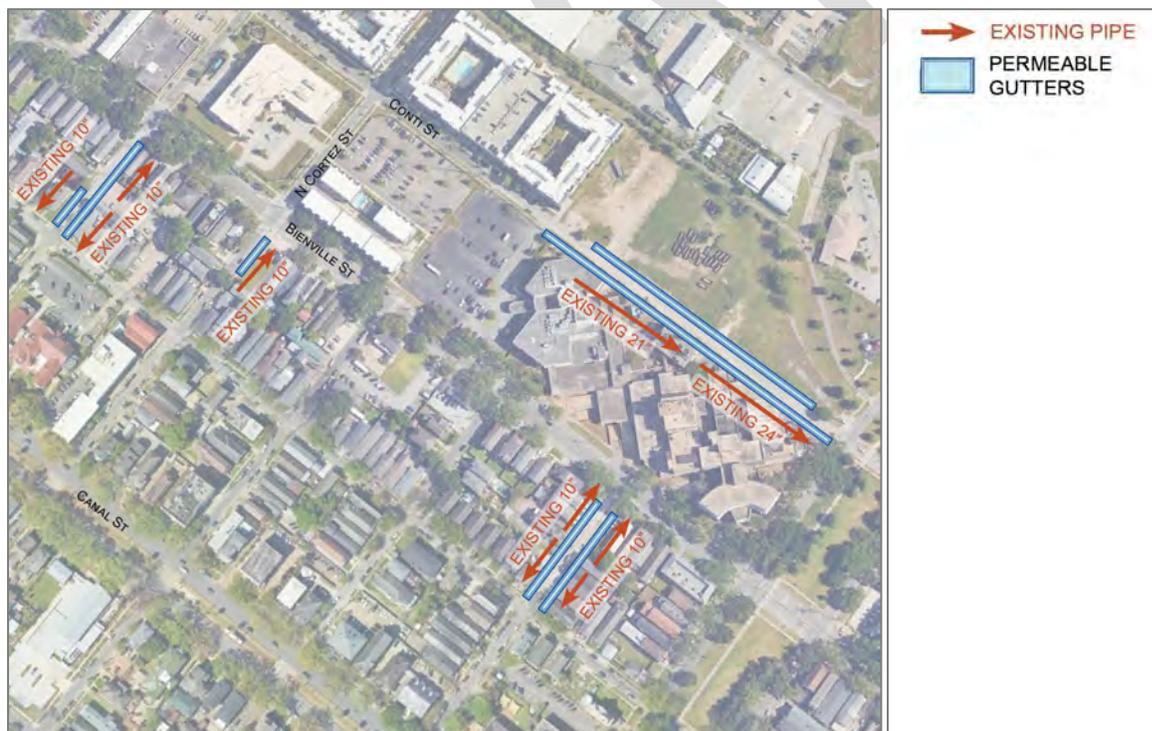


Figure 4-22. Baudin Street Area Permeable Gutters Flood Reduction for 1-Year (Right) and 10-Year (Left) Storm Events

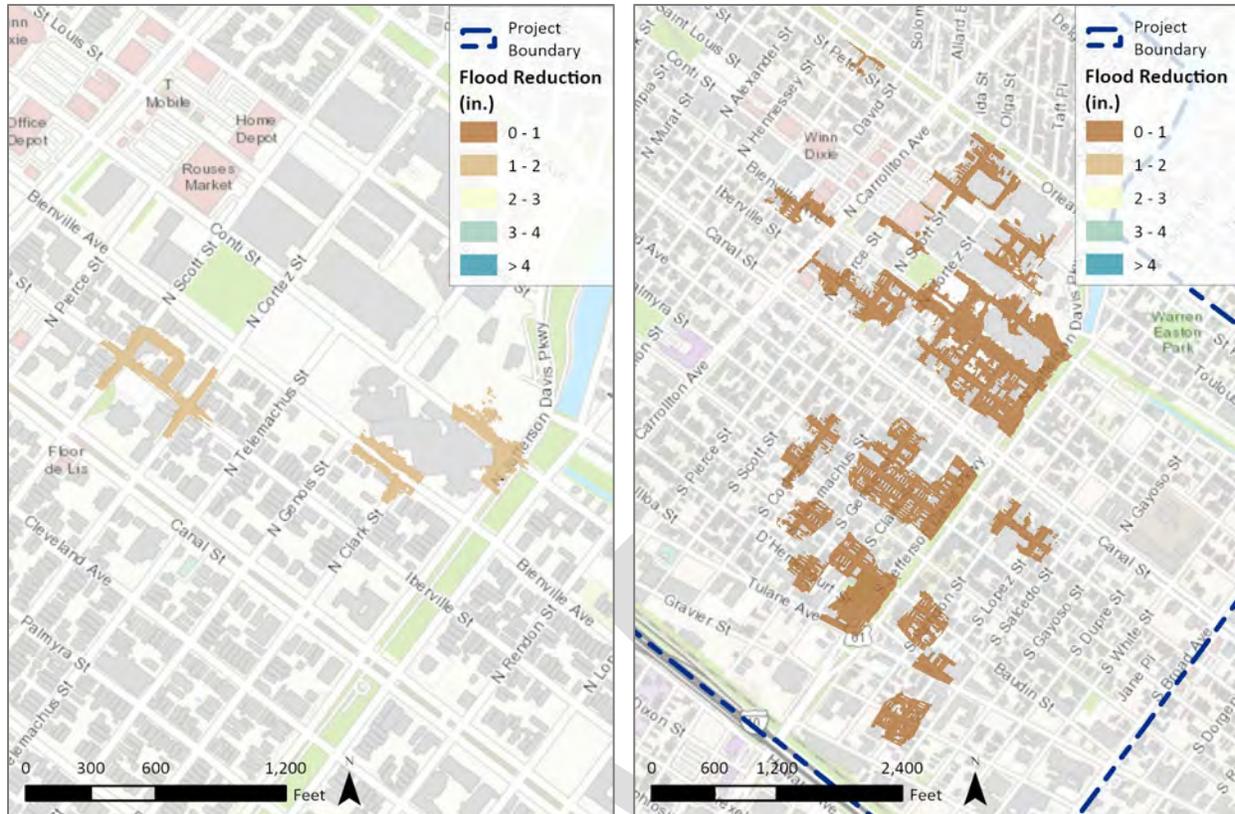
### 4.4.3 Bienville Street Area Alternative

Permeable gutters can be installed at the Bienville St area, along Conti St from N Cortez St to N Norman C Francis Pkwy. **Figure 4-23** shows the graphic representation of the proposed permeable gutter segments. The segments are on both sides of the street along Conti St, along N Scott St from Iberville St to Bienville St, on both sides of the street along N Scott St, along N Cortez St from Iberville St to Bienville St, on the east side along N Cortez St, along N Clark St from Iberville St to Bienville St, and on both sides along N Clark St. Permeable gutter segments typically measure 215 ft in length, except for the segment along Conti St which spans 700 ft and are 10.5 ft wide at each intersection. On some sides of the street, existing tree roots limit the ability to install subsurface permeable gutter storage, so installation is restricted to the opposite side. These permeable gutters will extend from the edge of the right-of-way to the boundary of on-street parking. Each segment will direct stormwater into an underground storage tank that is 3.5 ft deep with 92% void space and a cover depth above each tank ranging between 1.5 and 2 ft. The volume of storage added from this project is about 37,000 cu ft. The storage tanks will drain back into the existing stormwater system through a 6-inch diameter pipe. **Appendix H** provides the PC SWMM model for this alternative.

In this area, the deepest flooding in the 10-year storm is about 2.6 ft at the intersection of Conti St and N Norman C Francis Pkwy. According to the existing model, water ponds in this intersection for about 5 hours during the peak of the storm before it can drain away. **Figure 4-24** shows the flood reduction maps for the 1-year and the 10-year storm events. The flood reduction map for the 25-year storm event is in **Appendix I**.



**Figure 4-23. Permeable Gutters at Bienville Street Area**



**Figure 4-24. Bienville Street Area Permeable Gutters Flood Reduction for 1-Year (Right) and 10-Year (Left) Storm Events**

#### 4.4.4 Banks Street Alternative

Permeable gutters can be installed at the Banks St area. **Figure 4-25** shows the graphic representation of the permeable gutter segments. The segments are on both sides of the street along Cleveland Ave, S Cortez St, S Clark St, Palmyra St, Baudin St, and D’Hemecourt St. Permeable gutter segments are designed to be approximately 235 ft long, 10.5 ft wide, and 3.5 ft deep between each intersection. On some sides of the street, existing tree roots limit the ability to install subsurface permeable gutter storage, so installation is restricted to the opposite side. These permeable gutters will extend from the edge of the right-of-way to the boundary of on-street parking. Each segment will direct stormwater into an underground storage tank that is 3.5 ft deep with 92% void space. The cover depth above each tank will range from 1.5 to 2 ft. The volume of storage added from this project is about 48,000 cu ft. The storage tanks will drain back into the existing stormwater system through a 6-inch diameter pipe. **Appendix H** provides the PC SWMM model for this alternative.

In this area, the deepest flooding in the 10-year storm is about 2.6 ft at the intersection of Palmyra St and S Clark St. According to the model, water ponds in this intersection for about 6 hours during the peak of the storm before it can drain away. **Figure 4-26** shows the flood reduction maps for the 1-year and the 10-year storm events. The flood reduction map for the 25-year storm event is in **Appendix I**.

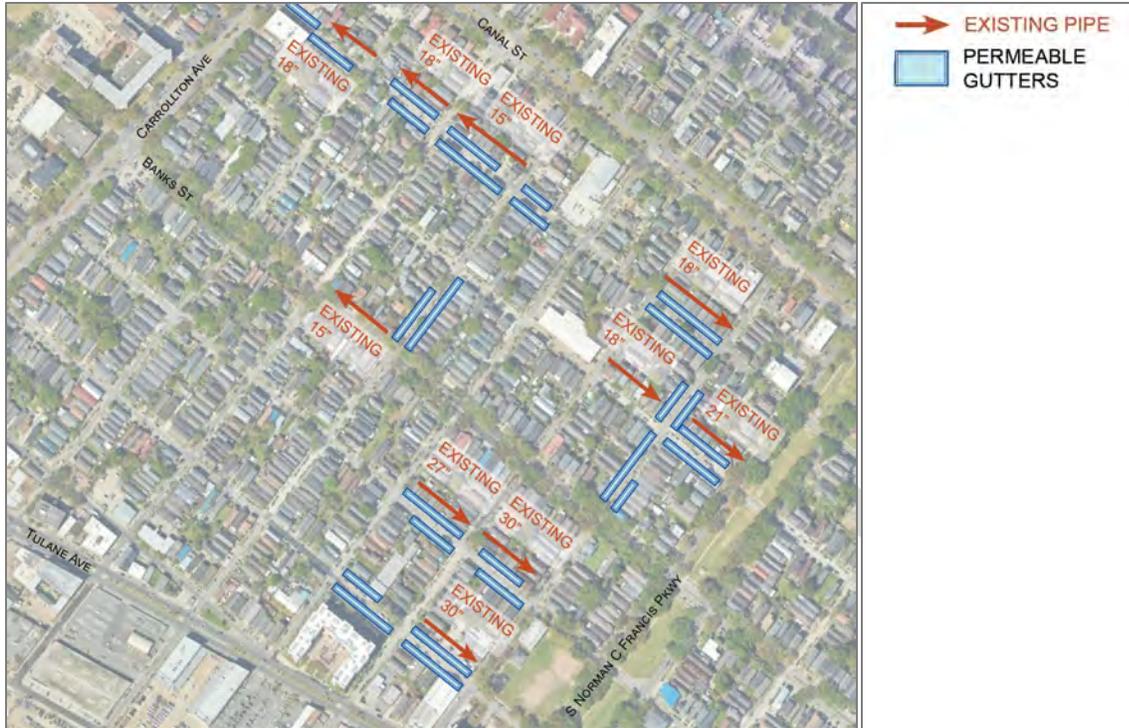


Figure 4-25. Permeable Gutters at Banks Street Area

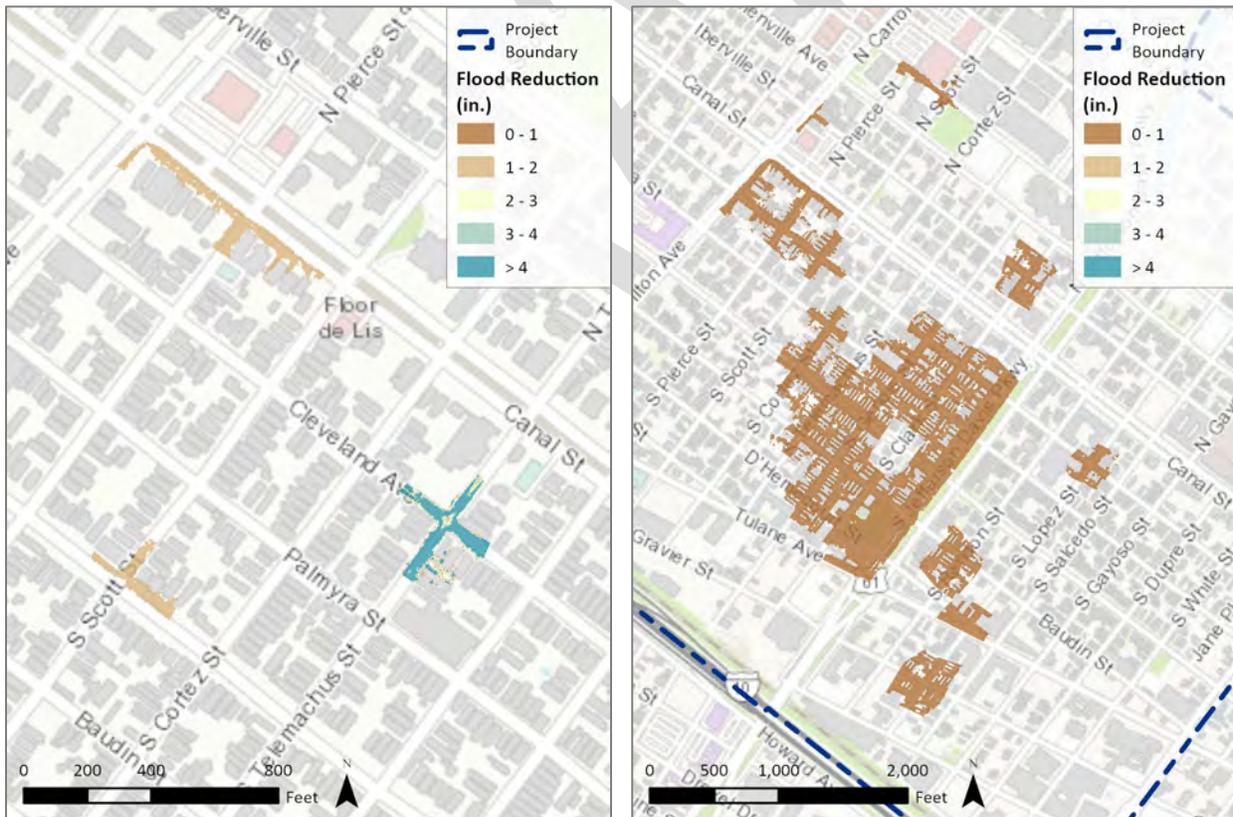
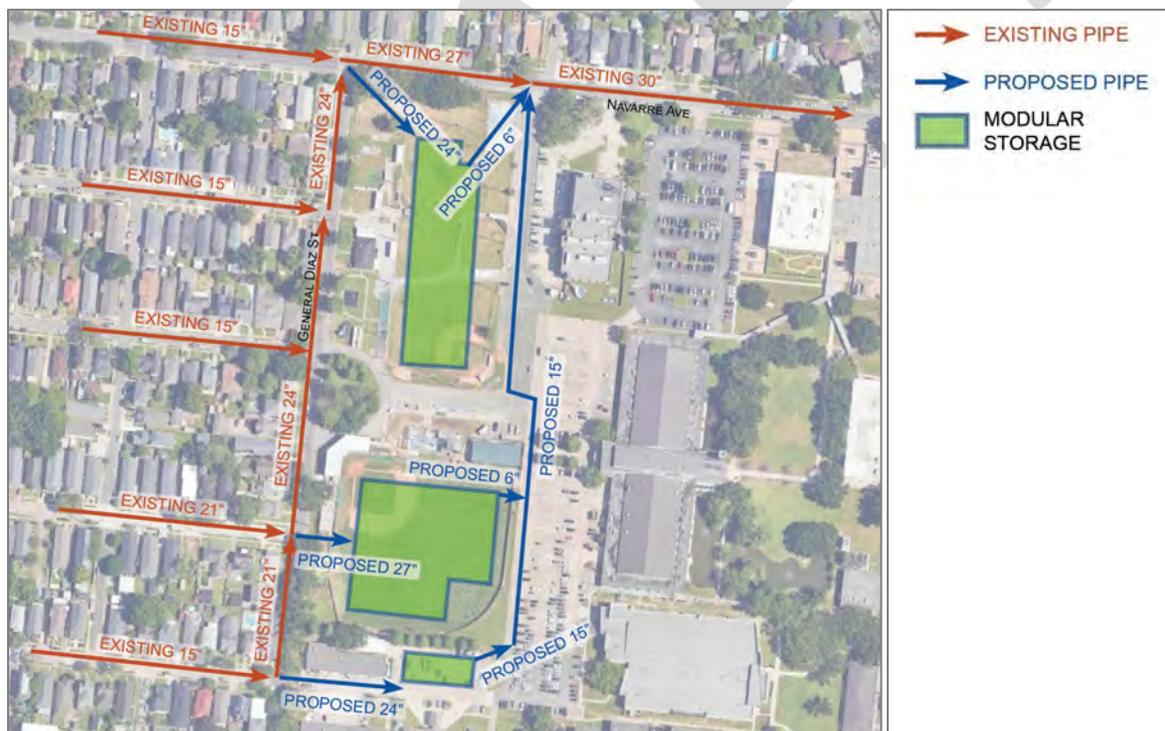


Figure 4-26. Banks Street Area Permeable Gutters Flood Reduction for 1-Year (Right) and 10-Year (Left) Storm Events

## 4.5 Navarre Neighborhood Improvements

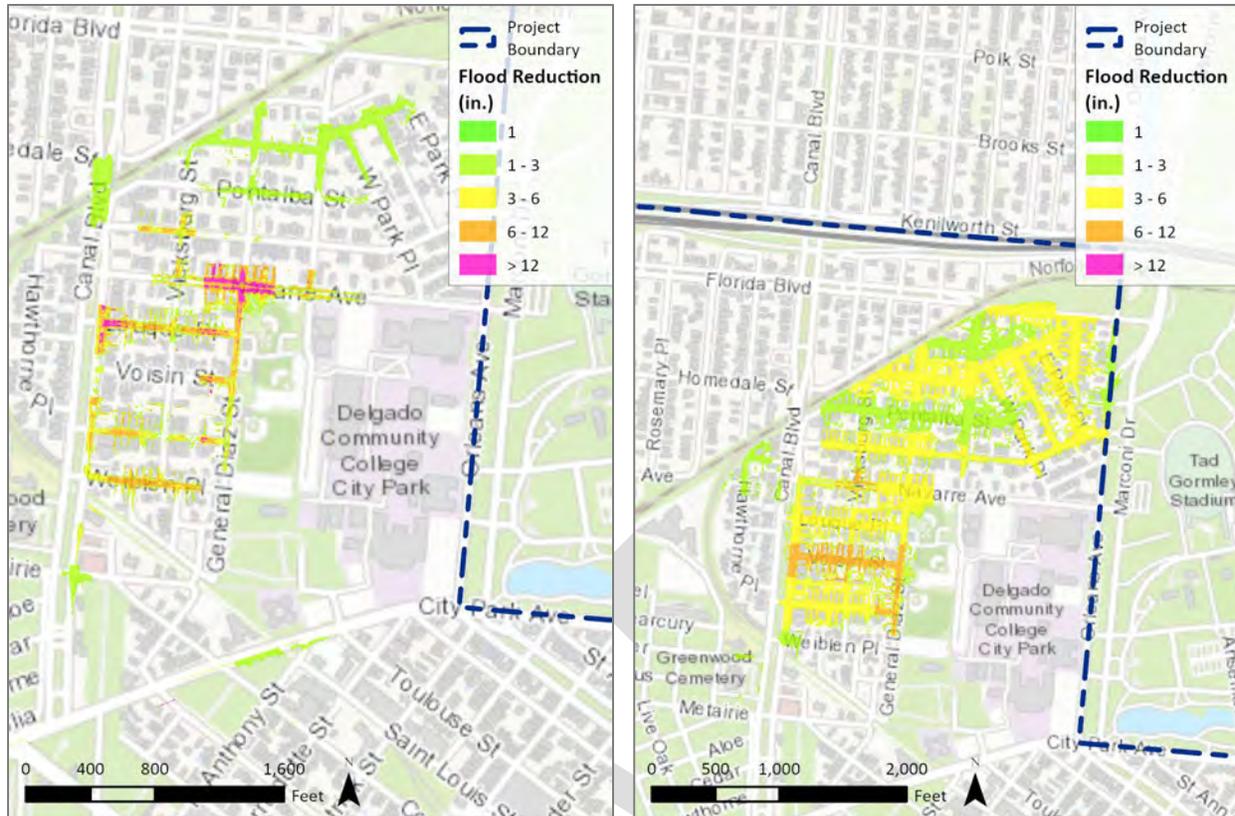
### 4.5.1 Delgado Baseball Field Alternative

The neighborhood south of Navarre Ave experiences significant flooding, similar to north of Navarre Ave, with many streets experiencing 2.0 ft of flooding. Delgado Community College main campus and Delgado Park with two baseball fields are located in this area. This alternative includes three modular storage tanks at this location, one on each baseball field and one in the parking lot off Weiblen Place and General Diaz St. The subsurface storage is not limited by tree roots, and the surface storage is not utilized. The storage tank at the northern most baseball field will be irregularly shaped and have an area of 55,048 sq ft. The tank below the previously mentioned tank will also be irregularly shaped and have an area of 67,848 sq ft. Water will flow into the tanks through a 2-foot HDPE pipe. The storage tanks in the baseball fields will utilize open curb cuts, one along Canal Blvd and one along Navarre Ave. The storage tank in the parking lot will be rectangular with an area of 9,744 sq ft and will discharge into an orifice at ground level and then drain back to the existing system using a 6-inch and 15-inch pipe. **Figure 4-27** shows the graphical representation of the subsurface modular storage tanks. All tanks will be 4.5 ft deep with 92% void space and have 2.0 ft of soil cover. The volume of storage added from this project is about 974,000 cu ft. **Appendix H** provides the PC SWMM model for this alternative.



**Figure 4-27. Subsurface Modular Storage at Delgado Baseball Field**

In this area, the deepest flooding in the 10-year storm is about 1 ft at the intersection of General Diaz St and Navarre Avenue. According to the existing model, water ponds in this intersection for about 3.5 hours during the peak of the storm before it drains away. **Figure 4-28** shows the flood reduction maps for the 1-year and the 10-year storm events. The flood reduction map for the 25-year storm event is in **Appendix I**.



**Figure 4-28. Delgado Baseball Field Subsurface Modular Storage Flood Reduction for 1-Year (Right) and 10-Year (Left) Storm Events**

### 4.5.2 Homedale Street Alternative

A combination of permeable gutters and bioswales can be installed along Homedale St. The bioswales are along the entirety of Homedale St, from Canal St to West End Blvd. **Figure 4-29** shows the graphic representation of the permeable gutter segments. The depths of the bioswales are 4 ft and the length varies from block to block between 90 ft and 250 ft. The bioswale allows infiltration and storage for flooding while also recharging the groundwater and enhancing urban aesthetics. The permeable gutters on Homedale St do not follow the general approach. Due to the use of bioswales, the permeable gutters sit above the bioswales and the tank for the permeable gutters extends below the bioswale. Segments will be designed to varying lengths, as allowed by distance between tree canopies, and 6 ft deep between each intersection. The depth cover above each tank will range from 1.5 to 2 ft. Each segment will direct stormwater into an underground storage tank that is 6 ft deep with 92% void space. The volume of storage added from this project is about 90,000 cu ft. The storage tanks will drain back into the existing stormwater system through a 6-inch diameter pipe. The permeable gutters and bioswales will extend from the edge of the right-of-way to the boundary of on-street parking. **Appendix H** provides the PC SWMM model for this alternative. This project requires complete reconstruction of Homedale St.

In this area, the deepest flooding in the 10-year storm is about 1 foot at the intersection of Homedale St and Rosemary Pl. According to the model, water ponds in this intersection for about 3 hours during the peak of the storm before it can drain away. **Figure 4-30** shows the flood reduction maps for the 1-year and the 10-year storm events. The flood reduction map for the 25-year storm event is in **Appendix I**.

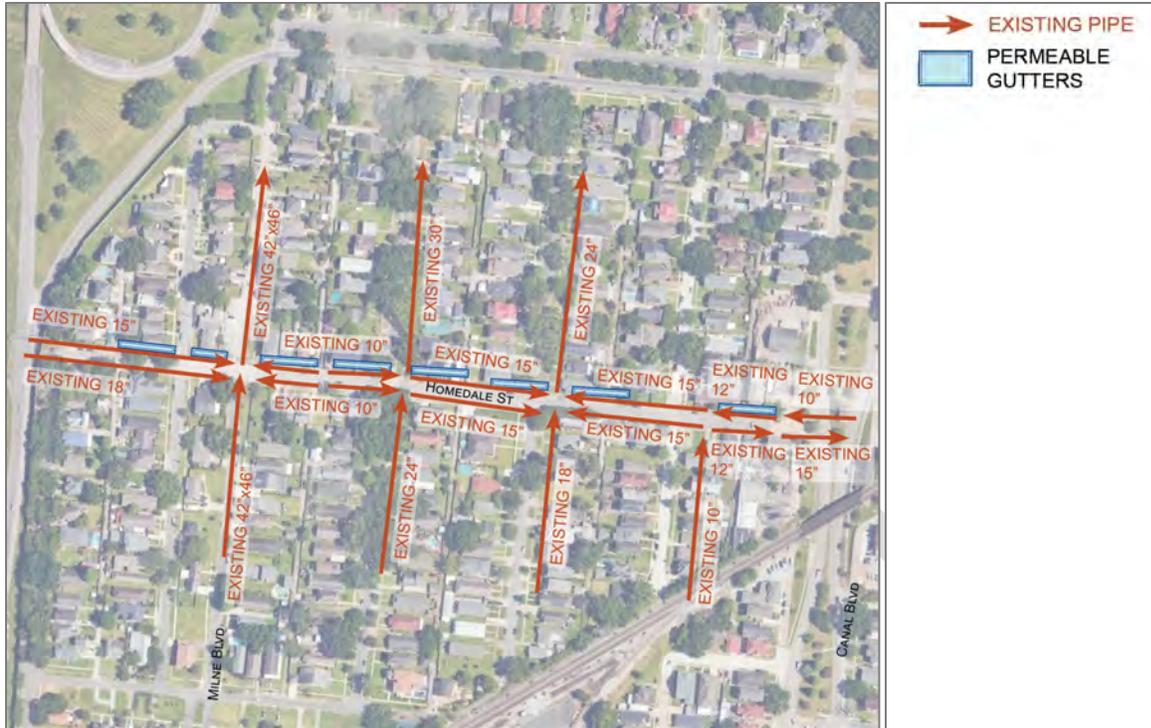


Figure 4-29. Permeable Gutters and Bioswales at Homedale Street



Figure 4-30. Homedale Street Permeable Gutters and Bioswales Flood Reduction for 1-Year (Right) and 10-Year (Left) Storm Events

### 4.5.3 Lakeview Playground Alternative

A modular storage tank can be used at Lakeview playground on General Diaz St. The storage tank will be rectangular with a width of 80 ft and a length of 140 ft. The tank will be 4.5 ft deep and have 92% void space with 2 ft of soil cover. There is minor tree cover in the park, and the tank will be positioned to avoid tree roots. **Figure 4-31** shows the graphical representation of the subsurface modular storage tank. Water will flow into the tank through a 1.25-foot HDPE pipe and will utilize open curb cuts along the north side of the park. There is no surface storage along with the modular storage tank. The storage will discharge into an orifice at ground level and then drain back to the existing system using a 6-inch pipe. **Appendix H** provides the PC SWMM model for this alternative.

In this area, the deepest flooding in the 10-year storm is about 1.3 ft at the intersection of General Diaz St and Weiblen Pl. According to the existing model, water ponds in this intersection for about 3.5 hours during the peak of the storm before it can drain away. **Figure 4-32** shows the flood reduction maps for the 1-year and the 10-year storm events. The flood reduction map for the 25-year storm event is in **Appendix I**.



**Figure 4-31. Subsurface Modular Storage at Lakeview Playground**



**Figure 4-32. Lakeview Playground Subsurface Modular Storage Flood Reduction for 1-Year (Right) and 10-Year (Left) Storm Events**

#### 4.5.4 Mound Avenue Alternative

A combination of improving the existing infrastructure, bioswales and modular tanks can be used along Mound Ave. The bioswales are along the south portion of Mound Ave, from intersection to intersection stopping at Rosemary Pl. **Figure 4-33** shows the graphical representation of the subsurface modular storage tank and bioswales. The depth of bioswales is 4.0 ft and the length varies from block to block. The bioswale allows infiltration and storage for flooding while also recharging the groundwater and enhancing urban aesthetics. The storage tank is located at McKay Park on Mound Ave with 1-foot cover. The tank will be 4.5 ft deep and have 92% void space. The volume of storage added from this project is about 150,000 cu ft. The tank will be positioned to avoid tree roots on the south side of the park. Water will flow into the tank through a 30-inch HDPE pipe and from the open bioswale that is along Mound Ave. The storage will discharge into an orifice at ground level and then will flow into a 15-inch pipe that will flow into a proposed 30-inch pipe that will run from the storage tank down Rosewood Alley to Homedale St, down Homedale St towards Canal St where it will enter the existing system on Canal St. The existing infrastructure along Homedale St will be modified to adjust for the proposed 30-inch pipe. **Appendix H** provides the PC SWMM model for this alternative.

In this area, the deepest flooding in the 10-year storm is about 1 ft at the intersection of Mound Ave and Rosemary Pl. According to the model, water ponds in this intersection for about 2 hours during the peak of the storm before it can drain away. **Figure 4-34** shows the flood reduction maps for the 1-year and the 10-year storm events. The flood reduction map for the 25-year storm event is in **Appendix I**.

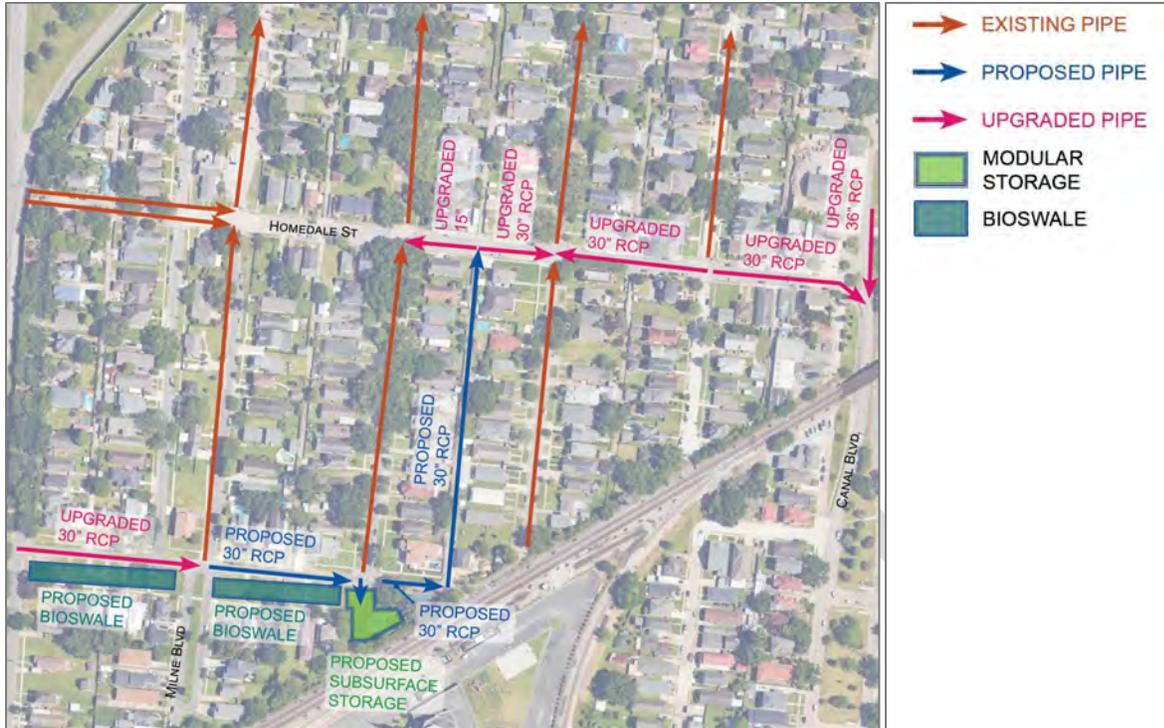


Figure 4-33. Subsurface Modular Storage and Bioswales at Mound Avenue



Figure 4-34. Mound Avenue Subsurface Modular Storage and Bioswales Flood Reduction for 1-Year (Right) and 10-Year (Left) Storm Events

### 4.5.5 Navarre Avenue Alternative

The neighborhood north of Navarre Ave experiences significant flooding, with many streets experiencing 2 ft of flooding. The railroad north of Navarre Ave creates a barrier/berm. North of the railroad, the flooding drops significantly when compared to south of the railroad. To help alleviate this, an alternative is adding permeable gutters to streets throughout this neighborhood. This includes Navarre Ave, Hidalgo St, Pontalba St, Marshall Foch St, Dale Ct, North Park, and Florida Blvd. The permeable gutters will extend from the edge of the right of way to the edge of the on-street parking. Some permeable gutters do not contain the same amount of storage as others, and this is due to the varying number of trees on each street. Excessive trees limit the number of permeable gutters that can be used. The storage deep and equivalent void space is consistent across all streets, with the depth being at 3.5 ft and the void space being 92%. The volume of storage added from this project is about 102,000 cu ft. The depth of cover for each tank varies between 1.5 through 2 ft deep. The storage tanks drain through a 6-inch diameter pipe back into the existing system. **Figure 4-35** shows the graphical representation of the subsurface permeable gutter segments. **Appendix H** provides the PC SWMM model for this alternative.

In this area, the deepest flooding in the 10-year storm is about 2.26 ft at the intersection of Marshall Foch Street and Homedale Street. According to the existing model, water ponds in this intersection for about 9 hours during the peak of the storm before it can drain away. **Figure 4-36** shows the flood reduction maps for the 1-year and the 10-year storm events. The flood reduction map for the 25-year storm event is in **Appendix I**.

This alternative would also be impacted by the prospective project below, see **Section 4.5.7**. This project has the potential to hold a significant amount of space for surface storage or a combination of surface and subsurface storage. Routing excess flooding from the neighborhood to this area would greatly reduce the stress on the existing system and would augment the permeable gutters and increase their effectiveness.

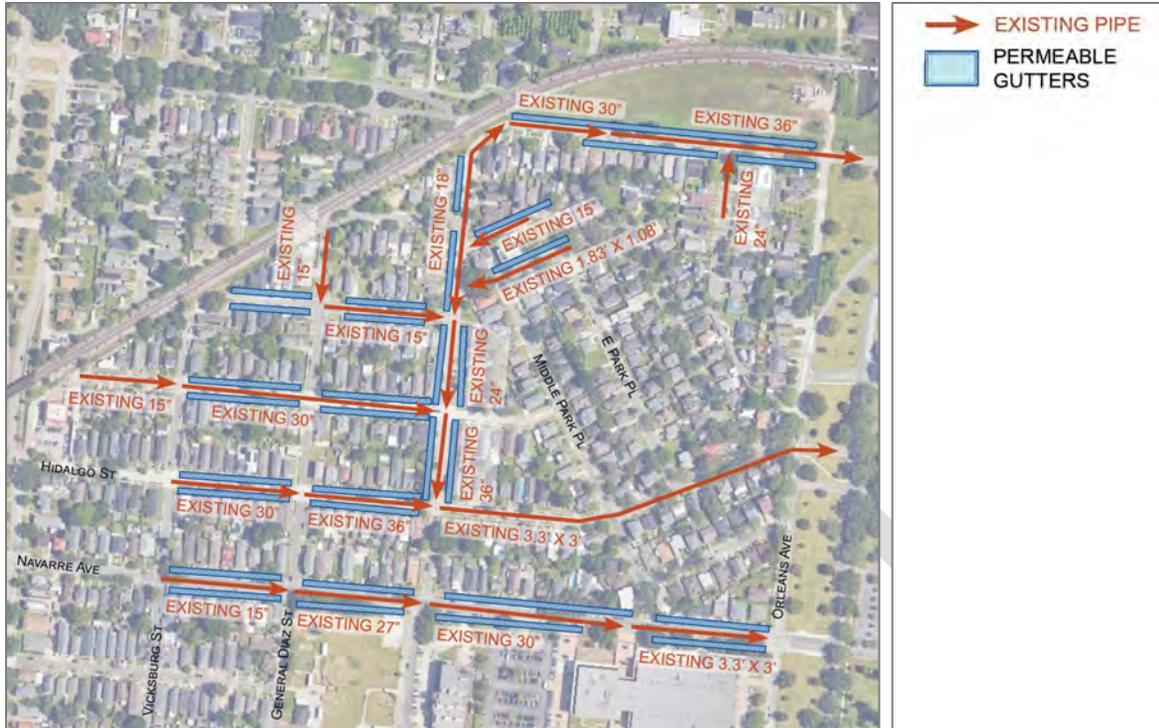


Figure 4-35. Permeable Gutters at Navarre Avenue

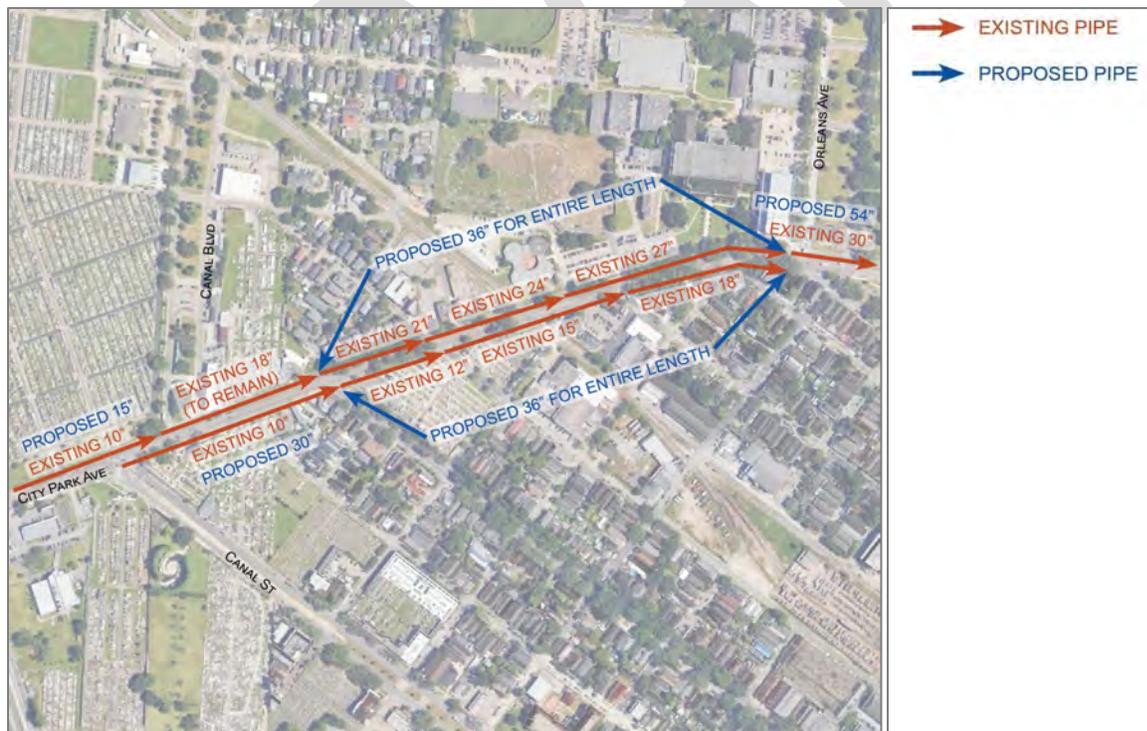


Figure 4-36. Navarre Avenue Permeable Gutters Flood Reduction for 1-Year (Right) and 10-Year (Left) Storm Events

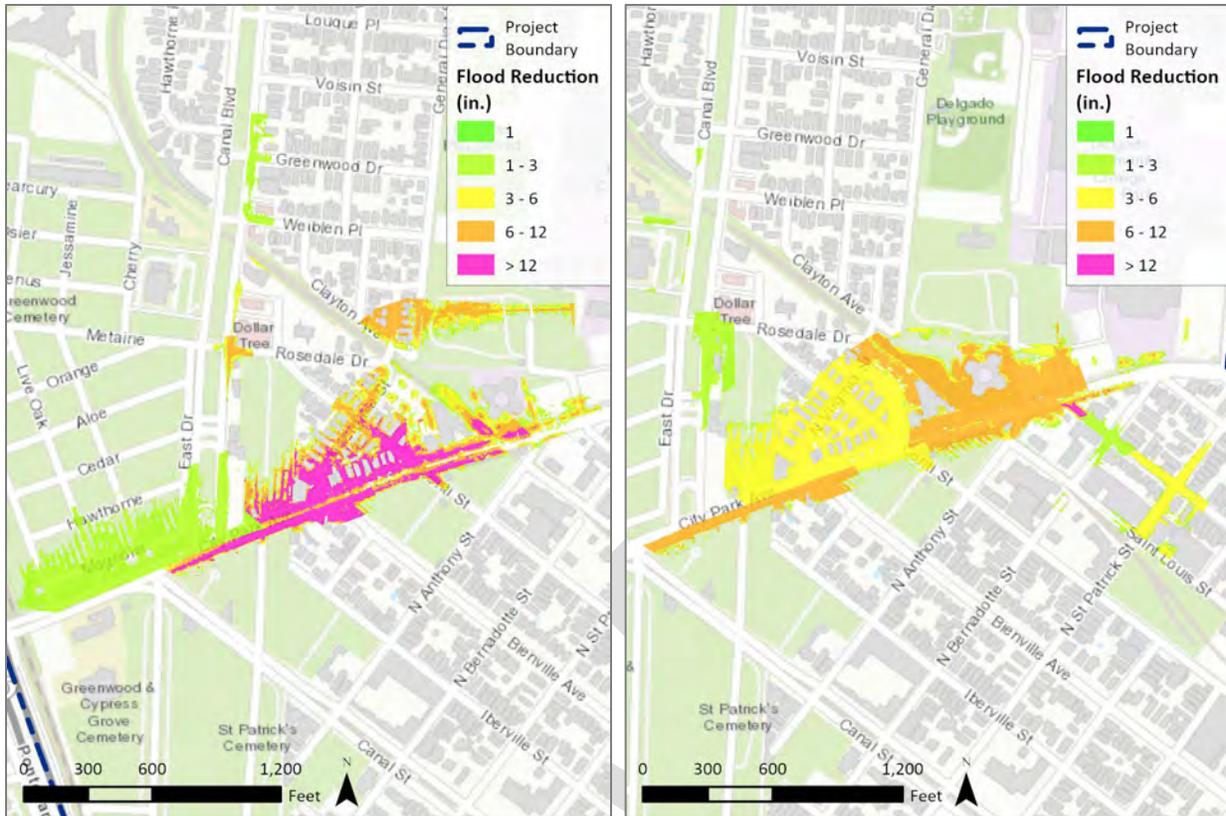
### 4.5.6 City Park Avenue Alternative

An alternative includes upsizing the existing infrastructure along City Park Ave. This is a well-used street, with an entrance/exit to I-10 being the start of the street and having Canal St begin shortly after the Interstate's entrance/exit. In addition, it leads to City Park neighborhood, Delgado Community College, and the Navarre Neighborhood. This project does not follow the general approach, as the methods in the general approach are not conducive to providing flood mitigation for this area. The current drainage system of City Park Ave utilizes pipes with diameters ranging from 18 to 30 inches and flows into a 28.1 ft by 12.9 ft box in the median of Orleans Ave and Marconi Dr. The project increases the diameter of the pipes to 15 inches and 30 inches in some areas then 36 inches until they meet the box on Orleans Ave and Marconi Dr. Increasing the pipe diameter would also require the invert elevation of the existing manholes to be lowered in certain locations to maintain a minimum cover of 2 ft. This project should be built in conjunction with other projects to eliminate downstream adverse effects, as increasing the pipe diameters will allow the water to move through the system faster, which may cause flooding further downstream. The model shows an increase in flooding along Orleans Ave and Marconi Dr when this alternative was solely applied. **Figure 4-37** shows the graphical representation of the upsizing of the existing infrastructure. **Appendix H** provides the PC SWMM model for this alternative.

In this area, the deepest flooding in the 10-year storm is about 2.2 ft at the intersection of City Park Ave and St Louis St. According to the model, water ponds in this intersection for about 3.5 hours during the peak of the storm before it can drain away. **Figure 4-38** shows the flood reduction maps for the 1-year and the 10-year storm events. The flood reduction map for the 25-year storm event is in **Appendix I**.



**Figure 4-37. Upsizing Existing Infrastructure along City Park Avenue**



**Figure 4-38. City Park Avenue Area Upsizing Existing Infrastructure Flood Reduction for 1-Year (Right) and 10-Year (Left) Storm Events**

#### 4.5.7 Prospective Project

An alternative was suggested by the City of New Orleans. This alternative was not evaluated throughout the project and in this report due to its proposed location on privately owned land. **Figure 4-39** illustrates the proposed site. Recently, the property owner has initiated discussions with the City of New Orleans concerning a potential transfer of ownership, which would convert the area into public land. At this time, no project has been developed for the site, unlike those outlined in previous sections.

The project location sits at a higher elevation than its neighborhood to the south, with elevation increasing until the right-of-way of the railroad tracks. The elevation next to the right-of-way is approximately 2.0 ft NAVD88, while the adjacent street elevation is approximately -6.0 ft NAVD88. The total area is approximately 3.3 acres and could potentially be the site of a modular storage tank that holds approximately 140,000 cu ft of stormwater. This will significantly reduce flooding in the area with amount of water it can hold which will in turn help reduce stress on the system and allow the pump station to better drain the area during large rain events. Currently, residents are using this location to park their cars. This area at the location is large and a portion of the it could be still be reserved for this use.



**Figure 4-39. Potential Area for a Prospective Modular Storage Tank Project**

## 4.6 All Combined Improvements

The all-combined improvements scenario represents a comprehensive integration of all alternatives across the project area. This unified approach leverages multiple interventions including subsurface modular storage tanks, stormwater parks, permeable gutters, and existing infrastructure upsizing.

**Figure 4-40** illustrates the location of these alternatives. Together, these measures aim to boost connectivity, expand water retention capacity, and reduce localized flooding during major storms. Key proposed projects of the scenario include:

- **Subsurface Modular Storage Tanks:** proposed beneath sites such as Gravier Park, the RTA parking lot, Warren Easton Jr High School’s athletic field, and other strategic locations. These tanks range in depth up to 4.5 ft, maintain a 92% void ratio, and are designed to collect and temporarily store large volumes of runoff with minimal impact to surface use.
- **Stormwater Parks:** proposed with engineered surface depressions and subsurface basins, stormwater parks such as the one at Warren Easton Jr High enhance infiltration, delay peak flows, and offer adaptable public space.
- **Permeable Gutters:** proposed along targeted corridors including Baudin St, D’Hemecourt St, and Ulloa St. These systems reduce surface runoff and promote infiltration. Underground storage integrated beneath permeable surfaces capture water and slowly release it into the broader drainage system.
- **Existing Infrastructure Upsizing:** Strategic pipe improvements ensure hydraulic connectivity between conveyance zones, allowing stormwater to redistribute and balance within the network. This improves overall system performance and reduces overload on vulnerable nodes.

Together, these improvements form an interconnected GSI network that supports long-term resilience. The scenario not only mitigates flooding but also aligns sustainability goals, promotes multi-functional urban space use, and strengthens the city’s capacity to adapt to future climate-driven events. **Figure 4-41** through **Figure 4-43** show the flood extent and flood reduction maps with all combined alternatives

integrated at 1-year, 10-year, and 25-year storm events. **Appendix J** provides a list of expected flooded streets during the 10-year storm when all improvements are implemented.

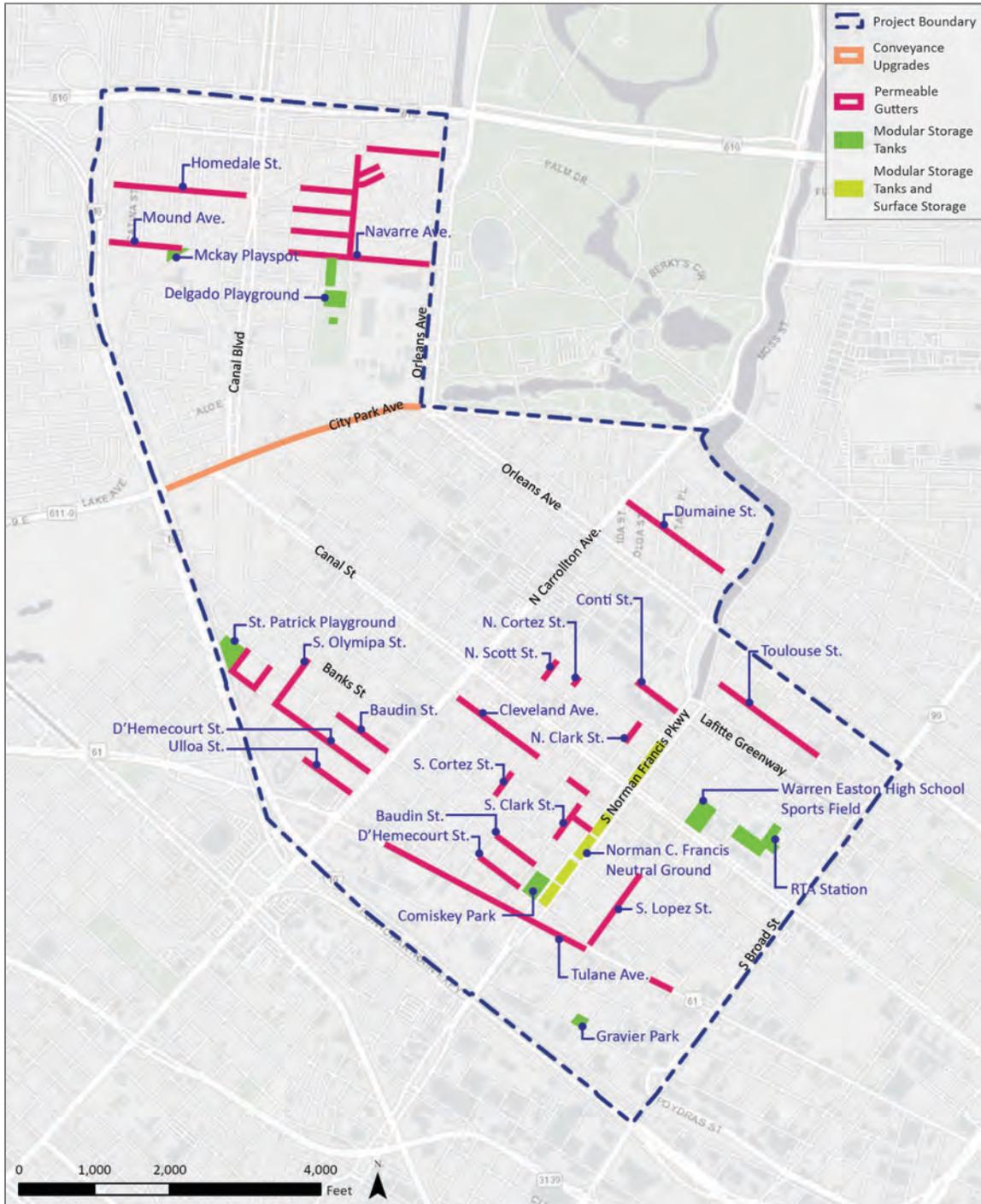


Figure 4-40. All combined Alternatives

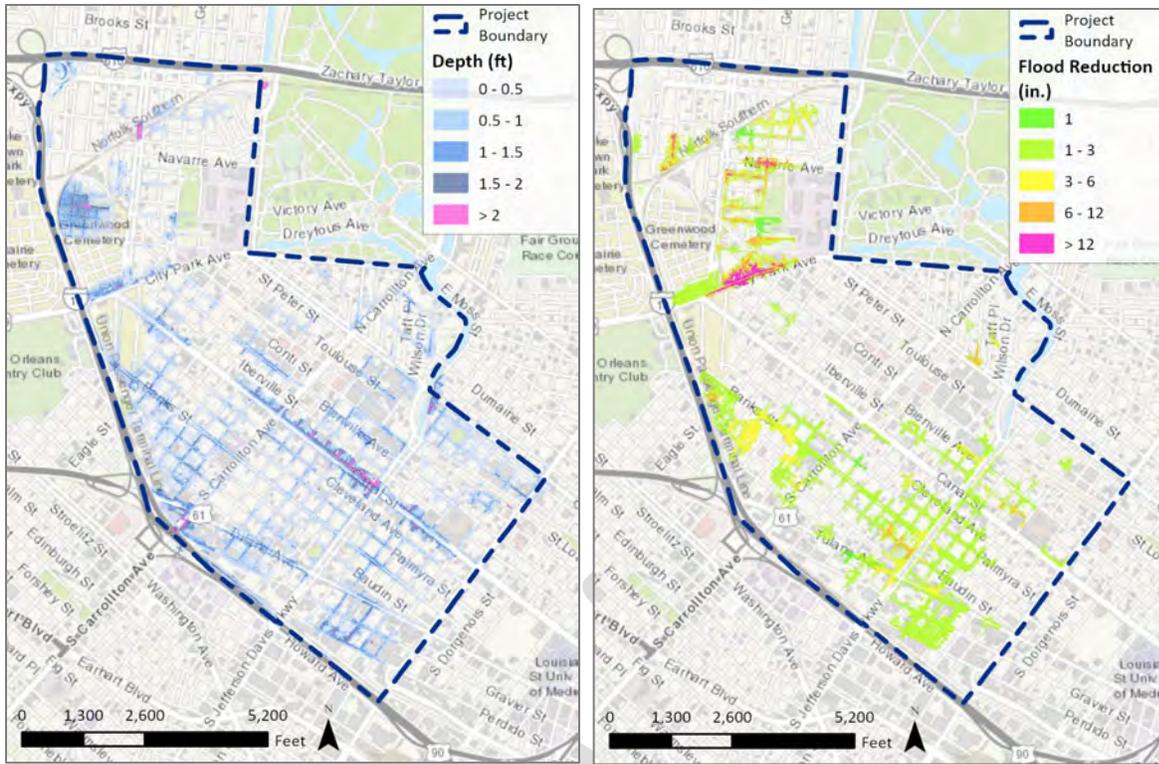


Figure 4-41. Flood Extent (Right) and Flood Reduction (Left) with All Combined Improvements at 1-Year Storm Event

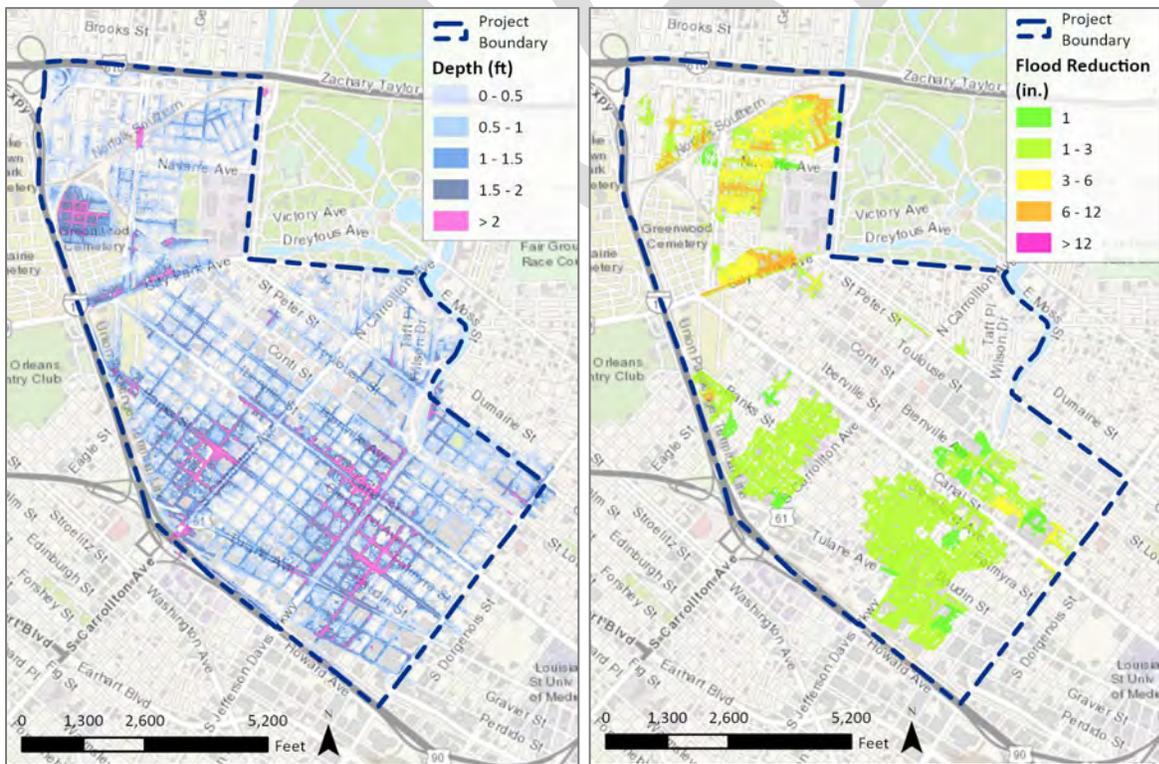


Figure 4-42. Flood Extent (Right) and Flood Reduction (Left) with All Combined Improvements at 10-Year Storm Event

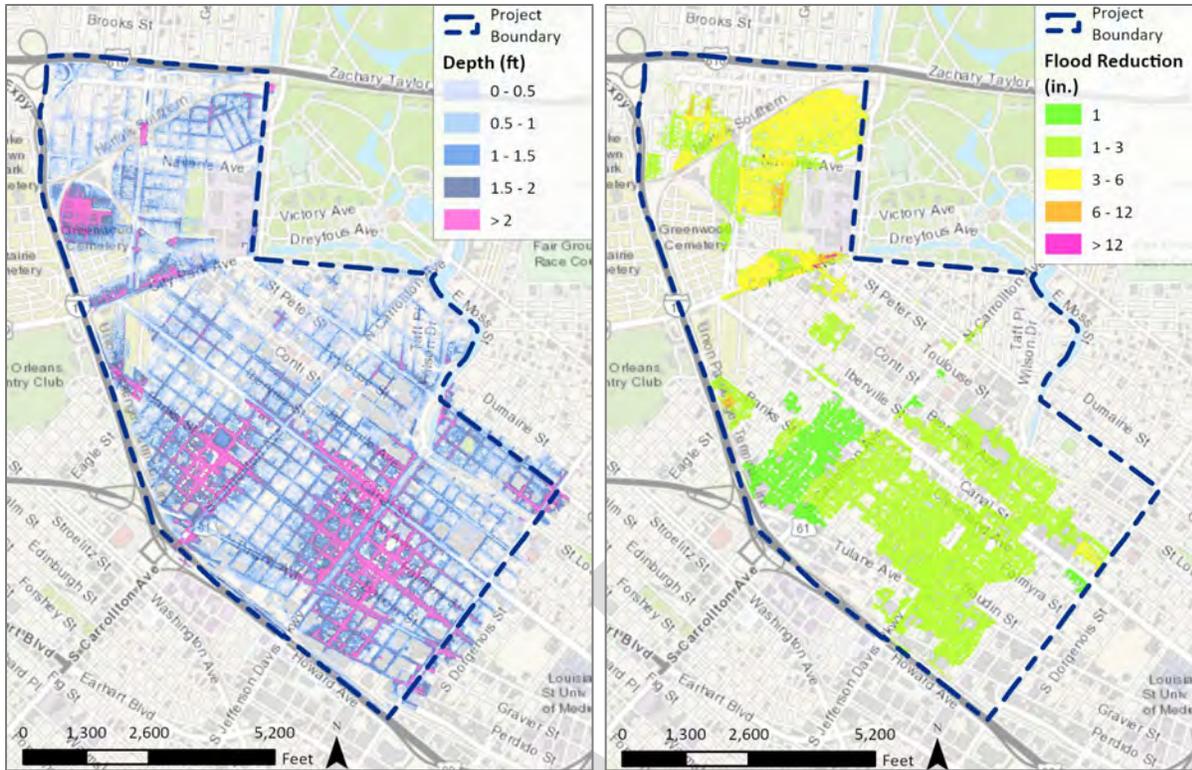


Figure 4-43. Flood Extent (Right) and Flood Reduction (Left) with All Combined Improvements at 25-Year Storm Event

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## 5.0 Recommendations and Conceptual Design

### 5.1 Recommendations

#### 5.1.1 Total Green Infrastructure Complexity Score

The suitability scoring system is designed to evaluate the appropriateness of a site for green and grey infrastructure improvements. The GIS-based model analyzed the following attributes: tree species, park and school open space, neutral grounds, utilities, topography, and roadways. The scoring, known as the GI complexity index, generally ranged from 0 to 6, where sites with lower scores were considered less complex to implement green and grey infrastructure improvements. The scores of each category are then combined to get the site's total complexity score. Below are descriptors of each criterion for the categories and rationale for the assigned numerical values.

The final suitability score for a site was a tally of each of the values of the input data within the project boundary drawn.

##### 5.1.1.1 Tree Suitability Criteria

The suitability calculation for a site considers existing trees on public property within a 20-foot buffer of the drawn project boundary. This 20-foot buffer is reflective of the areas that benefit from the effect of a tree, such as cooling and transpiration. Existing trees were scored based on the following criteria:

- Origin – Whether they are native, non-native, or invasive. Native trees scored a 6 as they are desirable species to retain. Non-native trees that have adapted to our climate scored a 3, and invasive species scored a zero.
- Location – Size of the right-of-way in which they are planted, with more open space receiving the most favorable scores as it is likely that the project intervention could avoid conflicts with the tree.
- Their flood tolerance – Tree species that are adapted to withstand periods of inundation received a more favorable score as they are more suited to being in GSI facilities.

##### 5.1.1.2 Park Suitability Criteria

The suitability calculation for a park site considers the size and on-site programmatic elements such as open fields, playground structures, paved courts, covered courts, buildings, and pools. A 10-foot buffer was applied in the model around the park features. Parks with certain features, such as a building or covered court, received less favorable scores, as they made the site more challenging for implementing infrastructure improvements. However, parks with large open fields received highly favorable scores as the sites are ideal for large-scale green and gray infrastructure improvements.

##### 5.1.1.3 School Open Space Suitability Criteria

The suitability of school sites is determined similarly to parks, based on the size of the open space and the on-site programmatic elements. Schools were also scored based on whether they are public or

private schools. Public schools scored more favorably than private schools, due to the complexity of completing a public project on privately owned land.

#### **5.1.1.4 Neutral Ground Suitability Criteria**

The suitability calculation for neutral grounds considered the size and on-site programming of the open space. Large open spaces scored more favorably than smaller open spaces. On-site programmatic elements were evaluated in a similar fashion to park and school open space. Streetcar lines were a unique element to neutral grounds, and when they were present, they score very unfavorably.

#### **5.1.1.5 Utility Suitability Criteria**

The suitability calculation for a site was scored based on existing utilities. Utilities were evaluated based on the type of utility and its size. Types of utilities included in the scoring were electrical, gas, fiber optics (when available), sewer, drainage, and water lines. Buried electrical, gas, and fiber optic lines had a score of 3, while sewer and water lines had no impact on the score. This was due to the typical depth of sewer and water lines typically falling below the limits of GSI improvements. If a project site had no drainage lines, then it scored very favorably, as this provided an opportunity to install infrastructure and therefore reduce flooding.

Utility sizes were categorized into the following: local, minor, major, collector, arterial, or principal. Larger utilities received a less favorable score due to the complexity of working around the existing infrastructure.

#### **5.1.1.6 Topography Suitability Criteria**

The suitability calculation for a site considered its relative proximity and elevation as it related to major drainage infrastructure (pump stations). The proximity of a project site was assessed based on buffer distances at 600, 1,800, and 3,000 ft, with closer project sites receiving less favorable scores. This was because it is typically more beneficial to capture and detain stormwater in the middle of the drainage basin. In addition, the project site was scored based on its relative elevation to the major drainage infrastructure. Sites that are higher in elevation than pump stations have a more favorable score than sites that are below them. These evaluations prioritized sites that were most likely to have flooding issues based on topography and time it took stormwater to reach the pump station outfall.

#### **5.1.1.7 Road Suitability Criteria**

The suitability calculation for roadways was based on the condition of the pavement and the width of the right-of-way. Roadways that had new pavements were scored less favorably than roadways with pavements in very poor condition.

### **5.1.2 Improvements Prioritization**

The prioritization of the alternatives was determined using the average depth of flooding reduction produced by the project for the 10-year 24-hour design storm. The projects with the highest flood reduction were given the highest priority. The cost associated with each project is also included in the table. This was considered when prioritizing; however, this was not given priority over flood reduction values. **Table 5-1** shows the prioritization of the alternatives and the total GSI complexity score along with other project information.

**Table 5-1. Proposed Projects Prioritization Matrix**

Priority Rank	Project Name	Flood Depth Reduced (Inch)	Total GSI Complexity Score	Cost (\$M)	Flood Volume Reduced (ac ft)	Flood Volume Reduced (MG)	Flood Footprint Reduction (ac)	Flood Volume Reduced/Cost (M\$/ac ft)	Flood Depth Reduced/Cost (M\$/inch)
1	Upsizing Conduits along City Park Ave	5.30	311	21.00	8.72	2.40	20.00	2.41	3.96
2	Bioswale and Modular Storage at Mound Park w Pumping	4.40	55	26.00	3.05	1.00	8.30	8.52	5.91
3	Modular Storage Tank at Delgado Park	3.80	13	43.00	15.93	4.40	50.70	2.70	11.32
4	Permeable Gutters along Homedale St	3.40	88	9.50	1.12	0.31	4.00	7.02	2.32
5	Modular Storage at RTA Parking and Warren-Easton	3.30	3	32.00	6.91	2.25	25.00	4.63	9.70
6	Modular Storage Tank at St Patrick Playground	2.40	19	13.70	1.24	0.40	6.00	11.05	5.71
7	Modular Storage at Gravier Park	1.55	18	4.90	0.85	0.27	7.00	5.77	3.16
8	Modular Storage along Norman C Francis	1.23	62	19.50	2.80	0.91	27.00	6.96	15.85
9	Permeable Parking in Navarre Neighborhood	1.10	202	17.40	1.22	0.34	12.70	13.81	15.27
10	Modular Storage Tanks at Lakeview Park Playground	1.00	43	3.50	0.39	0.11	4.40	8.97	3.50
11	Permeable Gutters near Dumaine St	0.55	55	4.30	0.39	0.11	8.00	11.02	7.82
12	Modular Storage Tank at Comiskey Park	0.38	17	10.00	3.74	1.10	120.00	2.67	26.32
13	Permeable Gutters near Bienville St	0.18	68	1.90	1.03	0.30	69.00	1.84	10.56
14	Permeable Gutters along Baudin Ave	0.16	184	6.00	1.15	0.40	88.00	5.23	37.50
15	Permeable Gutters along Tulane Ave	0.15	234	4.50	0.64	0.18	51.00	7.00	30.00
16	Permeable Gutters near Toulouse St	0.13	29	2.00	1.31	0.36	117.00	1.53	15.38
17	Permeable Gutters near Banks St	0.12	219	4.60	0.57	0.16	55.00	8.02	38.33
18	Permeable Gutters near S Lopez St	0.12	58	9.70	0.34	0.10	35.00	28.17	80.83

## 5.2 Conceptual Design

The 10% conceptual design drawings for the improvements and GSI proposed for the project, including general notes, are presented in **Appendix K**.

## 5.3 Conceptual Opinion of Probable Construction Cost

The conceptual opinion of probable construction cost (OPCC) developed for this study is at an Estimate Class 4 level as defined by AACE International (formerly the Association for the Advancement of Cost Engineering). This estimate class is typical for projects at the concept or feasibility phase of project definition. Quantities and unit costs to develop the OPCC are presented in Appendix J. Unit costs were developed from the proposed projects discussed in **Section 4**. Where available, costs were compared with industry standard unit cost references and adjusted using engineering judgement. The expected accuracy of Class 4 estimates can range from -30% to +50%. Actual construction costs are largely dictated by market conditions at the time of bidding. CDM Smith cannot guarantee that bids and actual costs will not vary from the OPCC presented in this section. In addition, the OPCC does not include costs for change orders, the City's administrative costs, land acquisition, easement acquisition, financing or funding costs, legal fees, or any other costs that would not be specifically part of a contractor's scope of work. **Table 5-2** summarizes the cost estimates, while additional details and quantities are provided in **Appendix L**.

**Table 5-2. Conceptual Opinion of Probable Construction Cost for the Alternatives**

Project	Total (\$M)	Construction (\$M)	Design (\$M)	Field Investigations (\$M)
Tulane Street Project	\$3.7	\$3.2	\$0.41	\$0.012
Dumaine Street Project	\$4.4	\$3.9	\$0.47	\$0.016
Comiskey Playground Project	\$10.1	\$9.1	\$0.96	\$0.026
Norman C Francis Project	\$19.5	\$17.8	\$1.6	\$0.082
Warren Easton/Regional Transit Authority Project	\$32.1	\$28.8	\$3.2	\$0.097
Gravier Park Project	\$4.9	\$4.4	\$0.52	\$0.034
S Lopez Street Project	\$9.7	\$8.8	\$0.92	\$0.030
Toulouse Project	\$2.3	\$2.05	\$0.28	\$0.000
St. Patrick Playground Project	\$13.7	\$12.5	\$1.2	\$0.028
Baudin Street Project	\$6.3	\$5.6	\$0.64	\$0.028
Bienville Street Project	\$1.9	\$1.7	\$0.24	\$0.008
Banks Street Project	\$4.7	\$4.2	\$0.51	\$0.015
Delgado Baseball Field Project	\$43.1	\$39.9	\$3.1	\$0.081
Homedale Street Project	\$9.5	\$8.6	\$0.91	\$0.017
Lakeview Playground Project	\$3.5	\$3.09	\$0.39	\$0.021
Mound Ave Project	\$26.2	\$24.1	\$2.3	\$0.048
Navarre Avenue Project	\$17.4	\$15.8	\$1.5	\$0.069
City Park Avenue Project	\$21.1	\$19.2	\$1.7	\$0.066





# 6.0 Implementation Determination

## 6.1 Phasing

It is recommended that some alternatives discussed in **Section 4** be completed in phases or in conjunction with other projects. **Table 6-1** describes what implementation schedule is recommended for each project.

**Table 6-1. Recommended Implementation Schedule for the Proposed Projects**

Project	Implementation	Details
Banks St	Single-Phase Project	<ul style="list-style-type: none"> <li>Project complexity is low and can be completed as a stand-alone, single-phase project.</li> </ul>
Baudin St	Single-Phase Project	<ul style="list-style-type: none"> <li>Project complexity is low and can be completed as a stand-alone, single-phase project.</li> </ul>
Bienville St	Single-Phase Project	<ul style="list-style-type: none"> <li>Project complexity is low and can be completed as a stand-alone, single-phase project.</li> </ul>
City Park Ave	Complete in conjunction with other project	<ul style="list-style-type: none"> <li>Project should be completed in conjunction with a different project that adds storage nearby to ensure that the conveyance upgrades don't push flooding downstream on City Park Ave.</li> <li>It is preferred that this project be completed in conjunction with the Mound or Delgado projects but pairing it with Homedale or Lakeview is also acceptable.</li> </ul>
Comiskey Playground	Single-Phase Project	<ul style="list-style-type: none"> <li>Project complexity is low and can be completed as a stand-alone, single-phase project.</li> </ul>
Delgado Baseball Fields	Multi-Phase Project	<ul style="list-style-type: none"> <li>This project's cost and high complexity make a multi-phase approach favorable to a single-phase project.</li> <li>Coordination with Delgado Community College will be required.</li> <li>There are three locations where the modular storage is being installed; both baseball fields and a parking lot located directly south of both fields.</li> <li>Phase-one includes the parking lot</li> <li>Phase-two includes Kirsch Ronney Stadium</li> <li>Phase-three includes Delgado Playground and baseball field.</li> <li>The parking lots use, and importance is unknown. If the parking lot needs to always remain useable, this limits how much of the parking lot can be demolished and under construction at a given time.</li> </ul>
Dumaine St	Single-Phase Project	<ul style="list-style-type: none"> <li>Project complexity is low and can be completed as a stand-alone, single-phase project.</li> </ul>
Gravier Park	Single-Phase Project	<ul style="list-style-type: none"> <li>Project complexity is low and can be completed as a stand-alone, single-phase project.</li> </ul>
Homedale	Single-Phase Project	<ul style="list-style-type: none"> <li>Project complexity is low and can be completed as a stand-alone, single-phase project.</li> </ul>
Lakeview Playground	Single-Phase Project	<ul style="list-style-type: none"> <li>Project complexity is low and can be completed as a stand-alone, single-phase project.</li> </ul>

Project	Implementation	Details
Mound Ave	Multi-Phase Project	<ul style="list-style-type: none"> <li>▪ Project's high complexity makes a multi-phase approach favorable to a single-phase project.</li> <li>▪ The modular storage proposed under McKay Park should be constructed as phase-one.</li> <li>▪ Phase-two will focus on constructing the bioswale along Mound Ave.</li> <li>▪ Phase-two will require coordination with the property owners along Mound Ave since their driveways will be blocked by the Bioswale construction.</li> <li>▪ All conveyance upgrades can be completed in phase three of the project.</li> <li>▪ It is important that the conveyance upgrades are completed as the final phase in the multi-phase approach so not to push flooding downstream.</li> </ul>
Norman C Francis	Single-Phase Project	<ul style="list-style-type: none"> <li>▪ Project complexity is low and can be completed as a stand-alone, single-phase project.</li> </ul>
South Lopez St	Single-Phase Project	<ul style="list-style-type: none"> <li>▪ Project complexity is low and can be completed as a stand-alone, single-phase project.</li> </ul>
St. Patrick Park	Single-Phase Project	<ul style="list-style-type: none"> <li>▪ Project complexity is low and can be completed as a stand-alone, single-phase project.</li> </ul>
Toulouse St	Single-Phase Project	<ul style="list-style-type: none"> <li>▪ Project complexity is low and can be completed as a stand-alone, single-phase project.</li> </ul>
Tulane St	Single-Phase Project	<ul style="list-style-type: none"> <li>▪ Project complexity is low and can be completed as a stand-alone, single-phase project.</li> </ul>
Warren Easton/Regional Transit Authority	Multi-Phase Project	<ul style="list-style-type: none"> <li>▪ Project cost and high complexity make a multi-phase approach favorable to a single-phase project.</li> <li>▪ The modular storage being installed under Warren Easton field should be constructed as phase-one.</li> <li>▪ Phase-two will focus on installing the modular storage under the RTA.</li> <li>▪ Coordination with the RTA will be required to see if phase two needs to be further divided into two phases.</li> <li>▪ The RTA Facility and parking lot must always remain usable, limiting how much of the parking lot can be demolished and under construction at a given time.</li> </ul>

## 6.2 Operations and Maintenance

Field visits, anecdotal evidence, and modeling identified several drainage infrastructure challenges that were created or exacerbated due to a lack of maintenance of the system. It is recommended that the City and SWBNO develop a Standards of Practice for the maintenance of stormwater drainage infrastructure that includes asset management, frequency of inspection and maintenance, as well as guidance on maintenance activities. Details to be provided in **Appendix M**

## 6.3 Funding

A matrix of available funding resources is included in **Appendix N**. The matrix includes federal and state opportunities for funding relevant GSI and stormwater management projects. The matrix also contains information such as type of funding, eligible applicants, types of eligible projects and websites to

request further information. The following potential sources of funding for the City of New Orleans to consider were identified.

### *Most Applicable Source*

The Clean Water State Revolving Loan Fund (CWSRF) program administered by the Louisiana Department of Environmental Quality (LDEQ) is one of the most applicable sources of funding for the projects identified in this study.

Loans provided by the CWSRF Program may be used for the construction of projects associated with water quality improvements, including GSI projects, wastewater treatment facilities, water efficiency projects, non-point source (NPS) projects, stormwater activities, subsurface remediation, planning and design, refinancing of eligible existing debt, and many other project types. The LDEQ CWSRF has a requirement to add a GSI project to the program annually and is often seeking candidate projects to fulfill this criterion. The program provides loans at varying rates, but they are typically below market interest rates with a 30-year maximum term loan. The CWSRF also can provide principal forgiveness funds (aka grants) for specific projects meeting key criteria.

### *Eligibility to Clean Water State Revolving Loan Fund Program*

The LDEQ CWSRF program funds structural and non-structural non-point source (NPS) projects that reduce polluted runoff for urban and agricultural land. The CWSRF program can fund:

- Urban stormwater control projects
- Agricultural best management practices (BMPs) implementation
- Conservation easements for source water protection
- Stream bank erosion control
- Wetlands in place to polish effluent
- GSI
- Innovative green projects
- Total/integrated water resources management planning and resulting structural projects; decentralized wastewater needs
- Dam rehabilitation

### *Research, Planning and Design*

The CWSRF program can provide funding for planning, land acquisition, design and construction activities. For purposes of stormwater drainage studies, watershed restoration planning, water reclamation and reuse projects, water recycling, water reuse, and diversifying the water supply, the US Bureau of Reclamation offers several grants that focus on planning. Typically, states or other organizations with water or power delivery authority are eligible applicants. It is possible to coordinate these with EPA or FEMA grants as well.

### *Federal Cross-Cutters*

The use of federal funds must meet specific federal regulatory requirements that often come with additional administrative requirements and project cost impacts related to the State Revolving Fund (SRF) programs. The following list of regulations applies to all projects funded through any SRF programs:

- Build America, Buy America Act (BABAA)
- Davis Bacon (prevailing wages)
- American Iron and Steel (AIS)
- NEPA and Archeological and Historic Preservation Act
- Endangered Species Act
- Civil Rights and Equal Employment Opportunity, Neutrality in Contracts, and OSHA regulations
- Disadvantaged Business Enterprise subcontracting
- Architectural and Engineering Services Procurement
- Signage

Recent federal executive orders like the “Unleashing American Energy” and the passing of the One Big Beautiful Bill Act (OBBA) have adjusted and eliminated some federal programs that directly impacted mitigation programs. The priorities of FEMA and the EPA have been adjusted to align with the new Administration goals, thus resulting in the agencies moving away from programs created by the Inflation Reduction Act.

Additional opportunities for funding include programs such as WIFIA, and lenders like Green Banks, as identified in the matrix. Depending upon project phasing, budget, schedule, and timing of bond sale, bond funds may be more cost effective than these lending programs provided that the City has access to them.