Storm Drain Master Plan

April 2026 / FINAL

carollo

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Contents

CHAPTER 1 BACKGROUND

1.1 Introduction 1-1
1.2 Storm Drainage System Overview 1-1
1.3 Scope and Authorization 1-3
1.4 Report Organization 1-3
1.5 Acknowledgments 1-4
1.6 Reference Material 1-4

CHAPTER 2 STUDY AREA DESCRIPTION

2.1 Study Area 2-1
2.2 Planning Period 2-1
2.3 Climate and Topography 2-1
2.4 Land Use 2-5

CHAPTER 3 PLANNING AND EVALUATION CRITERIA

3.1 Hydrologic Criteria 3-1
- 3.1.1 Precipitation Characteristics 3-1
- 3.1.2 Design Storms 3-1
- 3.1.3 Ground Slope 3-2

3.2 Hydraulic Criteria 3-3
- 3.2.1 Hydraulic Analysis 3-3

3.3 Planning and Design Criteria Summary 3-3

CHAPTER 4 STORM DRAINAGE SYSTEM FACILITIES AND HYDRAULIC MODEL

4.1 System Overview 4-1
4.2 Existing Discharge Locations 4-1
4.3 Modeling Software 4-3
4.4 Hydrologic Model 4-4
- 4.4.1 Design Hydrographs 4-4
- 4.4.2 SWMM Hydrologic Unit (Sub-catchment) 4-4
- 4.4.3 Soil Characteristics 4-4

4.5 Hydraulic Model 4-9
- 4.5.1 Elements of the Storm Drainage Hydraulic Model 4-9
- 4.5.2 Hydraulic Model Update Process 4-9

4.6 Model Verification 4-10
- 4.6.1 Historical Rainfall Event Analysis 4-10

4.7 Flow Direction Map 4-11

CHAPTER 5 CAPACITY EVALUATION AND PROPOSED IMPROVEMENTS

5.1 Capacity Evaluation 5-1
5.2 Storm Drainage System Capacity Improvements 5-4
5.2.1 Capital Project Prioritization 5-4
5.2.2 10-Year Design Storm Improvements 5-4
5.2.3 50-Year Design Storm Improvements 5-7

CHAPTER 6 CONDITION ASSESSMENT AND REHABILITATION/REPLACEMENT PROGRAM

6.1 Storm Drainage System Condition Assessment 6-1
6.1.1 Closed-Circuit Television Inspection Findings 6-1
6.2 Condition Based Recommendations 6-6
6.2.1 Ongoing/Recommended Condition Assessment Strategy 6-7

CHAPTER 7 CAPITAL IMPROVEMENT PROGRAM

7.1 Project Prioritization 7-1
7.2 Capital Improvement Project Costs 7-1
7.3 Cost Estimating Accuracy 7-1
7.4 Construction Unit Costs 7-2
7.4.1 Pipeline Unit Costs 7-2
7.5 Project Costs and Contingencies 7-2
7.5.1 Baseline Construction Cost 7-3
7.5.2 Estimated Construction Cost 7-3
7.5.3 Capital Improvement Cost 7-3
7.6 Capital Improvement Implementation 7-4

Appendices

APPENDIX A SOIL RESOURCE REPORT
APPENDIX B STREET FLOW DIRECTION MAPS
APPENDIX C EXHIBIT MAPS

Tables

Table 2.1 Study Area Climate 2-1
Table 2.2 Land Use Summary 2-5
Table 3.1 Planning and Design Criteria Summary 3-4
Table 4.1 City-Owned Drains by Diameter 4-3
Table 4.2 Percent Impervious/Pervious Area by Land Use 4-6
Table 4.3 Infiltration Rates for NRCS Hydrologic Soil Groups 4-7
Table 5.1 10-Year, 24-Hour Design Storm Improvements 5-6
Table 5.2 50-Year, 24-Hour Design Storm Improvements 5-7
Table 6.1 NASSCO PACP Structural and O&M Grade Descriptions 6-2

Table 6.2	Summary of CCTV Condition Ratings for Main Trunk Sewer (PACP Scoring)	6-2
Table 6.3	System Condition Projects Summary	6-6
Table 7.1	Pipeline Construction Unit Costs	7-2
Table 7.2	Recommended Capacity Improvements	7-5

Figures

Figure 1.1	Regional Location Map	1-2
Figure 2.1	Master Plan Study Area	2-3
Figure 2.2	Topography	2-4
Figure 2.3	Land Use	2-6
Figure 3.1	Type 1 10-year and 50-year, 24-hour Design Storms	3-2
Figure 4.1	Modeled Storm Drainage System	4-2
Figure 4.2	Hydrological Soil Group	4-8
Figure 4.3	Classification of the Historical Rainfall Events	4-11
Figure 5.1	10-Year, 24-Hour Design Storm Deficiency	5-2
Figure 5.2	50-Year, 24-Hour Design Storm Deficiency	5-3
Figure 5.3	Proposed Capacity Improvements	5-5
Figure 6.1	Maximum Structural Grades from CCTV Inspection	6-4
Figure 6.2	Maximum O&M Grades from CCTV Inspection	6-5

Abbreviations

Carollo	Carollo Engineers
CCTV	closed-circuit television
CIP	Capital Improvement Program
City	City of Gardena
CMP	corrugated metal pipe
County	Los Angeles County
DCIA	directly connected impervious area
DDF	depth duration frequency
DEM	Digital Elevation Model
ENR	Engineering News-Record
°F	degrees Fahrenheit
General Plan	2023 General Plan
GIS	geographic information system
HGL	hydraulic grade line
lf	linear foot
Master Plan	Storm Drain Master Plan
NASSCO	National Association of Sewer Service Company
NOAA	National Oceanic and Atmospheric Administration
NPS	National Plant Services, Inc.
NRCS	Natural Resources Conservation Service
O&M	operations and maintenance
PACP	Pipeline Assessment and Certification Program
R&R	rehabilitation/replacement
RCP	reinforced concrete pipe
SCS	Soil Conservation Service
SWMM	Storm Water Management Model
USDA	United States Department of Agriculture

CHAPTER 1 BACKGROUND

This chapter provides a brief overview of the City of Gardena's (City) need for its first Storm Drain Master Plan, outlines the objectives of the Plan, and introduces the seven chapters that describe the storm drain system.

1.1 Introduction

The City is a diverse community located in the South Bay region of Los Angeles County (County), California. The City encompasses approximately 3,749 acres (with over 99 percent of that comprising land and 1 percent waterways) and has a population of around 61,000 as of the 2020 census—though more recent estimates (2025) indicate a slight decline to roughly 56,700. The City is bordered by the City of Los Angeles neighborhood of Harbor Gateway on the east and south, the City of Torrance on the southwest, the unincorporated community of Alondra Park on the west, the City of Hawthorne on the northwest, and the unincorporated community of Athens to the north. Figure 1.1 presents a regional location map of the City.

1.2 Storm Drainage System Overview

The storm drainage system includes City- and County-owned infrastructure, such as drainage pipes, manholes, and catch basins. Maintenance responsibility depends on ownership: the City maintains its facilities, while the County maintains its own.

The City currently provides storm drainage services to approximately 1,340 acres (about 2.10 square miles). The City drainage area is defined as the cumulative area of modeled sub-catchments that discharge to City-owned stormwater infrastructure. This area represents the portion of the watershed contributing runoff to the City’s existing stormwater conveyance system during storm events and used for the hydraulic capacity analysis.

The system consists of approximately 12 miles of City-owned pipes and 25 miles of County-owned pipes, along with manholes, open channels, and catch basins owned by both entities. The total number of County-owned catch basins is 577, while the City owns 240 catch basins. In addition, the system includes approximately 5.5 miles of the Dominguez Channel and 1.5 miles of open channel along 135th Street. City-owned pipe diameters range from 6 to 81 inches, with flows discharging to the County storm drain system, the Dominguez Channel, an open channel leading to the Dominguez Channel, and the Willows Wetlands at the southern end of the City. The Gardena Willows Wetland Preserve, located in the City’s southeast corner, covers approximately 13.6 acres in total, including 9.4 acres of wetland and 4.2 acres of upland habitat.

The scope of this study includes only City-owned infrastructure that is operated and maintained by the City. Unless specified otherwise, the current model and report will refer exclusively to City infrastructure throughout the remainder of this document.

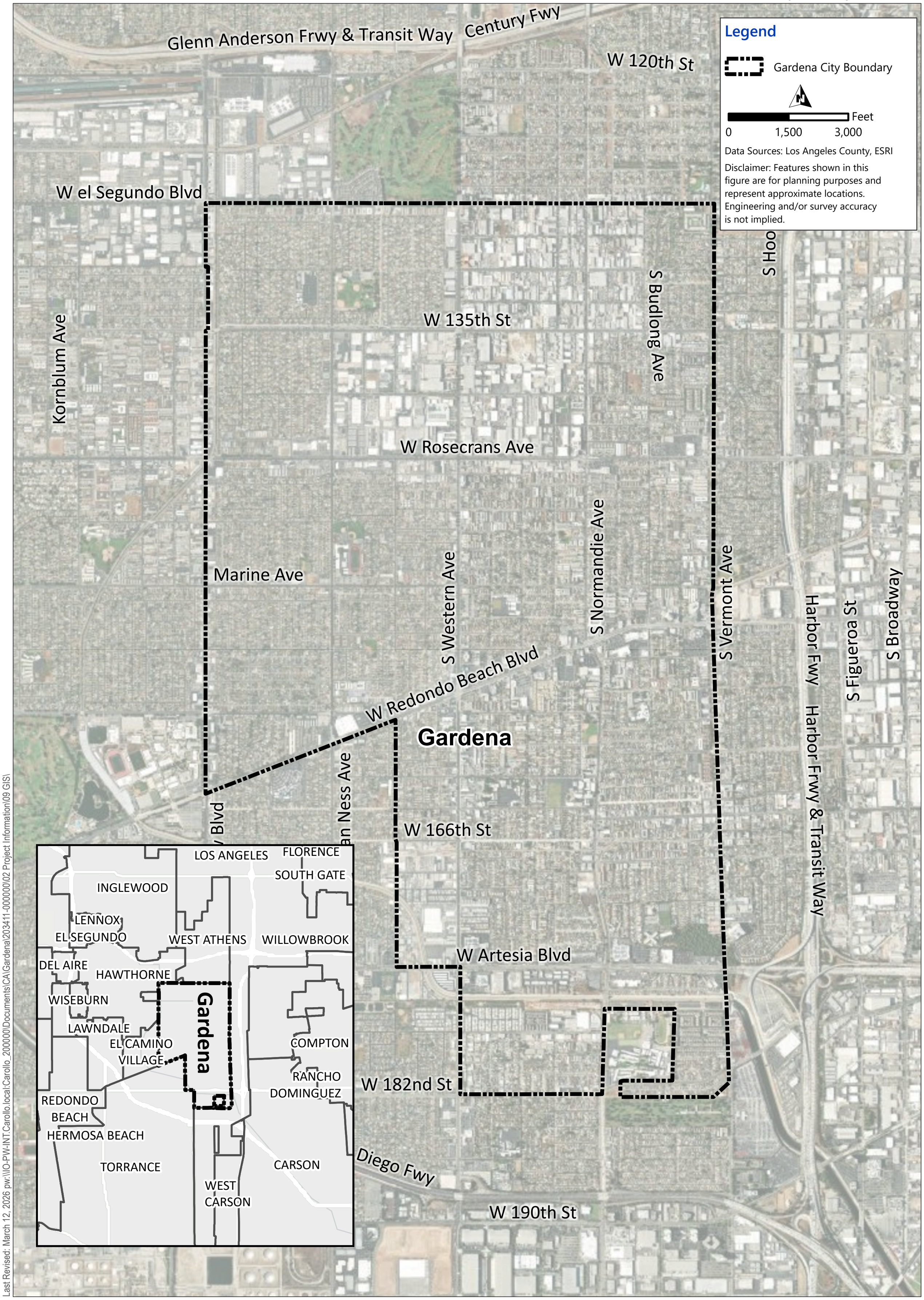

Figure 1.1 Regional Location Map

1.3 Scope and Authorization

The purpose of this Master Plan is to identify, analyze, and prioritize the capital improvement needs of the City's stormwater management system to reduce flood risks, enhance public safety, and protect the City's assets. On July 23, 2024, the City approved a professional services agreement with Carollo Engineers (Carollo) to prepare this Master Plan for the storm drainage system, which included the following main tasks:

- Task 1: Project Management and Quality Control.
- Task 2: System Inventory and Geographic Information System (GIS) Database Development.
- Task 3: Condition Assessment.
- Task 4: Hydrologic/Hydraulic Model Development and Evaluations:
  - Task 4.1 Watershed Development.
  - Task 4.2 Hydrologic/Hydraulic Model Development.
  - Task 4.3 Hydraulic Model Validation.
  - Task 4.4 Planning and Evaluation Criteria.
  - Task 4.5 System Evaluation of City Infrastructure.
- Task 5: Capital Improvement Projects:
  - Task 5.1 Develop Recommended Improvements (City Infrastructure).
  - Task 5.2 Rehabilitation and Replacement Program.
- Task 6: Master Plan preparation.

1.4 Report Organization

The storm drainage system master plan report contains seven chapters, followed by appendices that provide supporting documentation for the information presented in the report. The chapters are briefly described below:

- **Chapter 1 - Background.** This chapter presents a summary of the storm drainage system service area, the purpose, and scope for this Master Plan, and the objectives of the study. Referenced documents are also listed.
- **Chapter 2 - Study Area Description.** This chapter presents a description of the study area, defines the land use classifications, and summarizes the historical population trends.
- **Chapter 3 - Planning and Evaluation Criteria.** This chapter presents the planning criteria for evaluating the storm drainage system. The planning criteria address the storm drainage system capacity, gravity storm pipe slopes, maximum flood depths, and storm runoff coefficients.
- **Chapter 4 - Storm Drainage System Facilities and Hydraulic Model.** This chapter describes the City's existing system, and the hydraulic model was used for identifying existing system deficiencies and recommending improvements.
- **Chapter 5 - Capacity Evaluation and Proposed Improvements.** This chapter presents the results of the capacity evaluation of the storm drainage system and the proposed projects that correct capacity deficiencies and serve future users.

- **Chapter 6 - Condition Assessment and Rehabilitation/Replacement Program.** This chapter presents recommendations for the City to develop a storm drainage system maintenance, inspection, and rehabilitation/replacement program.
- **Chapter 7 - Capital Improvement Program.** This chapter presents the capital improvement program and projects, a summary of the capital costs, and is organized to assist the City in making financial decisions.

1.5 Acknowledgments

Carollo wishes to acknowledge and thank Kevin Kwak (Assistant Public Works Director), Jun DeCastro (Project Manager for City), Kevin Thomas (Public Works Superintendent), Dave Kirkwood (Public Works Lead), and John M Schener (Public Works Lead). Their cooperation and courtesy in obtaining a variety of necessary information were valuable components in completing and producing this report.

1.6 Reference Material

The following documents were referenced in the preparation of this master plan:

- City of Gardena Sewer Master Plan.
- City of Gardena Storm Drainage System Drawing.
- National Plant Services, Inc. (NPS) Report.
- Los Angeles County Storm Drain System: Web-Based Map Viewer.
- City of Gardena General Plan 2023.

CHAPTER 2 STUDY AREA DESCRIPTION

This chapter outlines the planning area for the City's storm drain system, defines land use classifications, and describes future growth assumptions within the City's service area.

2.1 Study Area

The 2023 General Plan (General Plan) planning boundary is the study area boundary for this Storm Drain Master Plan (Master Plan). The study area is shown in Figure 2.1.

The study area encompasses the portion of the City where stormwater runoff has the potential to enter the existing storm drain system. This area covers approximately 3,749 acres (about 5.6 square miles), representing the City's storm drainage service area. The analysis includes all City-owned storm drainage infrastructure, including drainage pipes, manholes, catch basins, 5.5 miles of the Dominiguez Channel, and 1.5 miles of open channel along 135th Street. Only facilities operated and maintained by the City are included in the study; County-owned infrastructure is excluded unless specifically noted. The study area accounts for runoff from all impervious and pervious surfaces within the City limits that contribute to the City's storm drainage system.

2.2 Planning Period

This Master Plan is intended to serve as a guiding document for planning and implementing storm drain system improvements and addressing existing capacity constraints.

2.3 Climate and Topography

Table 2.1 summarizes the study area's climate. In City, the summers are warm, arid, and clear, and the winters are long, cool, wet, and partly cloudy. The City experiences a Mediterranean climate with mild, wet winters and warm, dry summers. The wet season typically extends from November through March, with most of the City's rainfall occurring between December and February. The City receives relatively low rainfall, averaging around 13.55 inches annually. While the City experiences fog in the cooler months, it is generally light and does not result in significant drizzle.

Table 2.1 Study Area Climate

Month	Average Temperature (°F)(1)		Average Total Precipitation(1) (inches)
	Minimum	Maximum	
January	44.3	65.9	3.04
February	45.8	66.5	3.23
March	47.4	67.4	2.03
April	49.9	69.6	0.84
May	53.5	71.6	0.18
June	56.7	73.8	0.06
July	60.2	77.6	0.02

Month	Average Temperature (°F)(1)		Average Total Precipitation(1) (inches)
	Minimum	Maximum	
August	61.1	78.6	0.06
September	59.5	78	0.22
October	55.4	75.4	0.42
November	48.9	71.5	1.31
December	45	66.9	2.15
Average or Total	**52.3**	**71.9**	**13.55**

Notes:
°F - degrees Fahrenheit
(1) Data were obtained from the Torrance station, the closest available monitoring location to the study area.
Source: Western Regional Climate Center. Torrance, California (048973). https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca8973. Accessed May 8, 2025.

The topography of the City is relatively flat and urbanized, with elevations generally ranging from sea level to about 200 feet. Figure 2.2 shows the topography within the study area. Located in the Los Angeles Basin, Gardena is bordered by low hills to the east and west, but the landscape is predominantly developed with limited open, undeveloped land. The City's urban structure follows a more traditional grid layout, shaped by its proximity to larger urban centers like Los Angeles, Torrance, and Hawthorne, rather than being defined by a central core or prominent natural features.

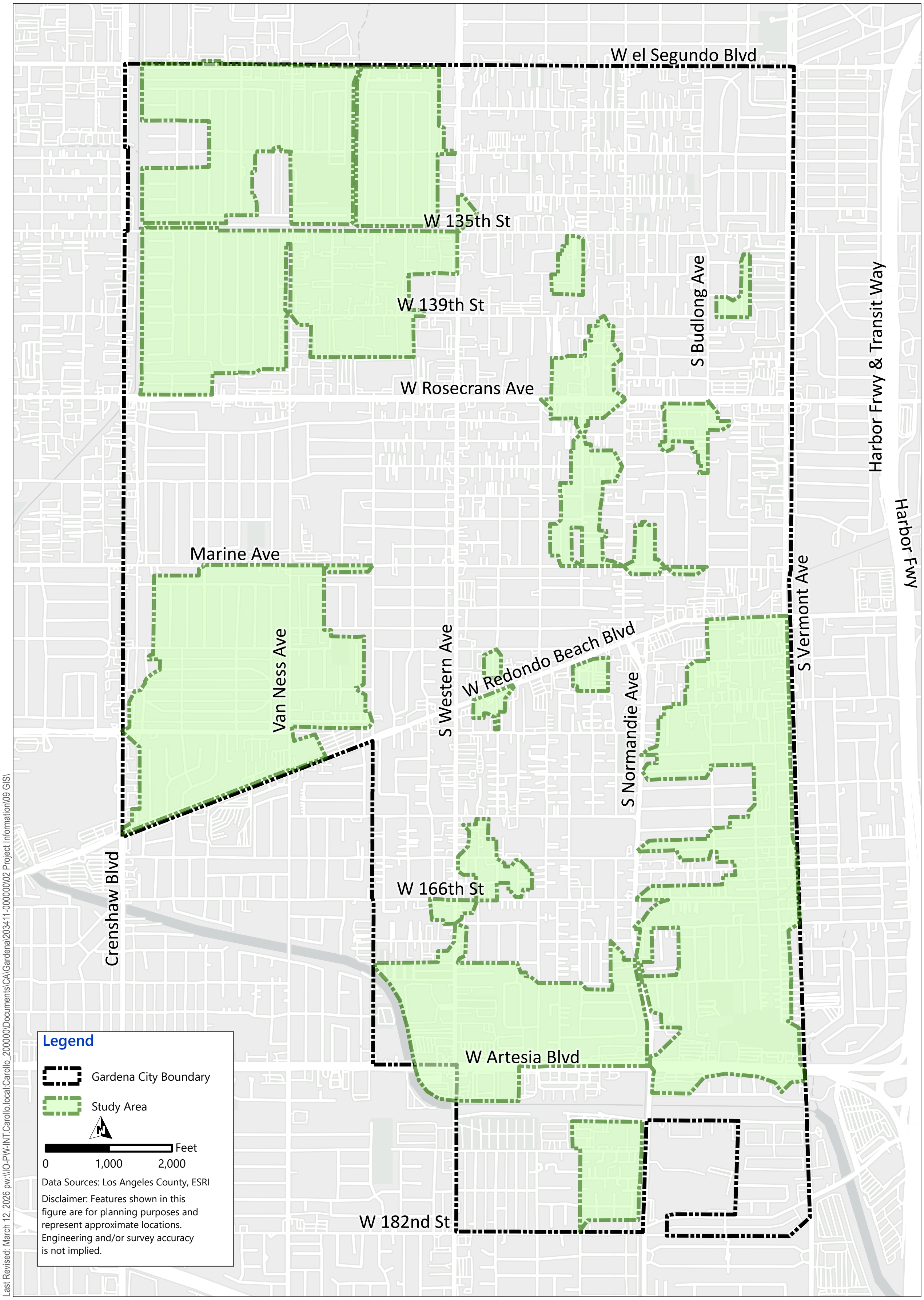

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Figure 2.1 Master Plan Study Area
CITY OF GARDENA

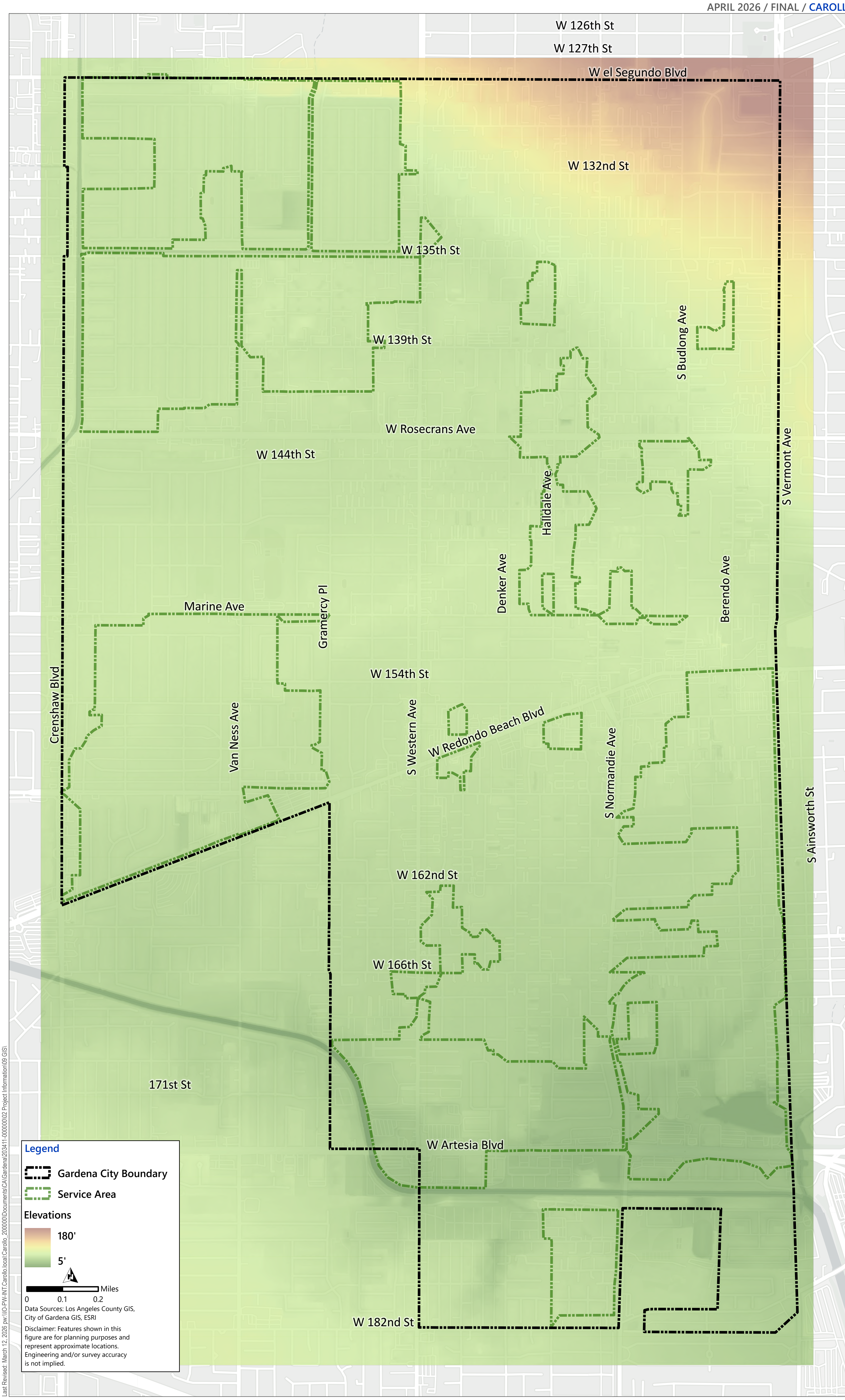

Figure 2.2 Topography
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2.4 Land Use

Land use information is an integral component in determining the amount of stormwater runoff generated within a given service area. The type of Land Use in an area will affect the volume and peak flow of the stormwater runoff. Adequately estimating the quantity of stormwater runoff from various land use types is important in sizing and maintaining storm drainage facilities. An important tool for determining land use projections is the City's General Plan. The City adopted its latest General Plan in February 2023.

Land use assumptions used in this study are consistent with the City's General Plan, as shown in Figure 2.3. Table 2.2 summarizes the land use types within the City limits. Gardena is a highly urbanized city that is approximately 99 percent developed. As of February 2023, only 7.42 acres remain vacant, including roughly 13 acres known as the Gardena Sumps, which cannot be developed. As a result, future development will either occur through limited infill development, through recycling of existing developed land, or through utilization of the overlay zones.

Table 2.2 Land Use Summary(1)

Land Use Description	Acres	Percentage
Residential - Single	1,245	33.2%
Residential - Double, Duplex, Or Two Units	94	2.5%
Residential - Three Units (Any Combination)	51	1.4%
Residential - Four Units (Any Combination)	77	2.0%
Residential - Five or More Apartments or Units	159	4.2%
Residential - Manufactured Home Park	52	1.4%
Commercial	379	10.1%
Industrial	557	14.9%
Recreational	19	0.5%
Institutional	79	2.1%
Public	215	5.7%
Vacant	7	0.2%
Right-of-Way	814	21.8%
Total	**3,749**	**100%**

Notes:
(1) The land use description was sourced from the City's General Plan.

The predominant land use continues to be single-family residential, accounting for 33.2 percent of the City's total area. Other residential types, including duplexes, multi-family units, and mobile home parks, represent approximately 12 percent of the City. Commercial uses, primarily located along Artesia Boulevard, Redondo Beach Boulevard, Crenshaw Avenue, and Western Avenue, cover 10.1 percent of the City. Industrial uses account for 14.87 percent and are largely situated north of Rosecrans Avenue between Van Ness Avenue and Normandie Avenue. Streets and rights-of-way occupy 21.8 percent of city land, while recreational, institutional, and public uses together account for approximately 8.3 percent.

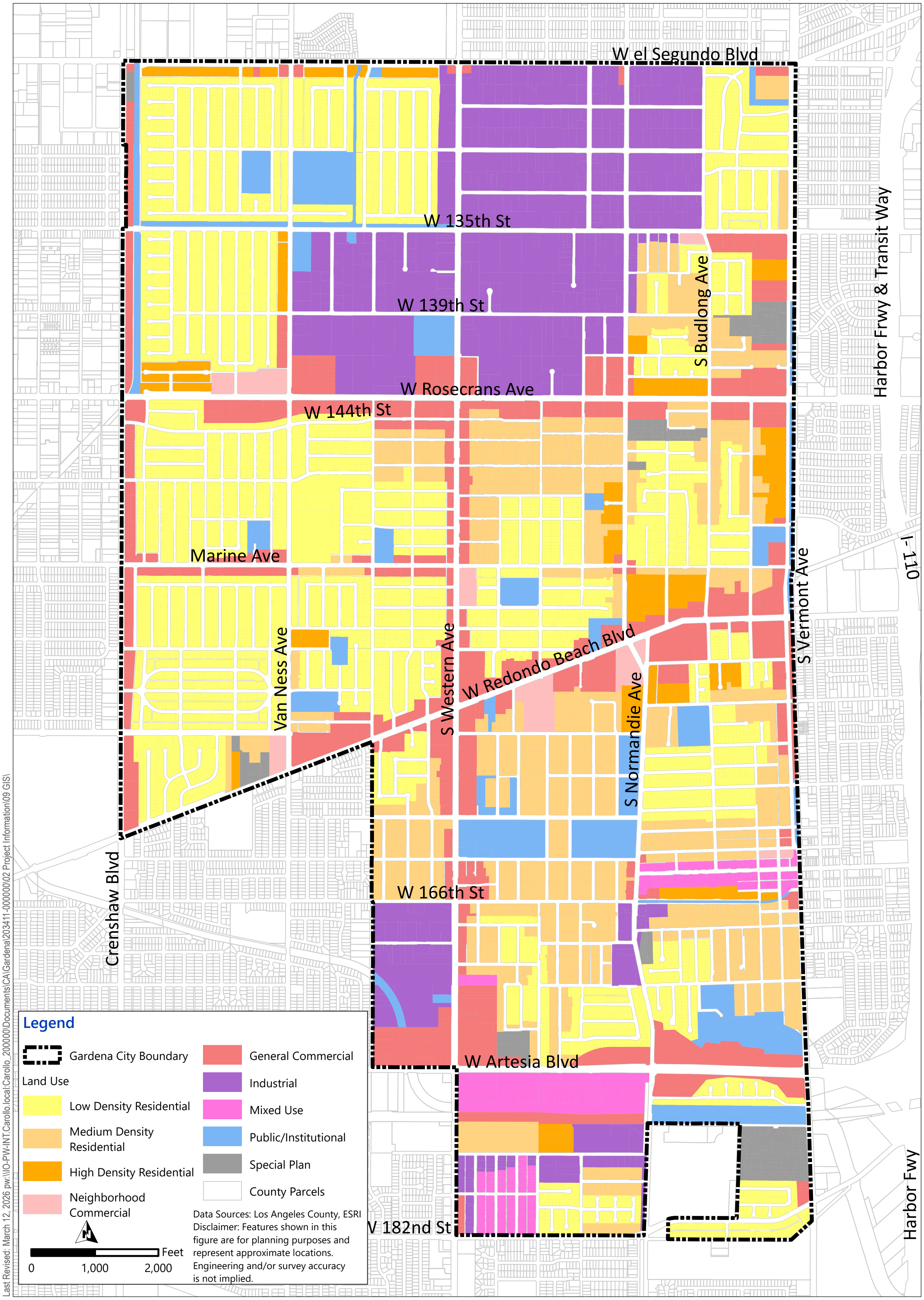

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Figure 2.3 Land Use
CITY OF GARDENA

CHAPTER 3 PLANNING AND EVALUATION CRITERIA

The capacity of the City's storm drainage collection system was evaluated based on the planning criteria defined in this chapter. The criteria were established to assess the performance of the storm drainage system, as simulated by the computer hydraulic model, and for sizing future facilities. The criteria consisted of specific guidelines recommended by the City, County, State regulatory agencies, and other planning criteria developed by Carollo based on engineering judgment and past experience.

Precipitation characteristics, design storm duration and frequency, and impervious versus pervious surfaces were reviewed to perform the hydrologic analysis on the system. Capacity deficiencies were identified through a comparison of the City's storm drainage system performance and the established planning criteria. Such a comparison defines the type, location, and extent of the facility deficiencies that should be corrected to maintain a storm drainage system with enough capacity to satisfy the selected storm conditions.

3.1 Hydrologic Criteria

This section describes the hydrologic characteristics of the City and the design storms that were used to estimate existing and future storm flows.

3.1.1 Precipitation Characteristics

The City's inland location results in a semi-arid climate, with a dry season extending from May through September. However, most of the City's rainfall typically occurs between November and April. The City experiences mild to moderate rainfall during the wet season, with occasional light drizzle. The average annual precipitation is approximately 13.55 inches.

3.1.2 Design Storms

The capacity of storm drainage facilities depends on the selected level of protection provided by those facilities. The level of protection is often expressed in terms of the frequency, or return period, of the storms for which the facilities are designed to prevent damage or for which the facilities will safely pass the stormwater flows. This storm is referred to as the design storm and is an idealized representation of a typical storm with a specified return period. Selection of the design storm can have a significant impact on the size and cost of required drainage facilities.

Two design storms were used for the evaluation of the City's existing storm drainage system and for the design of future storm drainage facilities. The 10-year, 24-hour event was used for evaluating storm conveyance facilities, while the 50-year, 24-hour event was used for evaluating the combined capacity of basins, streets, and pipes.

The City's design storms were developed using US Department of Agriculture and Natural Resources Conservation Service (NRCS) Type I distribution with the 24-hour volumes defined by National Oceanic and Atmospheric Administration (NOAA) Atlas 14. Figure 3.1 illustrates the 24-hour design storms for the 10-year and 50-year recurrence intervals. The 10-year event has a total volume of 3.8 inches, whereas the 50-year event has a total volume of 5.4 inches.

The 10-year, 24-hour design storm was used for sizing conveyance facilities for drainable areas. The 50-year, 24-hour design storm was used to determine if street flooding exceeds one foot in depth and could flood buildings or create serious safety hazards.

Figure 3.1 illustrates the 24-hour precipitation profiles for the 10-year and 50-year design storms.

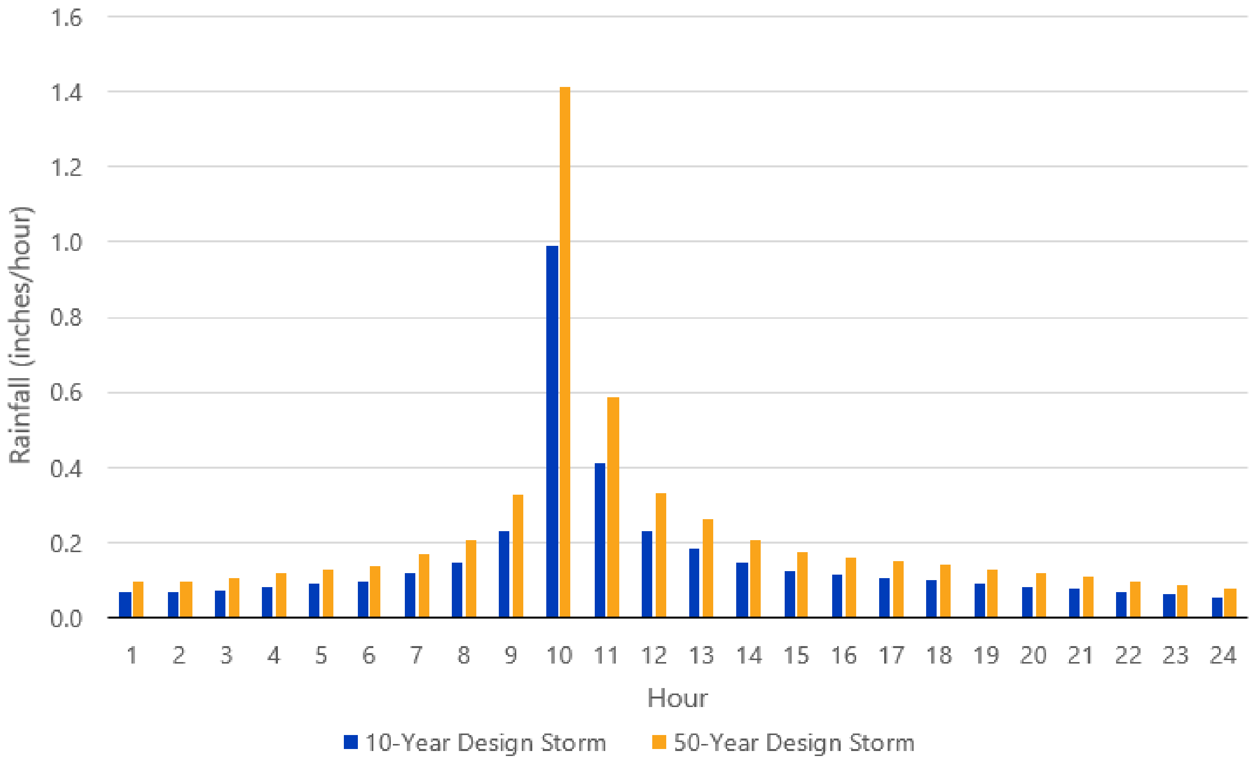

Figure 3.1 Type 1 10-year and 50-year, 24-hour Design Storms

3.1.3 Ground Slope

Ground slopes were determined using the City's elevation data and ArcView GIS. An average overland flow path slope is required for each hydraulic model subbasin. This value was automatically determined through the intersection of subbasin areas with the Digital Elevation Model (DEM) derived from the City elevation data points and survey data. The elevation grid was intersected with the subbasins, and the slope of each grid cell within the subbasin was calculated. Using the number of cells within each subbasin, the average basin slope was calculated. To verify this procedure, subbasin slopes for selected subbasins were manually estimated using available ground contour elevations and following guidelines provided by the hydraulic model manufacturer (described in Chapter 4).

3.2 Hydraulic Criteria

The City's storm drainage facilities were evaluated based on the planning and evaluation criteria defined in this section. The criteria were established to assess the performance of the storm drainage system, as simulated by the computer hydraulic model, and for sizing future facilities.

3.2.1 Hydraulic Analysis

3.2.1.1 Pipe Flow

Manning's equation for pipe flow was used to determine travel time for flow through pipes.

3.2.1.2 Manning Coefficient (n)

The Manning coefficient 'n' is a friction coefficient and varies for pipe material, smoothness of pipe and joints, and buildup of debris or other obstructions like root intrusion. For storm drainpipes, the Manning coefficient typically ranges between 0.012 and 0.015, depending on material type. The Manning's n value for all storm drains was assumed to be 0.013 for the hydraulic analysis. This is a conservative estimate for Manning's n value, but it is reasonable considering the age of some pipes in the drainage system.

3.2.1.3 Channel Flow

Manning's equation for open channel flow was used to derive travel time, velocity, flow, and width relationships for channels. The modeling software calculates ditch or channel travel time using entered values of slope, width, bank side slope, and Manning's n. The modeling software required input of a typical contributing area to determine depth of flow.

3.2.1.4 Surcharge Depth and Street Flooding

Storm drains are designed to surcharge under normal operation. It is common engineering practice to allow street curbs and gutters to act as storage and conveyance of stormwater, similar to overland flow, for a given rainfall intensity and duration to protect adjacent properties from flooding. When evaluating the adequacy of the existing conveyance facilities serving existing developments, City streets were allowed to flood and provide flow attenuation and storage capacity, thus avoiding cost-prohibitive improvements.

Floodwater was permitted to accumulate in streets up to 1 foot above the ground for the 50-year design storm. Floodwater was generally not allowed to accumulate in the streets during the 10-year design storm.

3.3 Planning and Design Criteria Summary

The City's storm drainage system was evaluated based on the analysis and design criteria described in this chapter. These criteria are summarized in Table 3.1.

Table 3.1 Planning and Design Criteria Summary

Design Storms				
Design Storm	Facilities to be Evaluated		Maximum HGL Depth/Flooding Depth Criteria	
10-year, 24-hour	Storm Sewer Conveyance Facilities		No flooding allowed	
50-year, 24-hour	Combined Capacity of Streets, Basins, and Pipes		Allowable 1 foot of flooding aboveground	
Precipitation Depth - Duration - Frequency				
Duration	10-Year		50-Year	
	(inches)	(inches/hour)	(inches)	(inches/hour)
24-hour	3.8	1.0	5.4	1.4
Design Hydrographs				
The Design Hydrographs were determined using the NOAA Atlas 14 10-year and 50-year 24-hour storms with 5-minute time steps.				
Manning's Friction Coefficient (n):				
RCP = 0.013 CMP = 0.024 Concrete Channel = 0.013				
Hydrology Analysis Design Criteria				
Storm Pattern = SCS Type 1 Hydrograph Method = SCS Unit Hydrograph Storm Duration = 24 hours Rainfall Precipitation (inches) = See Figure 3.1 (based on NOAA Atlas 14) Hydrologic Soil Group Definition = C (based on NRCS Soil Survey)				

Notes:
CMP - corrugated metal pipe; HGL - hydraulic grade line; RCP - reinforced concrete pipe; SCS - Soil Conservation Service

CHAPTER 4 STORM DRAINAGE SYSTEM FACILITIES AND HYDRAULIC MODEL

This chapter presents an overview of the City's storm drainage facilities. The chapter also describes the development of the City's storm drainage hydrologic and hydraulic models. These models were used for identifying existing system deficiencies and for recommending capital improvements.

4.1 System Overview

The City's storm drainage system is composed of infrastructure owned and maintained by both the City and County. This infrastructure primarily consists of catch basins and storm drainpipes. The system consists of approximately 12 miles of City-owned pipes and 25 miles of County-owned pipes. The total number of County-owned catch basins is 577, while the City owns 240 catch basins.

Drainage areas within the City were delineated based on infrastructure ownership and maintenance responsibility. Sub-catchments were delineated based on topography, flow direction, and slope to define drainage areas. Jurisdictional boundaries were then applied to distinguish between City- and County-owned stormwater facilities, such as catch basins and storm drainpipes.

Carollo confirmed asset ownership using the County's GIS storm drain network and coordination with the City through monthly meetings and technical workshops. The City also provided a citywide storm drain map that included as-built drawing numbers associated with individual pipes, which aided in identifying facilities under City jurisdiction.

Only storm drain facilities owned and maintained by the City were included in the hydraulic model. County-owned facilities were excluded from the modeling effort.

Figure 4.1 illustrates the modeled storm drainage system, including storm drain diameters, outfall locations, and open channels. Table 4.1 summarizes City-owned storm drains by diameter. Overall, the County owns and maintains approximately 25 miles of major storm drain infrastructure within the City, while the City owns and operates an additional 12 miles of local drainage network.

4.2 Existing Discharge Locations

The storm drainage network consists of large trunk lines owned and maintained by the County, with local drainage systems owned and operated by the City. City-owned drains typically discharge into County trunk lines, the Dominguez Channel, or into Willows Wetland located in the southern portion of the City. The Willows Wetland functions as a detention and treatment basin that receives runoff from portions of the City's storm drain network.

The Dominguez Channel is a large stormwater channel operated and maintained by the County. It originates in Hawthorne and flows through several cities, including Gardena, City of Carson, and City of Compton, before discharging into Los Angeles Harbor.

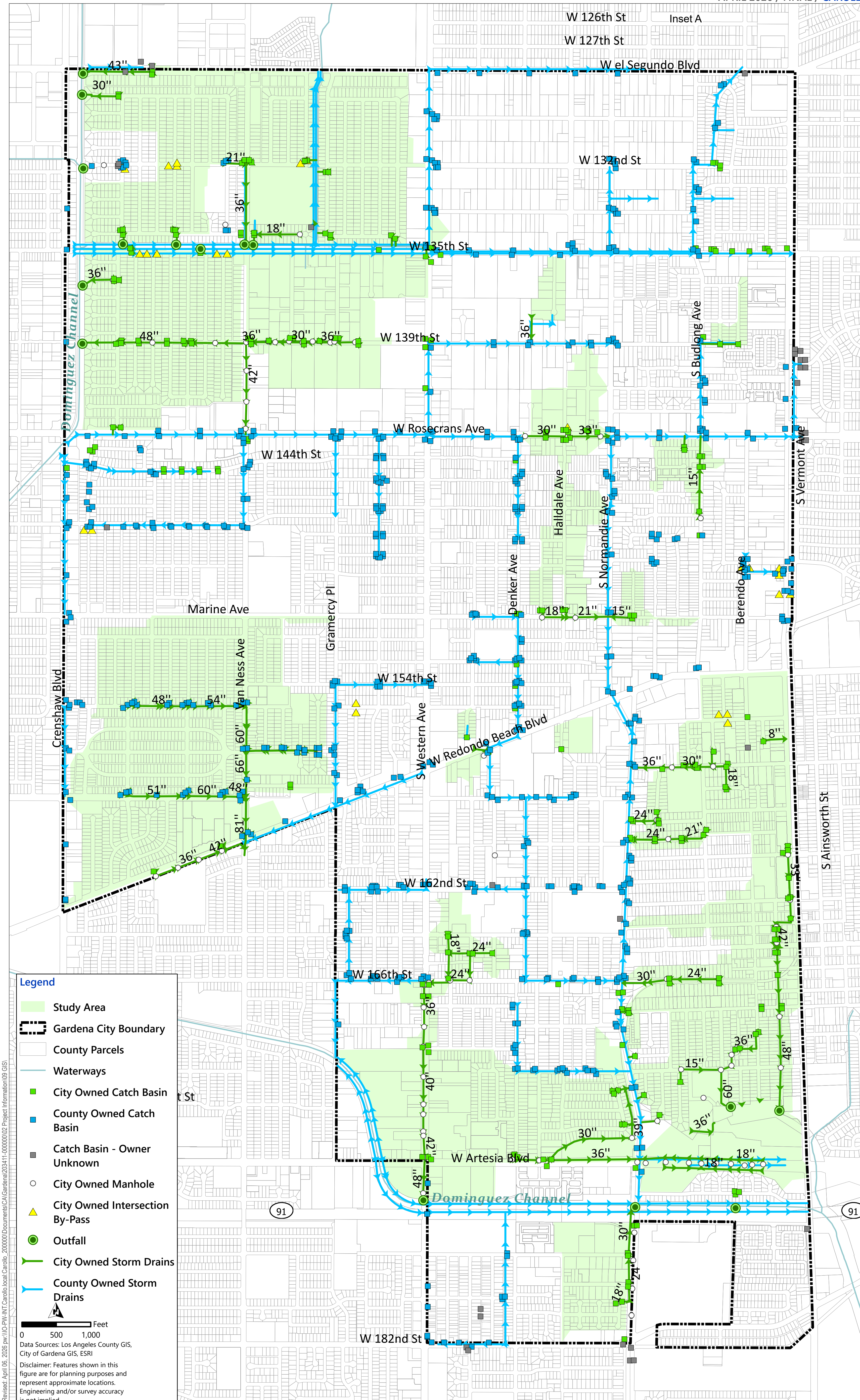

Figure 4.1 Existing Storm Drainage System

CITY OF GARDENA

Table 4.1 City-Owned Drains by Diameter

Diameter/Height (inches)	Length (feet)	Percentage of System
Circular Pipes		
6-10	383	1%
12-15	9,504	17%
18	10,486	19%
21-24	8,144	15%
27-30	4,761	9%
32-36	10,470	19%
39-42	5,054	9%
45-54	3,489	6%
60 and greater	3,450	6%
Subtotal	**55,741**	**100%**
Rectangular Channel (width x height)		
22 x 13	66	2%
60 x 48 - 63 x 48	1,228	40%
72 x 32 - 72 x 43	1,135	37%
78 x 48	62	2%
96 x 48	564	18%
Subtotal	**3,055**	**100%**
Total	**58,796**	

4.3 Modeling Software

The storm drainage system was evaluated using InfoWorks ICM (an integrated catchment modeling software). InfoWorks ICM is a hydrologic and hydraulic modeling platform developed by Innovyze, designed for simulating urban stormwater systems. The software enables fully integrated hydrologic and hydraulic analysis by modeling surface runoff, sub-catchment behavior, and flow routing within a single environment.

InfoWorks ICM supports both event-based and continuous simulations, allowing for analysis of stormwater system performance under a range of rainfall conditions. Hydrologic inputs account for rainfall intensity, surface imperviousness, land use, and soil characteristics. Hydraulic routing is performed using the fully dynamic wave method, which solves the Saint-Venant equations to simulate flow through a network of storm drainpipes, manholes, open channels, and storage elements.

This modeling approach provides a detailed assessment of stormwater system behavior and helps identify potential capacity limitations, surcharge conditions, and surface flooding risks under various storm scenarios.

4.4 Hydrologic Model

Hydrologic analysis of the study area was conducted using the hydrologic runoff module within InfoWorks ICM. This module simulates the generation of surface runoff in response to precipitation by representing the watershed as a network of interconnected hydrologic and hydraulic elements.

In InfoWorks ICM, the hydrologic model components represent distinct physical processes occurring within each sub-catchment, including rainfall interception, infiltration, surface runoff generation, and flow routing. Each sub-catchment is characterized by parameters such as area, slope, land use, soil properties, and the extent of directly connected impervious area (DCIA), which significantly influences runoff generation by representing impervious surfaces that convey runoff directly to the drainage system without any intervening pervious area. DCIA calculations are discussed in detail in Section 4.4.3.2.

Runoff generation is calculated using the Storm Water Management Model (SWMM) runoff method integrated within InfoWorks ICM, which incorporates nonlinear reservoir routing and infiltration losses modeled through options such as Horton, Green-Ampt method. These hydrologic processes are calibrated based on local site conditions to best represent actual runoff behavior.

The output from the hydrologic model consists of flow hydrographs at sub-catchment outlets, which serve as inputs to the hydraulic network model. These hydrographs are routed through the storm drainage system nodes and conduits using hydraulic solvers to assess system performance under various rainfall scenarios.

4.4.1 Design Hydrographs

The 10-year and 50-year, 24-hour storms were used in the analysis. The hyetographs, which are graphical representations of the distribution of rainfall over time, were balanced so that 5, 10, 15, etc., minute intensities are nested symmetrically within the 24-hour storm. They were constructed (by the NOAA 14 Atlas) from depth duration frequency (DDF) data provided in Chapter 3.

4.4.2 SWMM Hydrologic Unit (Sub-catchment)

Sub-catchments are hydrologic units of land whose topography and drainage system elements direct surface runoff to a single discharge point. The study area was delineated into approximately 841 individual sub-catchments, each assigned to an appropriate downstream outlet point. Of these, 276 sub-catchments discharge to City infrastructure, while the remaining sub-catchments extend into adjacent areas of the County. Sub-catchment boundaries and areas were determined based on surface flow patterns, catch basin ownership, right-of-way limits, development patterns, and available topographic data. Field observations were also conducted to verify drainage paths and ensure accurate representation of flow directions and contributing areas.

4.4.3 Soil Characteristics

For stormwater modeling, key factors relating land use to runoff are percent impervious and percent pervious area of the modeled area. The following sections describe the planning criteria and methods used to characterize the soil and runoff characteristics for the City.

4.4.3.1 Impervious Area

Multispectral imagery allows for common band combinations, such as near infrared (bands 4, 3, and 2). Near infrared allows the user to identify vegetation, water bodies, and man-made features. Vegetation appears as shades of red, water as shades of blue or black, and urban areas as shades of blue/gray.

An image processing model was developed whereby impervious and pervious surfaces were classified from the satellite imagery bands and then extracted based on user-defined variables. The classification method included 30 samples throughout the study area encompassing all land uses including multiple areas of vegetation, urban areas, and water. After the initial imagery reclassification, the results were extracted and the surfaces were reclassified as either pervious or impervious cover.

The analysis of the satellite imagery was used to determine the relative percent perviousness and imperviousness of the sub-catchments. These values were then used to calculate the DCIA. The DCIA values were then used in the hydraulic model. The methodology for calculating the DCIA for each sub-catchment is described in the following section.

4.4.3.2 Directly Connected Impervious Area

The basin proportion of directly connected or effective impervious area is related to land use, stormwater drainage system configuration, and recurrence intervals. If runoff from an impervious area flows directly into a concentrated flow path, i.e., into a gutter, it is considered directly connected. If it flows over a pervious area before becoming a concentrated flow, it is unconnected. Rainfall on impervious surfaces is not subject to losses by infiltration into the soil; the only losses in impervious areas are due to depression storage. All initial losses for impervious areas, typically 0.02 to 0.08 inches, were assumed to be satisfied by precipitation preceding the design storm.

The imperviousness derived from the satellite imagery represents the total average impervious area in a subbasin. To convert average percent imperviousness to DCIA, two equations were used. The following equation (developed by the U.S. Geological Survey [USGS]) was used for total impervious areas between 10 percent and 50 percent:

1. %DCIA = 3.6 + 0.4*I

   Where: I = percent total impervious area (between 10 percent and 50 percent)

For all remaining sub-catchments, the following equation was used:[1]

2. %DCIA = 0.04*I 1.7

   Where: I = percent total impervious area (<10 percent and >50 percent)

Table 4.2 provides the average percent perviousness and imperviousness of the City based on satellite imagery, and the resulting DCIA values that were used to populate the hydraulic model.

[1]Sutherland, R.C. Methodology for Estimating the Effective Impervious Area of Urban Watersheds. Watershed Protection Techniques. Vol. 2, No. 1 (Fall 1995).

Table 4.2 Percent Impervious/Pervious Area by Land Use

Land Use Category	Percent Impervious	Percent Pervious	Percent DCIA
Commercial	91	9	85
High-Density Residential	89	11	82
Industrial	96	4	94
Low-Density Residential	72	28	58
Medium Density Residential	82	18	71
Medium Density Residential - Overlay	96	4	94
Mixed Use	88	12	80
Mixed Use - Overlay	87	13	80
Neighborhood Commercial	94	6	90
Public	69	31	53
Specific Plan	84	16	74

4.4.3.3 Non-Effective Percent Imperviousness

In residential urban areas, either a portion of the pervious runoff area has no flow path to the drainage system, or the flow path is via groundwater drains, which effectively delays runoff until it does not contribute to the design hydrographs. These areas are typically backyards, swimming pools, dense shrub landscaping, and gardens.

4.4.3.4 Pervious Area Runoff and Infiltration Parameters

The remaining runoff originates from pervious areas. There are several ways to estimate the volume and/or the rate of infiltration of water into soil. Three excellent estimation methods are Green-Ampt, SCS method, and Horton's method. All these equations provide a relatively accurate assessment of the infiltration characteristics of the soil in question. Infiltration into the soil in pervious areas was estimated for each subbasin by the model using the Horton equation. Horton and Green-Ampt are widely used in SWMM, especially when using the SWMM runoff module. The Green-Ampt method accounts for multiple variables that other methods, such as Horton, do not. The Green-Ampt method is a function of the soil solution head, porosity, hydraulic conductivity, and time. Some of these parameters are difficult to estimate.

On the other hand, the Horton equation is an empirical formula that states that infiltration starts at a given rate and decreases exponentially with time. After a period of time, when the soil saturation level reaches a certain value, the rate of infiltration will become constant. Parameters for the Horton equation can be reasonably estimated from literature and USDA soil data.

Because the Horton parameters vary depending on soil type, soil maps were examined to determine the soil type within each drainage area. Weighted average soil properties were determined for each SWMM subbasin based on the amount of each hydrologic soil group in the subbasin and typical soil properties for each group.

Four hydrologic soil groups are used. The soils are classified based on water intake at the end of long duration storms after prior wetting, an opportunity for swelling, and without the proactive effects of vegetation. The hydrologic soil groups are:

A. Soils having high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well to excessively drained sands or gravels. These soils have a high rate of water transmission.

B. Soils having moderate infiltration rates when thoroughly wetted and consisting of moderately deep to deep, moderately well to well-drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

C. Soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes the downward movement of water or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.

D. Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with high swelling potential, soils with permanent high water table, soils with claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

By determining the percentages of each hydrologic soil group within a subbasin, maximum and minimum infiltration rates were calculated. The constant decay rate for Horton infiltration analysis was set to 0.0015 per second. Figure 4.2 shows the hydrologic soil groups within the City, which are based on data provided by the NRCS. As shown in Figure 4.2, the dominant Hydrologic Soil Group with the study area is Hydrologic Soil Group C, with a small portion designated as Hydrologic Soil Groups A and B (only 15 percent). Each soil group is associated with the typical infiltration soil properties as listed in Table 4.3. A detailed Soil Resource Report for the City is provided in Appendix A.

Table 4.3 Infiltration Rates for NRCS Hydrologic Soil Groups

Soil Group	Maximum Infiltration Rate (inches/hour)	Minimum Infiltration Rate (inches/hour)
A	2.0	0.065
B	1.5	0.050
C	1.0	0.035
D	0.5	0.020

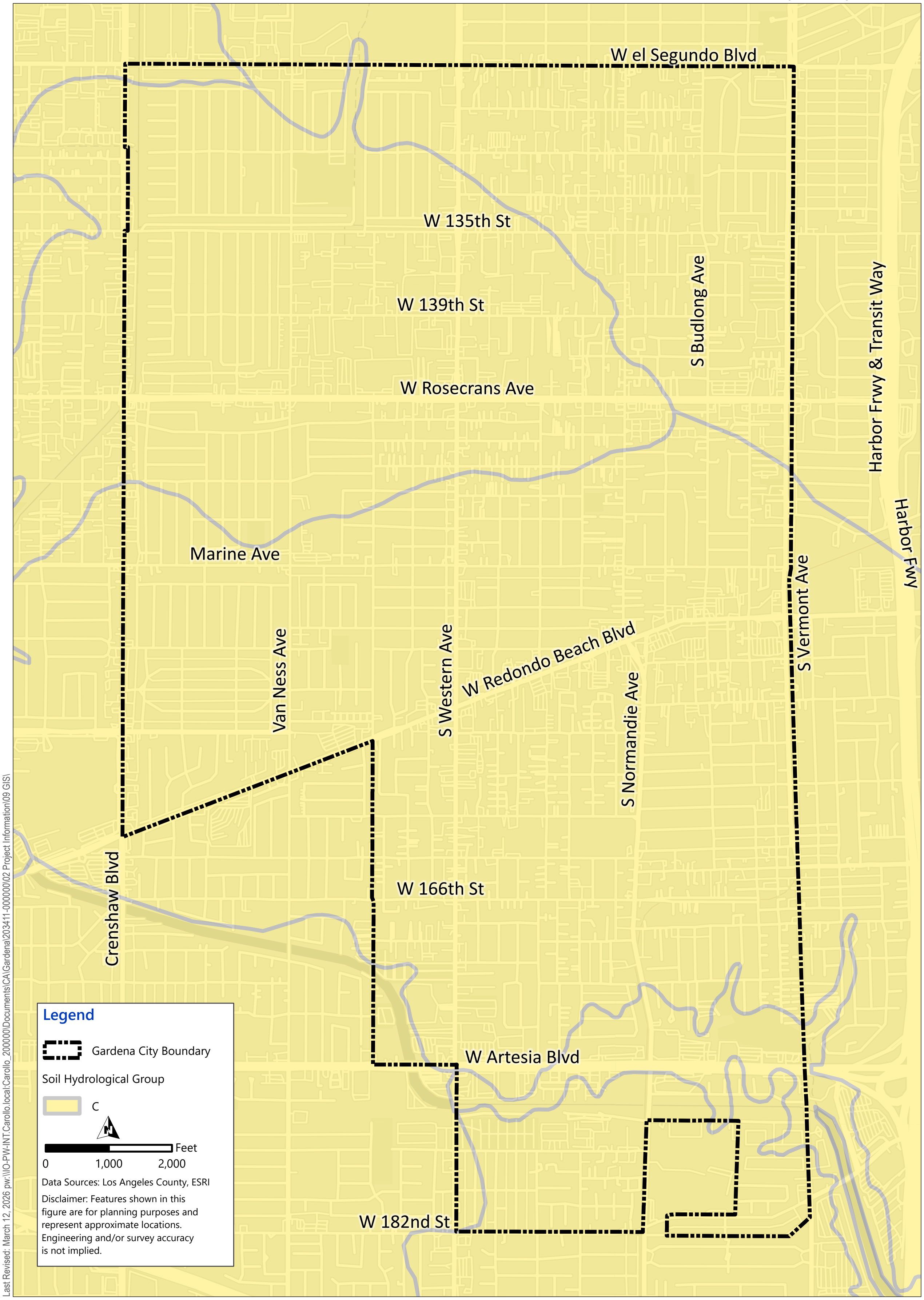

Figure 4.2 Hydrological Soil Group

4.5 Hydraulic Model

The InfoWorks ICM hydraulic model was used to simulate the hydraulic conditions in the City's storm drainage system. The computer hydraulic model was used to analyze the storm drainage system, to identify deficiencies, and to propose system improvements.

4.5.1 Elements of the Storm Drainage Hydraulic Model

The following provides an overview of the elements of a hydrologic storm drainage model and the required input parameters associated with each:

- **Nodes:** Storm drain manholes, inlets, and catch basins, as well as other locations where pipe sizes change or where pipelines intersect, are represented by junctions in the hydraulic model. Required inputs for junctions include rim elevation, invert elevation, and surcharge depth. Nodes are also used to represent the location where flows are split or diverted between two or more downstream links.
- **Conduits:** Gravity storm drains, and open channels are represented as conduits in the hydraulic model. Input parameters for conduits include length, friction factors (e.g., Manning's n for gravity mains), invert elevations, and cross section information (diameter or dimensions).
- **Outfalls:** Outfalls represent areas where flow leaves the system. For storm drainage system modeling, an outfall typically represents a discharge to a channel or some other water body.
- **Sub-catchments:** Sub-catchments are hydrologic units of land whose topography and drainage system elements direct surface runoff to a single discharge point (i.e., a modeled junction). Required input parameters for sub-catchments include area, associated rain gauge, percent impervious, average sub-catchment width, slope, soil types, and overland flow parameters.

4.5.2 Hydraulic Model Update Process

The InfoWorks ICM hydraulic model was used to simulate the hydraulic conditions in the City's storm drainage system. The computer hydraulic model was used to analyze the storm drainage system, to identify deficiencies, and to propose system improvements.

The hydraulic model update process consisted of six steps, as described below:

- **Step 1:** Storm drainage system data was obtained from multiple sources to support the development of the InfoWorks ICM model. NPS conducted a field survey and provided GIS shapefiles containing the locations of catch basins and manholes, along with an accompanying report that detailed pipe attributes such as length, material, connectivity (from-node and to-node), and functional status. Additional data sources included the County GIS online portal, which was referenced for catch basin locations, and a PDF document provided by the City that identified ownership (City vs. County) of catch basins.
- **Step 2:** Based on the data compiled in Step 1, the storm drainage network was reviewed, cleaned, and verified within ArcGIS Pro. This process included confirming connectivity between nodes, identifying data gaps or inconsistencies, and aligning catch basin and manhole attributes with available survey and other available data. Once the network was quality-checked and finalized, it was imported into the InfoWorks ICM.

- **Step 3:** To address gaps in the storm drainage network data, Carollo requested as-built drawings from the City. Where available, these drawings were used to fill in missing invert elevations and other relevant attributes. In areas where as-built information was not available, reasonable engineering assumptions were made to estimate the missing data, such as invert elevations and pipe slopes, based on surrounding infrastructure and standard design practices.

  Key properties within the InfoWorks ICM model, such as pipe inverts, lengths, and ground elevation, were flagged with their data source (e.g., "NPS Survey," "As-Built," or "Assumed") to document the origin of each dataset and support future verification or updates.
- **Step 4:** New sub-catchments were delineated in GIS to reflect the most up-to-date conditions. These sub-catchments incorporate current data on soil type, surface slope, flow path width, and percent imperviousness to ensure accurate hydrologic representation within the model.
- **Step 5:** Once all the relevant data was input into the hydraulic model, the model was reviewed to verify that the model data was input correctly and that the flow direction and size of the modeled facilities were logical.
- **Step 6:** The hydraulic model contains certain run parameters that need to be set by the user at the beginning of the project. These include run dates, time steps, reporting parameters, output units, and flow routing method. Once the run parameters were established, the model was debugged to ensure that it ran without errors or warnings.

4.6 Model Verification

The reasonableness of the model results and the hydraulic grade line profiles were evaluated during the initial model runs. This was accomplished by comparing areas of flooding predicted by the model with observations offered by the City. Areas around the City that experience flooding were confirmed by the model results. Following the verification process, the model was used for the existing and future storm drainage system analysis.

4.6.1 Historical Rainfall Event Analysis

The City experienced two significant storm events during the 2023–2024 period. The first occurred on January 14-15, 2023, with a total recorded rainfall depth of 1.80 inches. The second event occurred on February 4-6, 2024, with a total recorded rainfall depth of 5.19 inches. Historical rainfall data for both events were obtained from the West Gardena Station on Wundermap and applied in the hydraulic model to evaluate system performance and potential flooding. The classification of the historical rainfall events is provided in Figure 4.3. As shown, the maximum classification for the January 2023 event is approximately a 2-year, 4-hour event, and the maximum classification for the February 2024 event is approximately a 10-year, 2-day event.

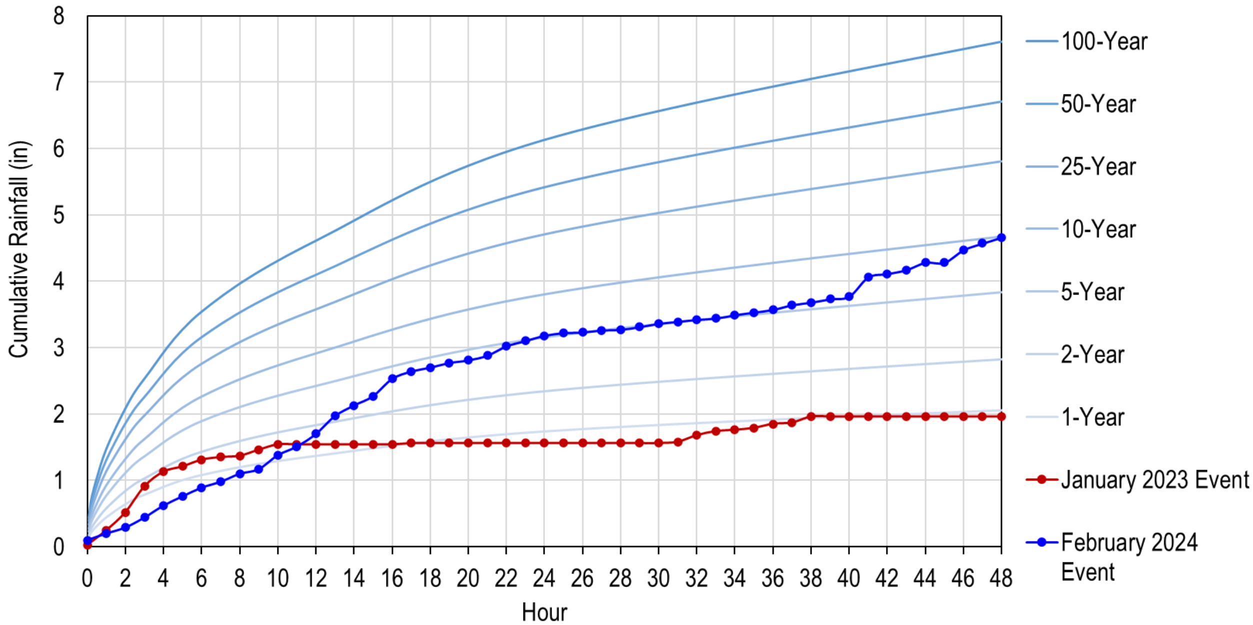

Figure 4.3 Classification of the Historical Rainfall Events

City staff confirmed that no flooding was observed within the service area during either event. Both storm events were evaluated in the hydraulic model. Overall, the 2024 event generated a substantially higher total runoff volume due to greater rainfall depth and storm duration; however, the peak instantaneous runoff was lower than the 2023 event, indicating that the rainfall was distributed over a longer period with less short-duration intensity. This finding aligns with City staff's observation that no flooding occurred during either storm, as the system was able to convey the flows without exceeding capacity.

4.7 Flow Direction Map

As part of Task 4.1, Carollo delineated both urban and natural watersheds with their respective flow paths tributary to the City. The work also included the development of Street Flow Directional Maps, which illustrate overland flow directions along roadways. For most streets, two flow arrows were assigned (one in each direction), with the exception of alleys that contain a center gutter. The flow direction map is provided in Appendix B.

Using engineering drawings and aerial imagery from Google Earth, flow paths associated with City-maintained catch basins were delineated and incorporated into the model. A comprehensive layer containing both City and County storm drainpipes was also developed to ensure accurate representation of the system. Sub-catchments were then delineated and linked to the corresponding City and County infrastructure within the model.

These steps are critical to ensure accurate runoff routing and reliable simulation of system performance under existing and future conditions.

CHAPTER 5 CAPACITY EVALUATION AND PROPOSED IMPROVEMENTS

This chapter presents the results of the capacity evaluation of the storm drainage system and the proposed projects that correct capacity deficiencies and serve future users.

5.1 Capacity Evaluation

Evaluation of the capacity of the City's storm drainage system involved identifying areas in the system where street flooding exceeded the maximum criteria. For the 10-year design event, the maximum HGL was not allowed to exceed the ground level (i.e., no flooding permitted). The storm drainage criteria allowed flooding up to 1 foot above the gutter flow line in the 50-year design storm event. Storm drains that lacked sufficient capacity to convey runoff generated from the design storm could produce backwater effects in the drainage system and potentially cause flooding. This chapter discusses the possible locations of existing and future flooding caused by these deficiencies. When an increase to capacity is required, it was assumed, unless otherwise noted, that storm drains would be replaced with a larger diameter pipeline.

When evaluating the adequacy of the storm drainage facilities serving existing developments, city streets were allowed to provide additional storage capacity through temporary flooding, where available. This approach reduced the number of required storms drain improvements. However, for storm drains located in city streets, the goal was to contain storm flows within the drainage pipelines, with only minimal ponding permitted during the 10-year design storm. Figure 5.1 illustrates the existing system capacity deficiencies under the 10-year, 24-hour design storm. For this analysis, no flooding was allowed, as it was used to evaluate pipeline sizing.

The storm drainage criteria allowed city streets to flood up to 1 foot above the gutter flow line in the 50-year design storm. If flooding exceeded 1 foot and additional gutter capacity was not available, then an improvement was necessary to correct the deficiency. Drainage pipes within a street that cannot be supplemented by overland flow should be designed to have sufficient capacity to convey the 50-year design storm while maintaining a hydraulic grade line below the manhole rim elevations. Figure 5.2 illustrates the existing system capacity deficiencies under the 50-year, 24-hour Design Storm.

Figures 5.1 and 5.2 show the modeled sub-catchments and their respective peak outflows to the storm drain system for the 10-year and 50-year design storms, respectively. The peak outflow from each sub-catchment is calculated based on rainfall, infiltration, depression storage for pervious and impervious areas, and flow routing. These outflows, expressed in gallons per minute, represent the water from each sub-catchment, entering the storm drain system. While higher peak outflows indicate areas where the drainage system may experience larger volumes of runoff, they do not necessarily correspond to flooding, as the system may have sufficient capacity to convey these flows. The figures and associated values are used as inputs to the hydraulic model to evaluate system performance and identify locations that could be susceptible to capacity constraints under the design storms.

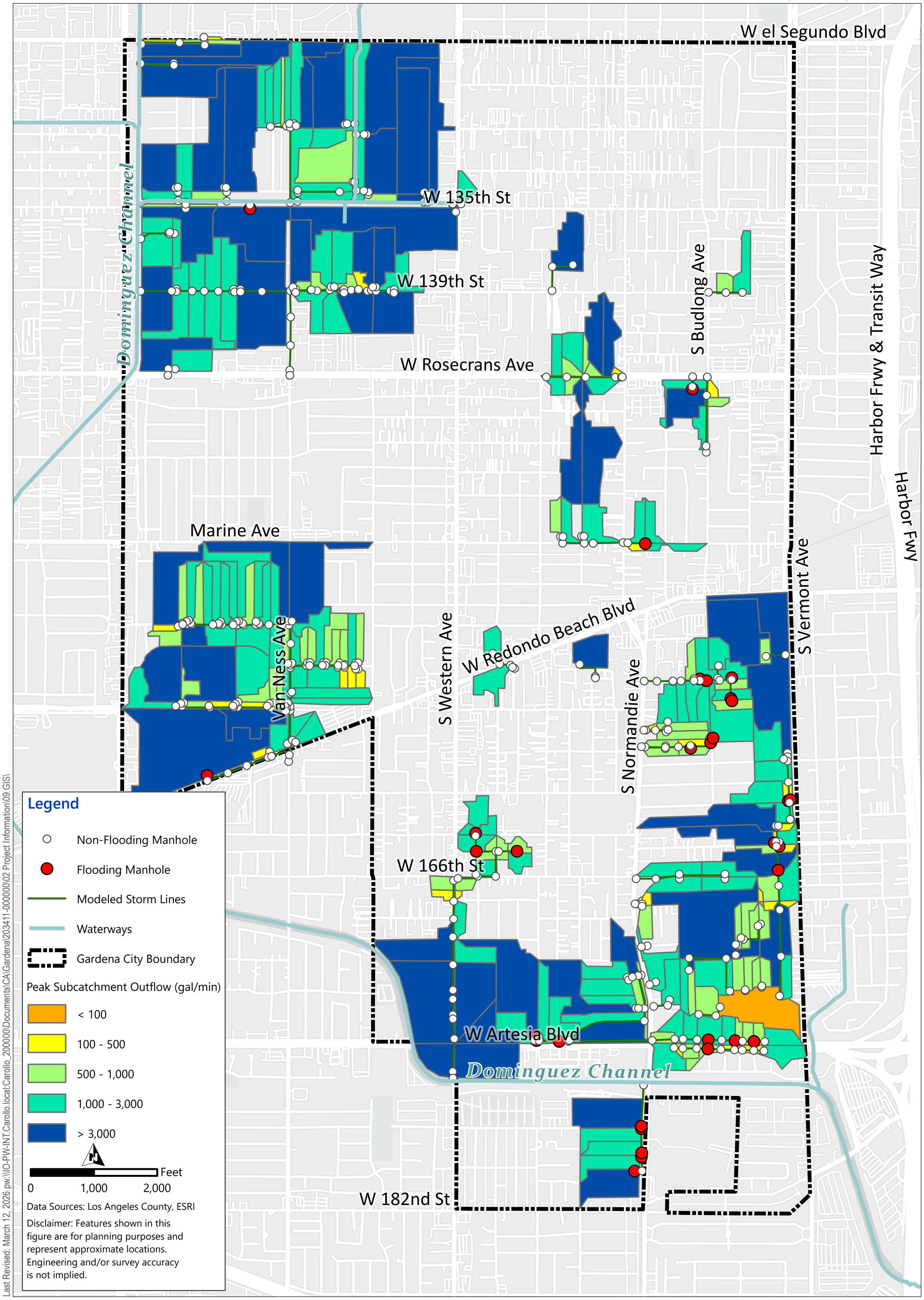

Figure 5.1 10-Year, 24-Hour Design Storm Deficiency
CITY OF GARDENA

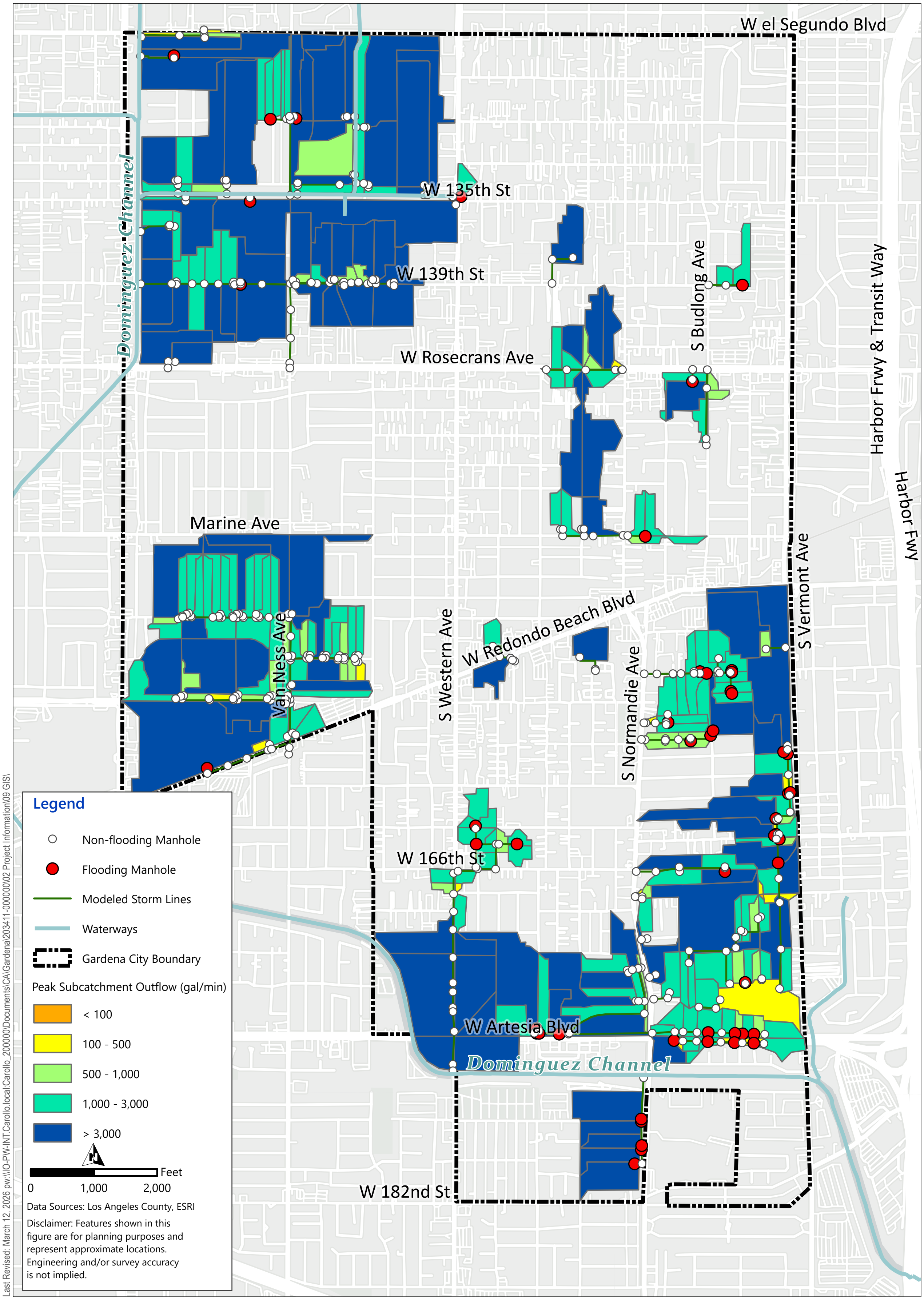

Figure 5.2 50-Year, 24-Hour Design Storm Deficiency
CITY OF GARDENA

5.2 Storm Drainage System Capacity Improvements

The recommended improvements to mitigate deficiencies under the 10-year and 50-year design storm events are shown on Figure 5.3. The following sections provide detailed descriptions of each recommended improvement as well as proposed project prioritization.

5.2.1 Capital Project Prioritization

When fully implemented, the capital projects will facilitate the collection, conveyance, storage, and discharge of peak storm flows to limit street flooding to the maximum allowed. Prioritizing the required capital improvements for the City's storm drainage system is an important aspect of the Master Plan.

The recommended pipeline improvements are developed through an iterative design process. First, capacity-deficient pipelines contributing to surcharging or exceeding the hydraulic grade line are identified. The existing system performance is then evaluated under the applicable design storm (e.g., 10-year or 50-year, 24-hour). Initial pipe upsizing is proposed to mitigate surcharging and ensure the hydraulic grade line remains below the ground surface or rim elevation. Hydraulic analyses are re-run to assess the effectiveness of these improvements, and pipe sizes are adjusted iteratively until the system meets all capacity, hydraulic grade line, and flooding criteria. When prioritizing improvements, projects that achieve the greatest reduction in flood volume are given priority. Constructability and cost considerations are also factored into prioritization to ensure that the recommended improvements are both feasible and economically efficient.

In addition, coordination with the City was an important part of the process. Since the City has already completed or scheduled projects in some of the same locations, consultation was necessary to avoid reopening recently improved streets. Through this collaboration, the Capital Improvement Program (CIP) projects were arranged to align both technical needs and the City's ongoing efforts.

5.2.2 10-Year Design Storm Improvements

This section provides a detailed description of each proposed storm drain collection system project to alleviate the 10-year, 24-hour design storm deficiencies. One primary aspect of the City's storm drainage system improvements is the development and implementation of a storm drain maintenance and inspection program as a part of a long-term rehabilitation/replacement program. This maintenance program is described in detail in Chapter 6 of this Master Plan.

Details of each improvement are provided in Table 5.1, with improvement IDs corresponding to those shown in Figure 5.3. For the improvement projects, the proposed diameter is shown along with the length of pipe. Figure 5.3 and Table 5.1 should be used together to locate the proposed improvement on the map and to gain details of the improvement (length, diameter, street location, etc.). It should be noted that all improvements were sized to accommodate the 50-year, 24-hour design storm volumes. Therefore, while the improvements listed below are required to alleviate a 10-year, 24-hour design storm deficiency, they are all sized to accommodate the 50-year, 24-hour design storm volumes.

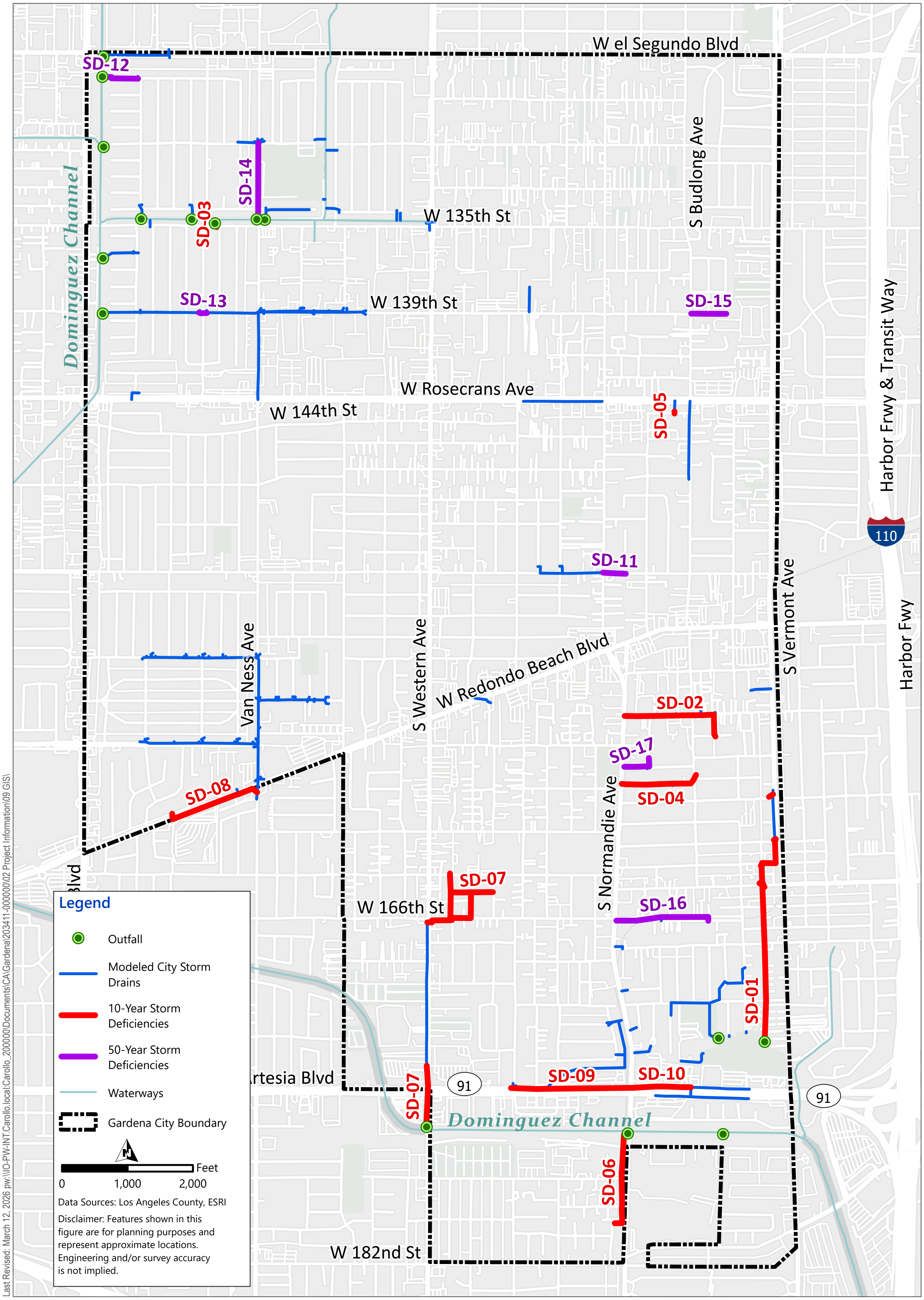

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Figure 5.3 Proposed Capacity Improvements
CITY OF GARDENA

Table 5.1 10-Year, 24-Hour Design Storm Improvements

Improvement ID	Original Diameter (inches)	Improvement Diameter (inches)	Total Length (feet)
SD-01	18-33	24-48	3,545
SD-02	10-18	18-36	1,715
SD-03	12	18	80
SD-04	15	21, 24	1,210
SD-05	6	12	35
SD-06	15-18	18-30	1,490
SD-07	12-40	18-48	2,150
SD-08	24	30-42	1,490
SD-09	24	36	1,865
SD-10	18	30-36	890
Total			**14,470**

The following improvements are recommended for the stormwater collection system to mitigate hydraulic deficiencies. Each project addresses the replacement of capacity-deficient pipelines that contribute to surcharge during the 10-year 24-hour design storm.

- **S New Hampshire Avenue (SD-01):** This project consists of replacing approximately 3,545 feet of 18- to 33-inch diameter pipelines along S New Hampshire Avenue with 24- to 48-inch diameter pipelines.
- **Magnolia Avenue (SD-02):** This project consists of replacing approximately 1,715 feet of 10- to 18-inch diameter pipelines along Magnolia Avenue with 18- to 36-inch diameter pipelines.
- **W 135th Street (SD-03):** This project consists of replacing approximately 80 feet of 12-inch diameter pipelines along W 135th Street with 18-inch diameter pipelines.
- **W 160th Street (SD-04):** This project consists of replacing approximately 1,210 feet of 15-inch diameter pipelines along W 160th Street with 21- and 24-inch diameter pipelines.
- **W 144th Street (SD-05):** This project consists of replacing approximately 35 feet of 6-inch diameter pipelines along W 144th Street with 12-inch diameter pipelines.
- **S Normandie Avenue (SD-06):** This project consists of replacing approximately 1,490 feet of 15- to 18-inch diameter pipelines along S Normandie Avenue with 18- to 30-inch diameter pipelines. The improvement is intended to upgrade the capacity of the existing system.
- **S Western Avenue (SD-07):** This project consists of replacing approximately 2,150 feet of 12- to 40-inch diameter pipelines along S Western Avenue with 18- to 48-inch diameter pipelines.
- **W Redondo Beach Boulevard (SD-08):** This project consists of replacing approximately 1,490 feet of 24-inch diameter pipelines along W Redondo Beach Boulevard with 30- to 42-inch diameter pipelines.
- **W Artesia Boulevard (SD-09):** This project consists of replacing approximately 1,865 feet of 24-inch diameter pipelines along W Artesia Boulevard with 36-inch diameter pipelines.
- **W Artesia Boulevard (SD-10):** This project consists of replacing approximately 890 feet of 18-inch diameter pipelines along W Artesia Boulevard with 30- to 36-inch diameter pipelines.

5.2.3 50-Year Design Storm Improvements

This section provides a detailed description of each proposed storm drain collection system project for the 50-year improvements.

Table 5.2 shows details of each improvement, including the improvement figure number corresponding to Figure 5.3. For future storm drains, the proposed diameter is shown along with the length of pipe. Figure 5.3 and Table 5.2 should be used together to locate the proposed improvement on the map and to gain details of the improvement (length, diameter, street location, etc.).

Table 5.2 50-Year, 24-Hour Design Storm Improvements

Improvement ID	Original Diameter (inches)	Improvement Diameter (inches)	Total Length (feet)
SD-11	12	15	350
SD-12	24	30	550
SD-13	18	24	125
SD-14	30	36	1,195
SD-15	12, 15	15, 18	540
SD-16	12-24	24-30	1,475
SD-17	12, 15	18, 24	515
Total			**4,750**

The following improvements are recommended for the stormwater collection system to mitigate hydraulic deficiencies. Each project involves replacing capacity-deficient pipelines that contribute to surcharging during the 50-year, 24-hour design storm. The analysis allows for up to 1 foot of surface flooding and was used to evaluate the overall system, including associated basins.

- **Marine Avenue (SD-11):** This project consists of replacing approximately 350 feet of 12-inch diameter pipelines along Marine Avenue with 15-inch diameter pipelines.
- **129th Street (SD-12):** This project consists of replacing approximately 550 feet of 24-inch diameter pipelines along 129th Street with 30-inch diameter pipelines.
- **W 139th Street (SD-13):** This project consists of replacing approximately 125 feet of 18-inch diameter pipelines along W 139th Street with 24-inch diameter pipelines.
- **Van Ness Avenue (SD-14):** This project consists of replacing approximately 1,195 feet of 30-inch diameter pipelines along Van Ness Avenue with 36-inch diameter pipelines.
- **W 139th Street (SD-15):** This project consists of replacing approximately 540 feet of 12- and 15-inch diameter pipelines along W 139th Street with 15- and 18-inch diameter pipelines.
- **W 166th Street (SD-16):** This project consists of replacing approximately 1,475 feet of 12- to 24-inch diameter pipelines along W 166th Street with 24- and 30-inch diameter pipelines.
- **W 159th Street (SD-17):** This project consists of replacing approximately 515 feet of 12- and 15-inch diameter pipelines along W 159th Street with 18- and 24-inch diameter pipelines.

CHAPTER 6 CONDITION ASSESSMENT AND REHABILITATION/REPLACEMENT PROGRAM

This chapter presents the storm drain system condition evaluations program of the City's existing storm drainage infrastructure in support of a rehabilitation/replacement (R&R) program for the City's storm drainage system. These efforts provide a preliminary understanding of system conditions and inform the development of the CIP which is included in Chapter 7.

6.1 Storm Drainage System Condition Assessment

This section presents the results of a condition assessment of the City's storm drains. The objective of the assessment was to identify potential condition-related risks and prioritize areas for future investigation, rehabilitation, or replacement. The assessment included a review and analysis of closed-circuit television (CCTV) inspection data for the City owned storm drains.

6.1.1 Closed-Circuit Television Inspection Findings

The City completed a targeted CCTV inspection of approximately 5.5 miles of its storm drainage system starting in 2024 and continued through 2025. The CCTV inspections were completed in accordance with National Association of Sewer Service Company's (NASSCO) Pipeline Assessment and Certification Program (PACP) framework to evaluate structural and operations and maintenance (O&M) defects.

CCTV inspection records serve as the basis for assessing the condition of storm drains within this analysis. In a CCTV inspection, a camera mounted on a robotic tractor physically travels through the pipe allowing an inspector to record defects and features based on the type of observations and location within the pipe. These observations are initially recorded qualitatively, then standardized into quantitative condition grade that support evaluation of structural integrity and operational performance.

6.1.1.1 Scoring and Findings

NASSCO's PACP provides a consistent, standardized framework for rating defects observed during CCTV inspections. The PACP standardized codes categorize observations into four families: structural defects, O&M observations, construction features, and miscellaneous features. The system provides a consistent method for evaluating pipe conditions, enabling standardized data management, and comparison for infrastructure planning.

Additionally, the PACP standard categorizes defects by type, severity, and location along a pipe segment, assigning numeric grades that quantify individual defect conditions. These grades are then used to generate composite condition scores, enabling consistent evaluation of overall pipe condition. Each segment is evaluated for both structural and O&M defects. Under PACP, defects are graded on a 1 to 5 scale where 1 indicates generally good condition and 5 indicates debilitating impairments and significant reduction in a pipe's service life. Grade 0 defects are used for general observations and required codes. Table 6.1 describes the structural and O&M defects associated with grades 1 through 5.

Table 6.1 NASSCO PACP Structural and O&M Grade Descriptions

Grade	Structural Defects	O&M Defects
1	Minor defects, no effect on service life (e.g., fine cracks, slight surface wear).	Minor O&M issues (e.g., light film of grease, small roots at joint, debris <10% cross-section). Routine maintenance not urgent.
2	Defects present, not yet affecting capacity or integrity (e.g., moderate cracks, slight joint offset).	Noticeable O&M issues (e.g., moderate debris, grease, or roots ~10–20% cross-section). Maintenance should be scheduled.
3	Significant defects that may begin to affect structural integrity or capacity (e.g., fractures, moderate deformation, infiltration evidence).	Significant O&M issues (e.g., roots, grease, deposits covering ~20–50% of cross-section). Maintenance required soon.
4	Severe defects reducing service life or risking failure (e.g., broken pieces, severe deformation, major joint offset, infiltration).	Severe O&M issues (e.g., large root masses, grease plugs, debris covering ~50–80% of cross-section). High-priority maintenance.
5	Most severe defects; imminent or existing failure (e.g., collapse, severe deformation >40%, holes, severe infiltration).	Most severe O&M issues; obstruction >80% of cross-section, near or full blockage. Immediate/emergency maintenance needed.

Each pipe segment receives a "Maximum Defect Grade" and "Overall Segment Grade" based on the highest observed defect. The PACP system also supports assignment of defect codes, location references (e.g., distance from upstream manhole), and digital images or videos for documentation.

Table 6.2 summarizes the findings from the 2024 and 2025 inspections. Figure 6.1 and Figure 6.2 show the maximum structural grade, and O&M grade for each inspected segment, respectively.

Table 6.2 Summary of CCTV Condition Ratings for Main Trunk Sewer (PACP Scoring)

Condition Metric	Value
Total Length Inspected	29,200 lf
Inspection Year	2024 and 2025
No Structural Defects	125 (81%)
Maximum Structural Grade 1–2 (Good to Fair)	16 (10%)
Maximum Structural Grade 3 (Moderate Defects)	8 (5%)
Maximum Structural Grade 4 (Poor Condition)	6 (4%)
Maximum Structural Grade 5 (Immediate Attention)	0 (0%)
Maximum O&M Grade 3 (Significant Issues)	20
Maximum O&M Grade 4–5 (High Debris/Root Intrusion)	2
Most Common Structural Defects	Multiple cracks, joint offsets
Most Common O&M Defects	Deposits, roots

Notes:
lf - linear feet

6.1.1.2 Key Observations

Key findings from the 2024 and 2025 inspections include:

- 4 percent of inspected segments had Structural Grades of 4 or higher.
- Common structural defects included fractures, cracks, and joint offsets.
- Six segments were identified as high priority for renewal.

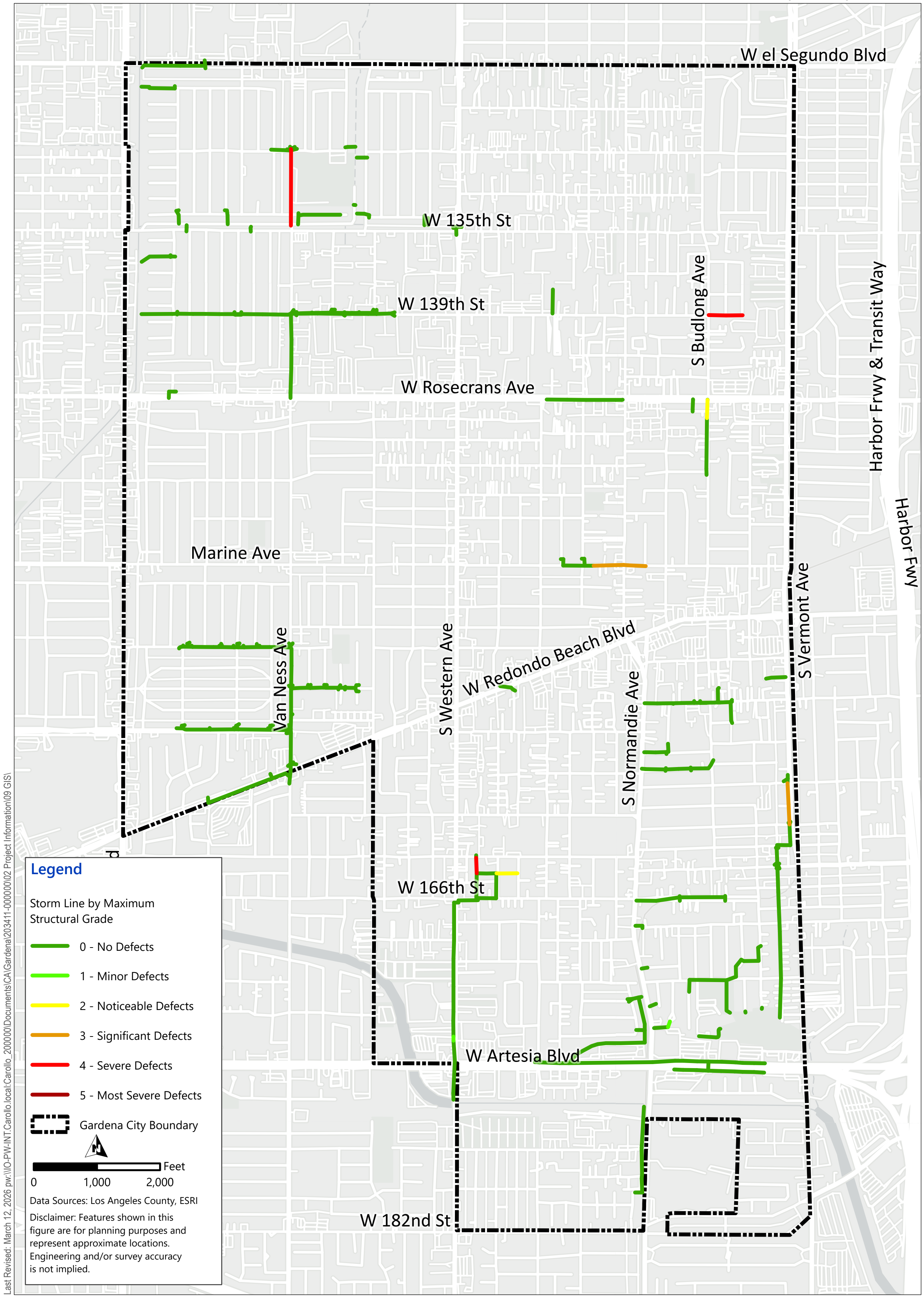

Figure 6.1 Maximum Structural Grades from CCTV Inspection

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Figure 6.2 Maximum O&M Grades from CCTV Inspection

6.2 Condition Based Recommendations

Two sets of recommendations were developed to mitigate structural deficiencies and recommended O&M activities based on the condition assessment data. Table 6.3 summarizes these recommendations. The pipe segments flagged as needing a structural project were cross-checked with the capacity project recommendations developed in Chapter 5. Segments that overlapped with capacity projects had their condition assessment project removed. A total of four segments were identified as needing an R&R project.

In addition, Table 6.3 lists pipe segments with recommended O&M activities consisting of root control and cleaning. These recommendations do not have projects IDs as they are recommended to be completed during the City's routine O&M efforts.

Table 6.3 System Condition Projects Summary

Project ID	Location / Description	Basis for Recommendation	Recommended Action	Pipe Diameter (inches)	Pipe Length (linear feet)	Capacity Project?
SD-18	134th Place	Segment is coded as Broken. Replacement recommended.	Replace	12	250	No
SD-19	Vermont Avenue	Segment has longitudinal fractures. Lining is recommended.	Line	30	655	No
SD-20	139th Street	Segment has an infiltration dripper. Spot repair recommended.	Spot Repair	--	275	No
SD-20	132nd Street	Segment has fine deposits. Spot repair recommended.	Spot Repair	--	20	No
-	Budlong Avenue	Roots present. Root control recommended.	Root Control	18	240	-
-	Magnolia Avenue	Roots present. Root control recommended.	Root Control	18	190	-
-	169th Place	Roots present. Root control recommended.	Root Control	18	90	-
-	Hobart Boulevard	Roots present. Root control recommended.	Root Control	12	80	-
-	Redondo Beach Boulevard	Roots present. Root control recommended.	Root Control	15	100	-
-	Redondo Beach Boulevard	Roots present. Root control recommended.	Root Control	60	60	-
-	156th Street	Grease present. Inspection recommended.	Inspect Source of Grease	36	0	-
-	Rosecrans Avenue	Grease present. Inspection recommended.	Inspect Source of Grease	30	0	-
-	Redondo Beach Boulevard	Grease present. Inspection recommended.	Inspect Source of Grease	24	0	-

Project ID	Location / Description	Basis for Recommendation	Recommended Action	Pipe Diameter (inches)	Pipe Length (linear feet)	Capacity Project?
-	139th Street	Cleaning recommended.	Clean	60	280	-
-	132nd Street	Cleaning recommended.	Clean	36	20	-
-	Budlong Avenue	Cleaning recommended.	Clean	15	70	-
-	139th Street	Cleaning recommended.	Clean	36	330	-
-	Budlong Avenue	Cleaning recommended.	Clean	15	30	-
-	Budlong Avenue	Cleaning recommended.	Clean	15	10	-
-	168th Street	Cleaning recommended.	Clean	18	50	-
-	New Hampshire Avenue	Cleaning recommended.	Clean	30	550	-
-	La Salle Avenue	Cleaning recommended.	Clean	12	20	-
-	Rosecrans Avenue	Cleaning recommended.	Clean	33	310	-
-	Alley	Cleaning recommended.	Clean	15	40	-
-	Alley	Cleaning recommended.	Clean	15	40	-
-	170th Street	Cleaning recommended.	Clean	15	40	-
-	Catalina Avenue	Cleaning recommended.	Clean	18	10	-
-	139th Street	Cleaning recommended.	Clean	60	450	-

6.2.1 Ongoing/Recommended Condition Assessment Strategy

To improve asset management and facilitate accurate CIP planning, the following steps are recommended:

- Inspect 10 percent of the system annually.
- Clean storm drains prior to inspection.
- Integrate inspection results into GIS and computerized maintenance management system platforms.

As more data is collected, the City can refine condition assessments, better manage risk, and optimize capital spending over time.

CHAPTER 7 CAPITAL IMPROVEMENT PROGRAM

This chapter presents the recommended CIP for the City's storm drainage system, a summary of the capital costs, and a basic assessment of the possible financial impact on individual existing and future users. This chapter is organized to assist the City in making financial decisions and in planning storm drainage system improvements and maintenance activities for the 10-year and 50-year design storms. The CIP is based on the evaluation of the City's storm drainage system, planning area, and land use, as detailed in the recommended projects described in the previous chapters.

7.1 Project Prioritization

As discussed in Chapters 5 and 6, the capital projects identified will allow the City to provide reliable storm water conveyance throughout the service area. The improvement projects were prioritized based on the following factors:

- Reducing the risk of stormwater ponding in the streets.
- Rehabilitating or replacing pipelines to prevent failures.

Based on these factors, each project was assigned an implementation year. More critical projects were phased into earlier phases (years) of the CIP.

7.2 Capital Improvement Project Costs

The proposed system improvements, capacity upgrades, and long-term maintenance plan set the foundation for the City's storm drainage system CIP. The cost estimates presented in this study are opinions developed from bid tabulations, cost curves, information obtained from previous studies, and Carollo's experience on other projects. The costs are based on the *Engineering News-Record* (ENR) Greater Los Angeles Construction Cost Index for May 2025, which is 15,977.

7.3 Cost Estimating Accuracy

The cost estimates presented in the CIP have been prepared for general master planning purposes and for guidance in project evaluation and implementation. Final costs of a project will depend on actual labor and material costs, competitive market conditions, final project scope, implementation schedule, and other variables such as preliminary alignment generation, investigation of alternative routings, and detailed utility and topography surveys.

The Association for the Advancement of Cost Engineering defines an order of magnitude estimate for master plan studies as an approximate estimate made without detailed engineering data. It is normally expected that an estimate of this type would be accurate within plus 50 percent to minus 30 percent. This section presents the assumptions used in developing order of magnitude cost estimates for recommended facilities.

7.4 Construction Unit Costs

The construction costs are representative of storm drainage system facilities under normal construction conditions and schedules. Construction costs have been estimated for public works improvements, assuming new construction within existing developed areas.

7.4.1 Pipeline Unit Costs

Storm drainage system pipeline improvements range in size from 8 inches to 48 inches in diameter. Pipe casings up to 48 inches in diameter are included for major crossings (e.g., creeks, canals, highways, railroad). Pipeline unit costs are shown in Table 7.1. The construction cost estimates are based upon these unit costs, which are for "typical" field conditions with construction in stable soil at a depth ranging between 10 to 15 feet. The unit costs below were compared to bid summaries of a sewer master plan performed by Carollo for the City in 2021 and were similar to cost estimates considered. All unit costs presented in Table 7.1 are for reinforced concrete pipe (RCP).

Table 7.1 Pipeline Construction Unit Costs

Diameter (inches)	Unit Cost ($/lf)[1]
8	$340
10	$400
12	$460
15	$585
18	$696
21	$773
24	$897
27	$1,033
30	$1,178
33	$1,264
36	$1,352
42	$1,557
48	$1,792

Notes:
(1) ENR Greater Los Angeles Construction Cost Index for May 2025 is 15,977.

7.5 Project Costs and Contingencies

Project cost estimates are calculated based on a variety of elements, such as the project location, size, length, land acquisition needs, and other factors. Allowances for project contingencies consistent with an order of magnitude estimate are also included in the project costs prepared as a part of this study, as outlined in this section.

7.5.1 Baseline Construction Cost

The baseline construction cost is the total estimated construction cost, in dollars, of the proposed improvement. Pipeline baseline construction costs were calculated by multiplying the estimated length by the unit cost listed in Table 7.1. All costs are presented in 2025 dollars.

7.5.2 Estimated Construction Cost

Contingency costs must be reviewed on a case-by-case basis because they will vary considerably with each project. Consequently, it is appropriate to allow for uncertainties associated with the preliminary layout of a project. Such factors as unexpected construction conditions, the need for unforeseen mechanical items, and variations in final quantities are a few of the items that can increase project costs, making it wise to incorporate allowances in preliminary estimates. To assist the City in making financial decisions for these future construction projects, construction contingency costs will be added to the planning budget as percentages of the baseline construction cost, ultimately providing the estimated construction cost.

Since knowledge about site-specific conditions of each proposed project is limited at the master planning stage, a 30 percent contingency was applied to the baseline construction cost to account for unforeseen events and unknown conditions. A 30 percent contingency to account for unknown site conditions such as poor soils, unforeseen conditions, environmental mitigations, and other unknowns is typical for master planning projects. The estimated construction cost for the proposed storm drainage system improvement is the baseline construction cost plus the 30 percent construction contingency.

7.5.3 Capital Improvement Cost

Other project construction contingency costs include costs associated with project engineering design and services, construction management, and legal services. Engineering services associated with new facilities include preliminary investigations and reports; right-of-way acquisition; foundation explorations; preparation of drawings and specifications during construction; surveying and staking; sampling of testing material; and start-up services. For this study, engineering costs are assumed to equal 10 percent of the estimated construction cost.

Construction phase professional services cover items such as construction management, engineering services, materials testing, and inspections during construction. For this study, construction management costs are assumed to be equal to 10 percent of the estimated construction cost.

Finally, project administration costs cover items such as legal fees, environmental/CEQA compliance requirements, financing expenses, administrative costs, and interest during construction. The cost of these items varies, but for the purpose of this study, it is assumed that project administration costs equal 7.5 percent of the estimated construction cost.

The capital improvement cost is the total of the estimated construction cost (including construction contingency) plus the other contingencies discussed in the previous paragraphs. As shown in the following sample calculation of the capital improvement cost, the total cost of all project construction contingencies (construction, engineering services, construction management, and project administration) is 65.8 percent of the baseline construction cost. The 30 percent construction contingency is applied to the baseline construction cost to determine the estimated construction cost. Then, the 10 percent for engineering services, 10 percent for construction management, and 7.5 percent for project administration are applied to the estimated construction cost. This results in a total mark-up of 65.8 percent of the baseline cost. Note that contingencies were not applied to land acquisition costs. Calculation of 65.8 percent is the overall mark-up on the baseline construction cost to arrive at the capital improvement cost. It is not an additional contingency.

Example:

Baseline Construction Cost	**$1,000,000**
Construction Contingency (30%)	$300,000
Estimated Construction Subtotal	**$1,300,000**
Engineering Services (10%)	$130,000
Construction Management (10%)	$130,000
Project Administration (7.5%)	$97,500
Capital Improvement Cost	**$1,657,500**

A summary of the capital project costs is presented in Table 7.2. This table identifies the recommended improvement projects, provides a brief description of the project, identifies facility size (e.g., pipe diameter and length), and the capital improvement cost. The implementation timeframe was based on the priority of each project to correct existing deficiencies or to serve future users.

7.6 Capital Improvement Implementation

The CIPs are prioritized based on their urgency to mitigate existing deficiencies that currently cause flooding or capacity issues, other existing deficiencies, and for servicing anticipated development. The proposed capital improvements are based on analyses using both the 10-year and 50-year design storms. Additionally, condition related improvements were recommended based on the condition assessment. Proposed improvement implementation is described in more detail in Chapter 6. Exhibit maps for each improvement are provided in Appendix C.

Table 7.2 Recommended Capacity Improvements

Project ID	Project Name	Description	Existing Pipe Size (inches)	Proposed Pipe Size (inches)	Rounded Pipe Length (feet)	Unit Cost ($/lf)	Baseline Construction Cost ($)(3)	Total Construction Cost ($)	Total Capital Cost ($)(1,2,4,5,6)
Capacity Related Improvements									
10-Year Improvements									
SD-01	S New Hampshire Avenue	Replacing approximately 3,545 feet of 18- to 33-inch diameter pipelines along S New Hampshire Avenue with 33- to 48-inch diameter pipelines.	18	33	25	$1,264	$31,700	$41,300	$52,600
			18	24	155	$897	$139,100	$180,900	$230,600
			24	30	85	$1,178	$100,200	$130,300	$166,100
			33	42	1,535	$1,557	$2,389,300	$3,106,100	$3,960,300
			33	48	1,745	$1,792	$3,127,200	$4,065,400	$5,183,400
SD-02	Magnolia Avenue	Replacing approximately 1,715 feet of 10- to 18-inch diameter pipelines along Magnolia Avenue with 18- to 36-inch diameter pipelines.	10, 12	18	340	$696	$236,700	$307,800	$392,400
			18	24	205	$897	$184,000	$239,200	$305,000
			18	30	585	$1,178	$689,000	$895,700	$1,142,100
			18	36	585	$1,352	$790,800	$1,028,100	$1,310,800
SD-03	W 135th Street	Replacing approximately 80 feet of 12-inch diameter pipelines along W 135th Street with 18-inch diameter pipelines.	12	18	80	$696	$55,700	$72,500	$92,400
SD-04	W 160th Street	Replacing approximately 1,210 feet of 15-inch diameter pipelines along W 160th Street with 21- and 24-inch diameter pipelines.	15	21	430	$773	$332,400	$432,200	$551,000
			15	24	780	$897	$699,900	$909,900	$1,160,100
SD-05	W 144th Street	Replacing approximately 35 feet of 6-inch diameter pipelines along W 144th Street with 12-inch diameter pipelines.	6	12	35	$460	$16,200	$21,100	$26,900
SD-06	S Normandie Avenue	Replacing approximately 1,490 feet of 15- to 18-inch diameter pipelines along S Normandie Avenue with 18- to 30-inch diameter pipelines. The improvement is intended to upgrade the capacity of the existing system.	15	18	340	$696	$236,700	$307,800	$392,400
			13, 15	24	455	$897	$408,300	$530,800	$676,800
			18	30	695	$1,178	$818,600	$1,064,200	$1,356,900
SD-07	S Western Avenue	Replacing approximately 2,135 feet of 12- to 40-inch diameter pipelines along S Western Avenue with 18- to 48-inch diameter pipelines.	12	18	300	$696	$208,800	$271,500	$346,100
			12, 15	24	450	$897	$403,800	$525,000	$669,300
			18, 24	30	450	$1,178	$530,000	$689,000	$878,500
			40	42	320	$1,557	$498,100	$647,600	$825,700
			40	48	630	$1,792	$1,129,000	$1,467,700	$1,871,400
SD-08	W Redondo Beach Boulevard	Replacing approximately 1,490 feet of 24-inch diameter pipelines along W Artesia Boulevard with 30- to 42-inch diameter pipelines.	24	30	85	$1,178	$100,200	$130,300	$166,100
			24	36	1,090	$1,352	$1,473,400	$1,915,500	$2,442,200
			24	42	315	$1,557	$490,400	$637,600	$812,900
SD-09	W Artesia Boulevard	Replacing approximately 1,865 feet of 24-inch diameter pipelines along W Artesia Boulevard with 36-inch diameter pipelines.	24	36	1,865	$1,352	$2,521,000	$3,277,300	$4,178,600
SD-10	W Artesia Boulevard	Replacing approximately 890 feet of 18-inch diameter pipelines along W Artesia Boulevard with 30- to 36-inch diameter pipelines.	18	30	180	$1,178	$212,000	$275,600	$351,400
			18	36	710	$1,352	$959,800	$1,247,800	$1,590,900
Subtotal 10-Year Improvements							**$17,610,500**	**$22,894,800**	**$29,190,600**

Project ID	Project Name	Description	Existing Pipe Size (inches)	Proposed Pipe Size (inches)	Rounded Pipe Length (feet)	Unit Cost ($/lf)	Baseline Construction Cost ($)(3)	Total Construction Cost ($)	Total Capital Cost ($)(1,2,4,5,6)
50-Year Improvements									
SD-11	Marine Avenue	Replacing approximately 350 feet of 12-inch diameter pipelines along Marine Avenue with 15-inch diameter pipelines.	12	15	350	$585	$204,700	$266,200	$339,300
SD-12	129th Street	Replacing approximately 550 feet of 24-inch diameter pipelines along 129th Street with 30-inch diameter pipelines.	24	30	50	$1,178	$58,900	$76,600	$97,700
SD-13	W 139th Street	Replacing approximately 125 feet of 18-inch diameter pipelines along W 139th Street with 24-inch diameter pipelines.	18	24	125	$897	$112,200	$145,900	$186,000
SD-14	Van Ness Avenue	Replacing approximately 1,195 feet of 30-inch diameter pipelines along Van Ness Avenue with 36-inch diameter pipelines.	30	36	1,195	$1,352	$1,615,400	$2,100,100	$2,677,600
SD-15	W 139th Street	Replacing approximately 540 feet of 12- and 15-inch diameter pipelines along W 139th Street with 15- and 18-inch diameter pipelines.	12	15	265	$585	$155,000	$201,500	$257,000
			15	18	275	$696	$191,400	$248,900	$317,300
SD-16	W 166th Street	Replacing approximately 1,475 feet of 12- to 24-inch diameter pipelines along W 166th Street with 24- and 30-inch diameter pipelines.	12, 18	24	785	$897	$704,400	$915,800	$1,167,600
			24	30	690	$1,178	$812,700	$1,056,600	$1,347,100
SD-17	W 159th Street	Replacing approximately 515 feet of 12- and 15-inch diameter pipelines along W 159th Street with 18- and 24-inch diameter pipelines.	12	18	160	$696	$111,400	$144,900	$184,700
			15	24	355	$897	$318,600	$414,200	$528,100
Subtotal 50-Year Improvements							**$4,284,700**	**$5,570,700**	**$7,102,400**
Condition Related Improvements (Spot Repairs / Observed Deposits) (7)									
SD-18	134th Place	Replacing approximately 250 feet of 6-inch diameter pipeline along 134th Place with a 12-inch diameter pipeline.	6	12	250	$460	$115,200	$149,800	$191,000
SD-19	Vermont Avenue	Line approximately 655 feet of 30-inch diameter pipeline along Vermont Avenue.	30	30	655	$630	$412,700	$536,600	$684,100
SD-20	132nd Street and 139th Street	This project consists of spot repairs for two storm drains along 132nd Street and 139th Street.	--	--	2	$5,000	$10,000	$13,000	$16,600
Subtotal Condition Related Improvements							**$537,900**	**$699,400**	**$891,700**
Total Capacity Related Improvements							**$22,433,100**	**$29,164,900**	**$37,184,700**

Notes:
(1) All costs are in 2025 dollars.
(2) ENR Greater Los Angeles Construction Cost Index for May 2025 is 15,977.
(3) Baseline construction cost is based on multiplying the unit cost by length of each proposed diameter.
(4) Cost estimates do not include costs for land acquisition, easements or ROW acquisition.
(5) Total project costs include a 10% markup for engineering, and a 10% markup for construction management and a 7.5% markup for project administration of the estimated construction cost.
(6) Estimated construction cost includes a 30% contingency of the baseline construction cost.
(7) Condition related improvements consist of spot repairs and addressing observed defects or deposits in the storm drain system.

APPENDIX A SOIL RESOURCE REPORT

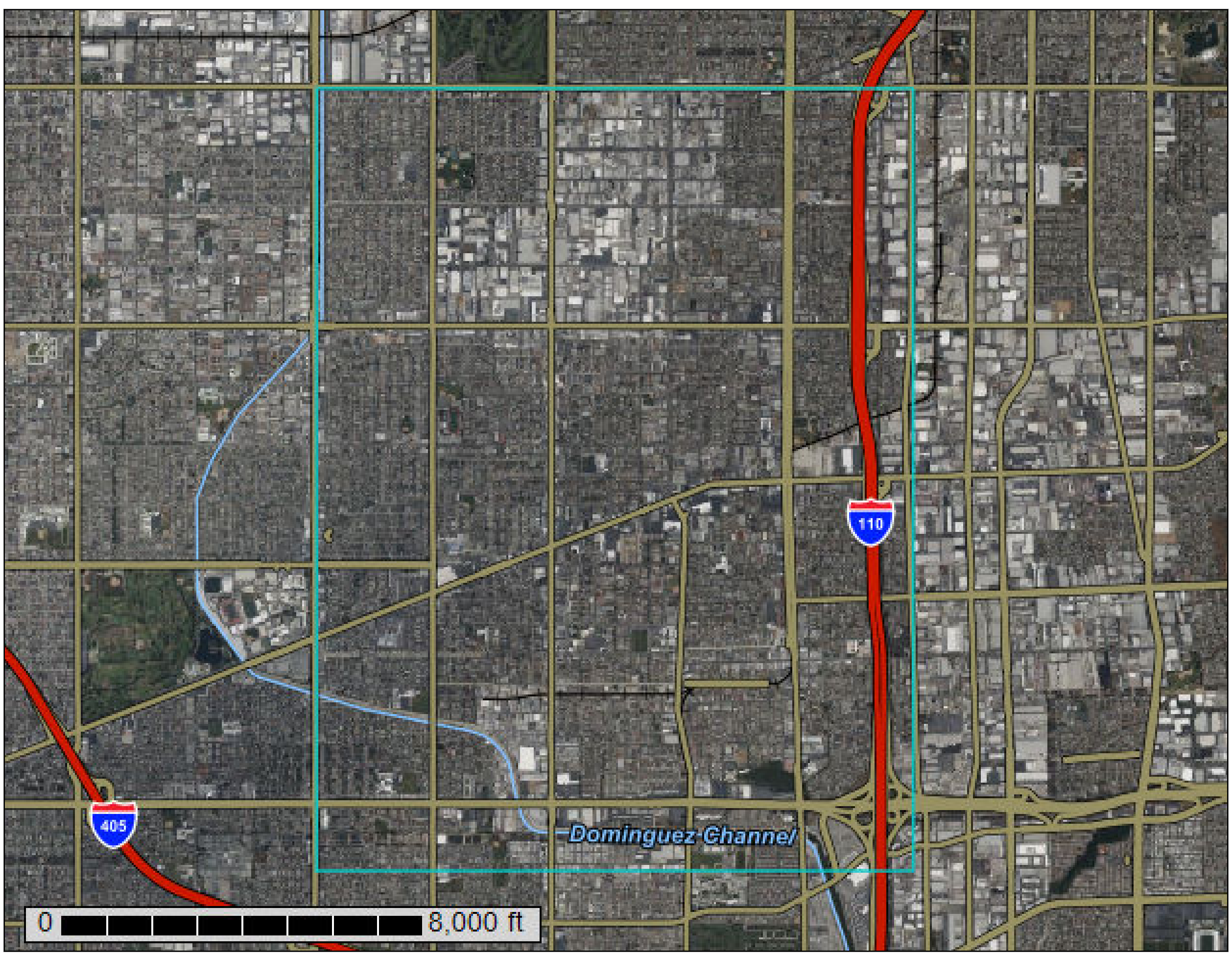
United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Los Angeles County, California, Southeastern Part



February 10, 2025

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

Preface.. 2
How Soil Surveys Are Made..5
Soil Map.. 8
Soil Map..9
Legend..10
Map Unit Legend.. 11
Map Unit Descriptions..11
Los Angeles County, California, Southeastern Part..13
1013—Urban land-Centinela-Typic Xerorthents, fine substratum complex, 0 to 2 percent slopes.. 13
1014—Urban land-Aquic Xerorthents, fine substratum-Cropley complex, 0 to 5 percent slopes.. 15
1125—Urban land-Typic Xerorthents, terraced-Windfetch complex, 2 to 9 percent slopes..17
1130—Urban land-Windfetch-Typic Haploxerolls complex, 0 to 2 percent slopes..20
1133—Urban land-Thums-Windfetch complex, 0 to 2 percent slopes........ 22
W—Water..25
References..26

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

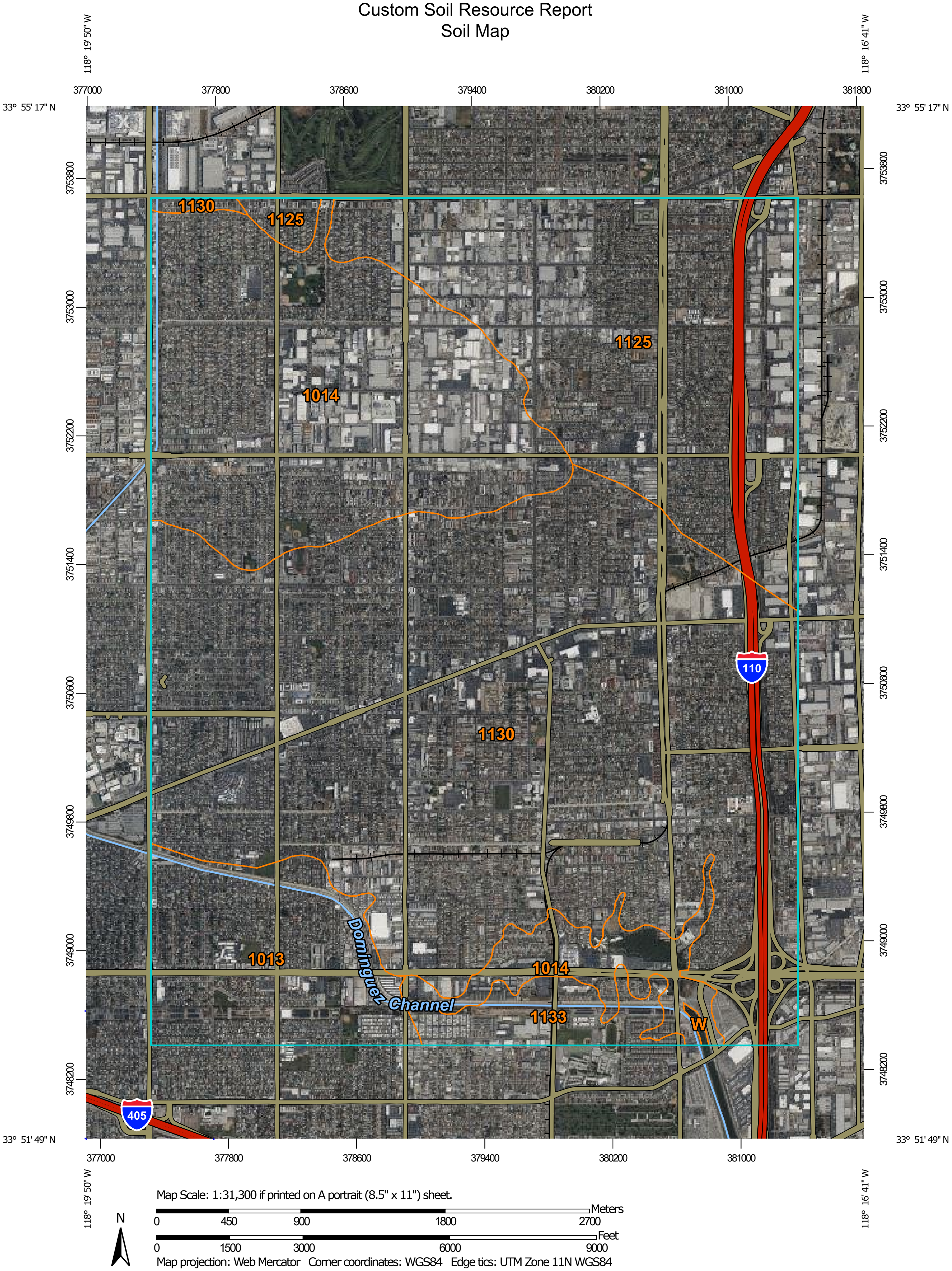
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map


118° 19' 50" W
118° 16' 41" W
33° 55' 17" N
33° 51' 49" N
377000
377800
378600
379400
380200
381000
381800
3753800
3753000
3752200
3751400
3750600
3749800
3749000
3748200
1130
1125
1014
1013
1133
W
Dominguez Channel
110
405
Map Scale: 1:31,300 if printed on A portrait (8.5" x 11") sheet.
Meters
0 450 900 1800 2700
Feet
0 1500 3000 6000 9000
N
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Los Angeles County, California, Southeastern Part
Survey Area Data: Version 11, Sep 3, 2024

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Apr 14, 2022—Apr 23, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1013	Urban land-Centinela-Typic Xerorthents, fine substratum complex, 0 to 2 percent slopes	408.8	7.7%
1014	Urban land-Aquic Xerorthents, fine substratum-Cropley complex, 0 to 5 percent slopes	1,164.9	22.1%
1125	Urban land-Typic Xerorthents, terraced-Windfetch complex, 2 to 9 percent slopes	1,053.1	20.0%
1130	Urban land-Windfetch-Typic Haploxerolls complex, 0 to 2 percent slopes	2,520.8	47.8%
1133	Urban land-Thums-Windfetch complex, 0 to 2 percent slopes	127.5	2.4%
W	Water	3.3	0.1%
Totals for Area of Interest		**5,278.5**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Los Angeles County, California, Southeastern Part

1013—Urban land-Centinela-Typic Xerorthents, fine substratum complex, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2tb9h
Elevation: 0 to 120 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 62 to 64 degrees F
Frost-free period: 360 to 365 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Urban land: 55 percent
Centinela and similar soils: 20 percent
Typic xerorthents, fine substratum, and similar soils: 15 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Setting

Landform: Terraces

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: 0 inches to manufactured layer
Runoff class: Very high

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Ecological site: R019XG909CA - Terrace
Hydric soil rating: No

Description of Centinela

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Discontinuous human-transported material over mixed alluvium

Typical profile

^A - 0 to 3 inches: loam
^Cu - 3 to 17 inches: loam
2Bss - 17 to 37 inches: clay
2Bkss - 37 to 55 inches: clay
2Bk - 55 to 79 inches: clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained

Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: Rare
Calcium carbonate, maximum content: 2 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 4.0
Available water supply, 0 to 60 inches: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: C
Ecological site: R019XG909CA - Terrace
Hydric soil rating: No

Description of Typic Xerorthents, Fine Substratum

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Human-transported material over mixed alluvium

Typical profile

^A - 0 to 4 inches: clay loam
^Cu - 4 to 12 inches: clay loam
^C1 - 12 to 28 inches: clay
^C2 - 28 to 37 inches: loam
2Bkss - 37 to 55 inches: clay
2Bkss - 55 to 79 inches: clay

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 4.0
Available water supply, 0 to 60 inches: High (about 9.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: C
Ecological site: R019XG909CA - Terrace
Hydric soil rating: No

Minor Components

Aquic haploxerepts

Percent of map unit: 5 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Typic xerorthents, coarse fill surface

Percent of map unit: 5 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

1014—Urban land-Aquic Xerorthents, fine substratum-Cropley complex, 0 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2w612
Elevation: 0 to 240 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 63 to 64 degrees F
Frost-free period: 360 to 365 days
Farmland classification: Prime farmland if irrigated and drained

Map Unit Composition

Urban land: 55 percent
Cropley and similar soils: 20 percent
Aquic xerorthents, fine substratum, and similar soils: 20 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Setting

Landform: Alluvial fans

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 0 inches to manufactured layer
Runoff class: Very high
Frequency of flooding: Rare
Frequency of ponding: Rare

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Ecological site: R019XG911CA - Loamy Fan
Hydric soil rating: No

Description of Aquic Xerorthents, Fine Substratum

Setting

Landform: Alluvial fans
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Human-transported material over mixed alluvium

Typical profile

^Au - 0 to 7 inches: loam
^Cu1 - 7 to 30 inches: loam
^Cu2 - 30 to 37 inches: loam
2Bkg - 37 to 79 inches: clay

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: Rare
Calcium carbonate, maximum content: 5 percent
Maximum salinity: Very slightly saline to slightly saline (2.0 to 4.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 10.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: C
Ecological site: R019XG911CA - Loamy Fan
Hydric soil rating: No

Description of Cropley

Setting

Landform: Alluvial fans
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Discontinuous human-transported material over mixed alluvium

Typical profile

^Au - 0 to 5 inches: clay loam
^Cu1 - 5 to 19 inches: clay
^Cu2 - 19 to 30 inches: clay
2Bkss - 30 to 47 inches: clay
2Bk - 47 to 79 inches: clay

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: Rare
Calcium carbonate, maximum content: 3 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: C
Ecological site: R019XG911CA - Loamy Fan
Hydric soil rating: No

Minor Components

Grommet

Percent of map unit: 5 percent
Landform: Alluvial fans
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

1125—Urban land-Typic Xerorthents, terraced-Windfetch complex, 2 to 9 percent slopes

Map Unit Setting

National map unit symbol: 2w615
Elevation: 20 to 260 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 63 to 64 degrees F
Frost-free period: 360 to 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 65 percent
Windfetch and similar soils: 15 percent
Typic xerorthents, terraced, and similar soils: 15 percent
Minor components: 5 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Setting

Landform: Fan remnants

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: 0 inches to manufactured layer
Runoff class: Very high

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Ecological site: R019XG911CA - Loamy Fan
Hydric soil rating: No

Description of Typic Xerorthents, Terraced

Setting

Landform: Fan remnants
Landform position (three-dimensional): Tread, riser
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Human-transported material

Typical profile

^A - 0 to 5 inches: loam
^Cu1 - 5 to 15 inches: clay loam
^Cu2 - 15 to 30 inches: clay loam
^Cu3 - 30 to 55 inches: clay loam
^Cu4 - 55 to 79 inches: clay loam

Properties and qualities

Slope: 2 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 3 percent
Maximum salinity: Very slightly saline to slightly saline (2.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 8.0
Available water supply, 0 to 60 inches: High (about 10.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: R019XG911CA - Loamy Fan
Hydric soil rating: No

Description of Windfetch

Setting

Landform: Fan remnants
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Riser
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Discontinuous human-transported material over mixed alluvium

Typical profile

^A - 0 to 2 inches: loam
^Au - 2 to 16 inches: loam
2Bt - 16 to 28 inches: clay loam
2Btk1 - 28 to 37 inches: clay loam
2Btk2 - 37 to 51 inches: loam
2Btk3 - 51 to 79 inches: loam

Properties and qualities

Slope: 2 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 3 percent
Maximum salinity: Very slightly saline to slightly saline (2.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 12.0
Available water supply, 0 to 60 inches: High (about 10.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: R019XG911CA - Loamy Fan
Hydric soil rating: No

Minor Components

Centinela

Percent of map unit: 3 percent
Landform: Fan remnants
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Thums

Percent of map unit: 1 percent
Landform: Fan remnants
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Riser
Down-slope shape: Linear

Across-slope shape: Linear
Hydric soil rating: No

Calcic haploxeralfs

Percent of map unit: 1 percent
Landform: Fan remnants
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Riser
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

1130—Urban land-Windfetch-Typic Haploxerolls complex, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2mytz
Elevation: 0 to 530 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 62 to 65 degrees F
Frost-free period: 360 to 365 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Urban land: 50 percent
Windfetch and similar soils: 25 percent
Typic haploxerolls and similar soils: 15 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Setting

Landform: Terraces

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: 0 inches to manufactured layer
Runoff class: Very high

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Ecological site: R019XG909CA - Terrace
Hydric soil rating: No

Description of Windfetch

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Discontinuous human-transported material over mixed alluvium

Typical profile

^A1 - 0 to 8 inches: loam
A2 - 8 to 26 inches: loam
A3 - 26 to 30 inches: loam
Bt - 30 to 41 inches: clay loam
Btk1 - 41 to 49 inches: clay loam
Btk2 - 49 to 79 inches: sandy clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 3 percent
Maximum salinity: Very slightly saline to slightly saline (2.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 10.0
Available water supply, 0 to 60 inches: High (about 10.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: R019XG909CA - Terrace
Hydric soil rating: No

Description of Typic Haploxerolls

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Discontinuous human-transported material over mixed alluvium

Typical profile

A1 - 0 to 6 inches: loam
A2 - 6 to 17 inches: fine sandy loam
C1 - 17 to 43 inches: fine sandy loam
C2 - 43 to 79 inches: fine sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches

Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 8.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: R019XG909CA - Terrace
Hydric soil rating: No

Minor Components

Sepulveda

Percent of map unit: 5 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Thums

Percent of map unit: 4 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Abaft

Percent of map unit: 1 percent
Landform: Dunes
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

1133—Urban land-Thums-Windfetch complex, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2p662
Elevation: 0 to 110 feet

Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 63 to 64 degrees F
Frost-free period: 360 to 365 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Urban land: 50 percent
Thums and similar soils: 20 percent
Windfetch and similar soils: 15 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Setting

Landform: Terraces

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: 0 inches to manufactured layer
Runoff class: Very high

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Ecological site: R019XG909CA - Terrace
Hydric soil rating: No

Description of Thums

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Discontinuous human-transported material over alluvium and/or palustrine estuarine deposits

Typical profile

^A - 0 to 3 inches: loam
^C - 3 to 10 inches: loam
2Btk1 - 10 to 24 inches: clay loam
2Btk2 - 24 to 43 inches: clay
2Btkn - 43 to 59 inches: clay

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Maximum salinity: Very slightly saline to slightly saline (2.0 to 4.0 mmhos/cm)

Sodium adsorption ratio, maximum: 20.0
Available water supply, 0 to 60 inches: High (about 9.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: C
Ecological site: R019XG909CA - Terrace
Hydric soil rating: No

Description of Windfetch

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Discontinuous human-transported material over alluvium and/or palustrine estuarine deposits

Typical profile

^Au - 0 to 5 inches: silt loam
^Cu - 5 to 16 inches: loam
2Btk1 - 16 to 35 inches: clay loam
2Btk2 - 35 to 47 inches: clay loam
2Btk3 - 47 to 57 inches: clay loam
2Btk4 - 57 to 65 inches: clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Maximum salinity: Very slightly saline to slightly saline (2.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 12.0
Available water supply, 0 to 60 inches: High (about 10.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: R019XG909CA - Terrace
Hydric soil rating: No

Minor Components

Sepulveda

Percent of map unit: 10 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear

Across-slope shape: Linear
Hydric soil rating: No

Typic argiaquolls, drained

Percent of map unit: 5 percent
Landform: Depressions
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

W—Water

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Water

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: Unranked

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APPENDIX B

STREET FLOW DIRECTION MAP

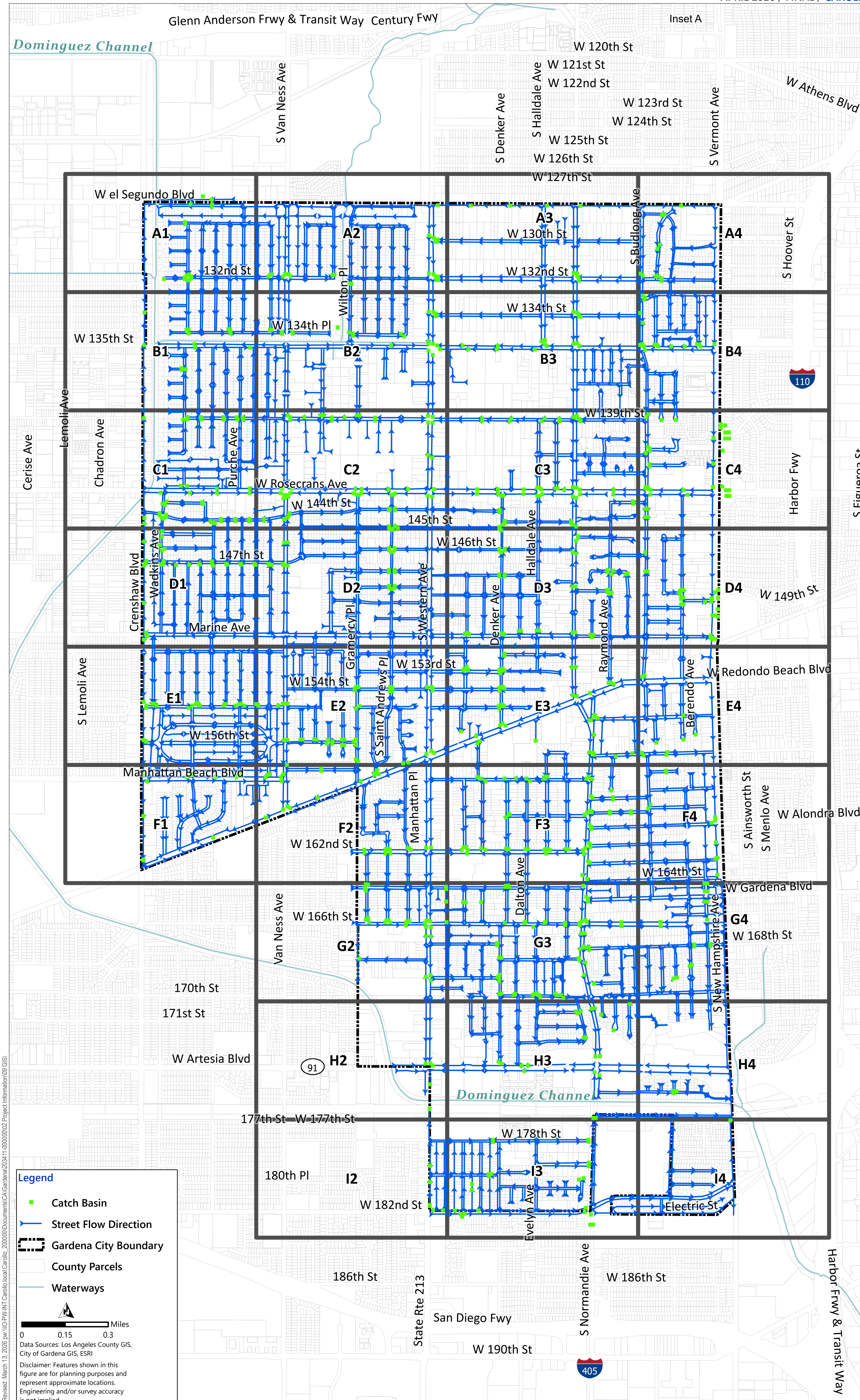


Figure B.1 Gardena Storm Street Flows Direction
CITY OF GARDENA

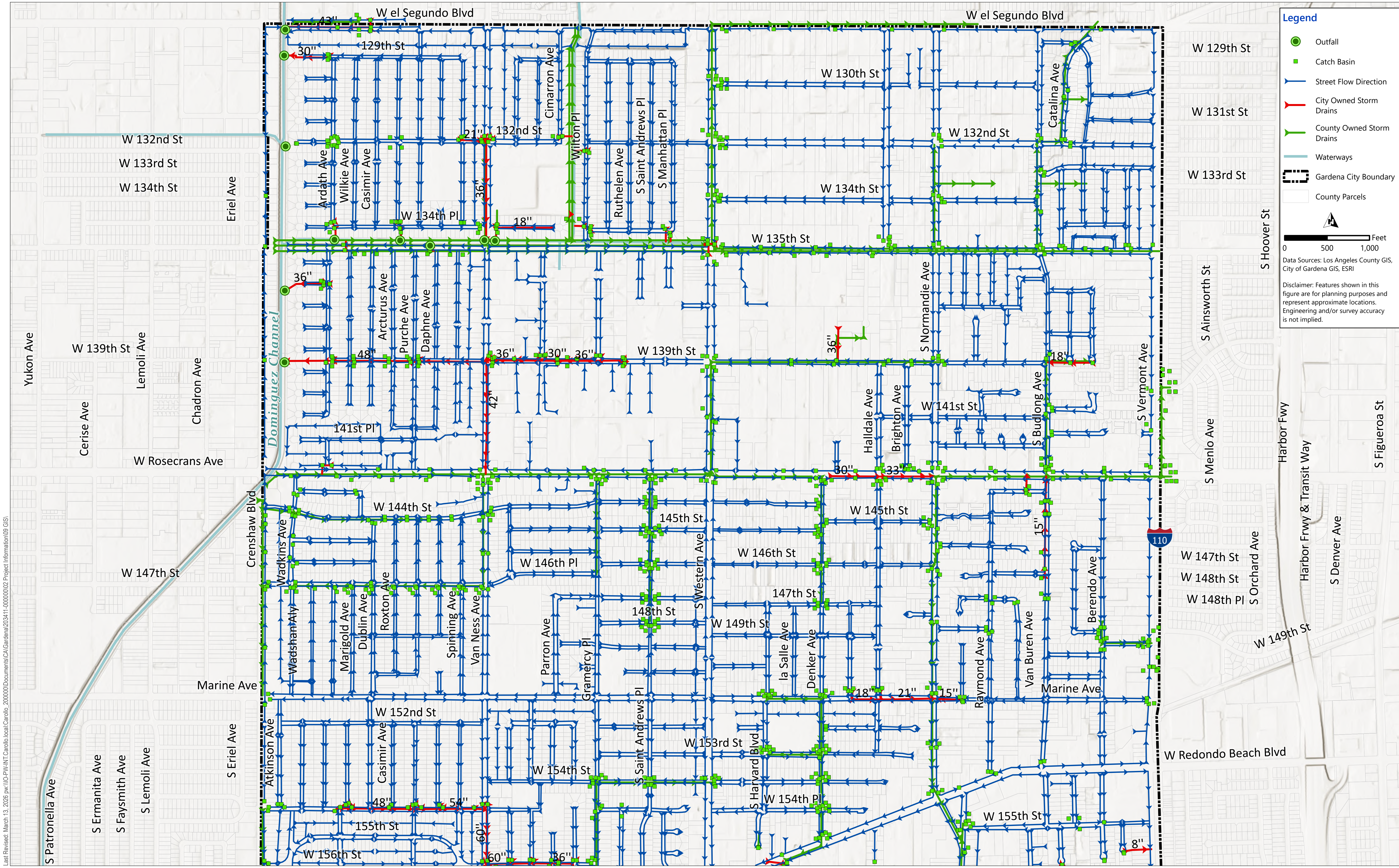


Figure B.2 Gardena Storm Street Flows Direction with Existing System Drains

CITY OF GARDENA

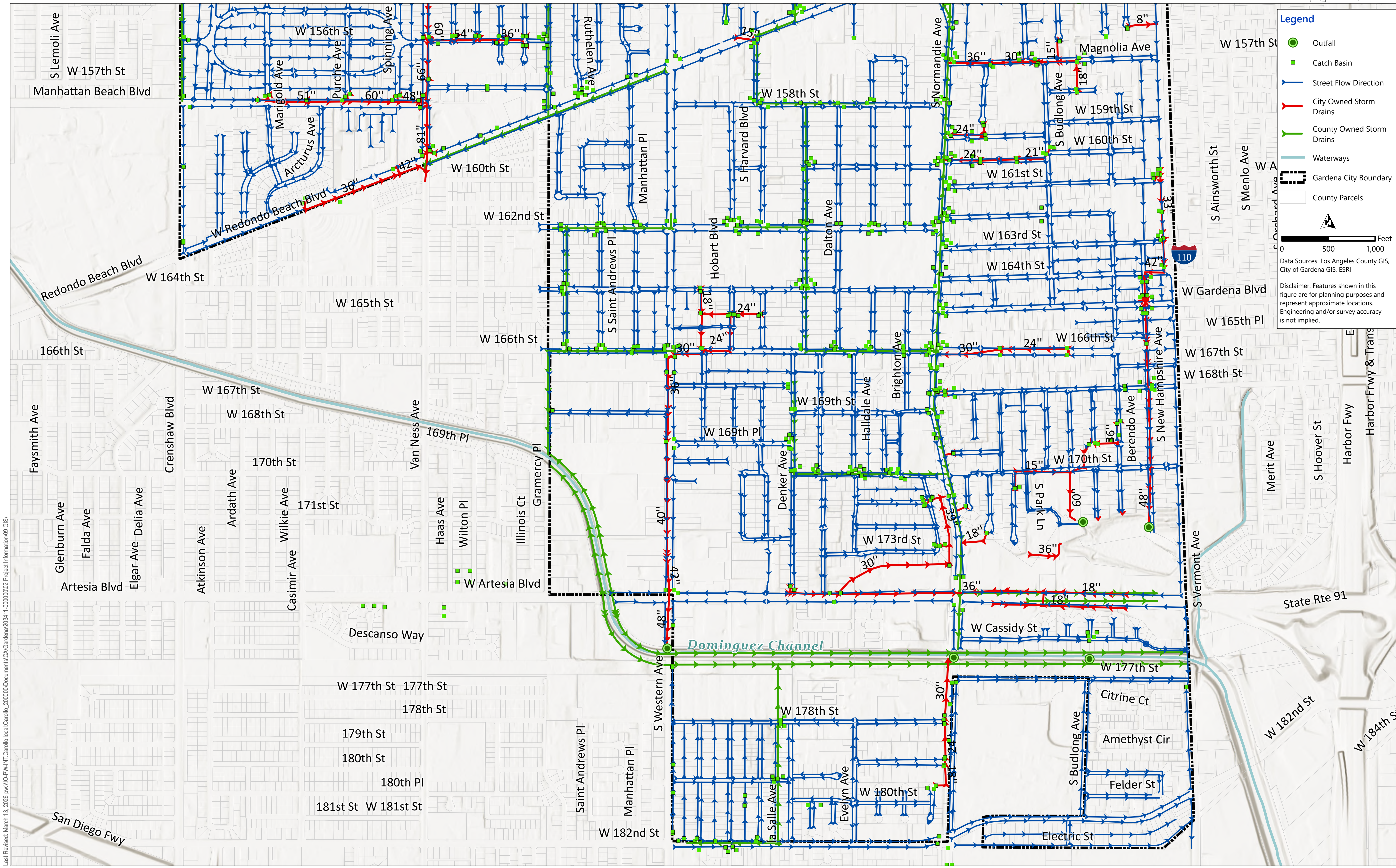
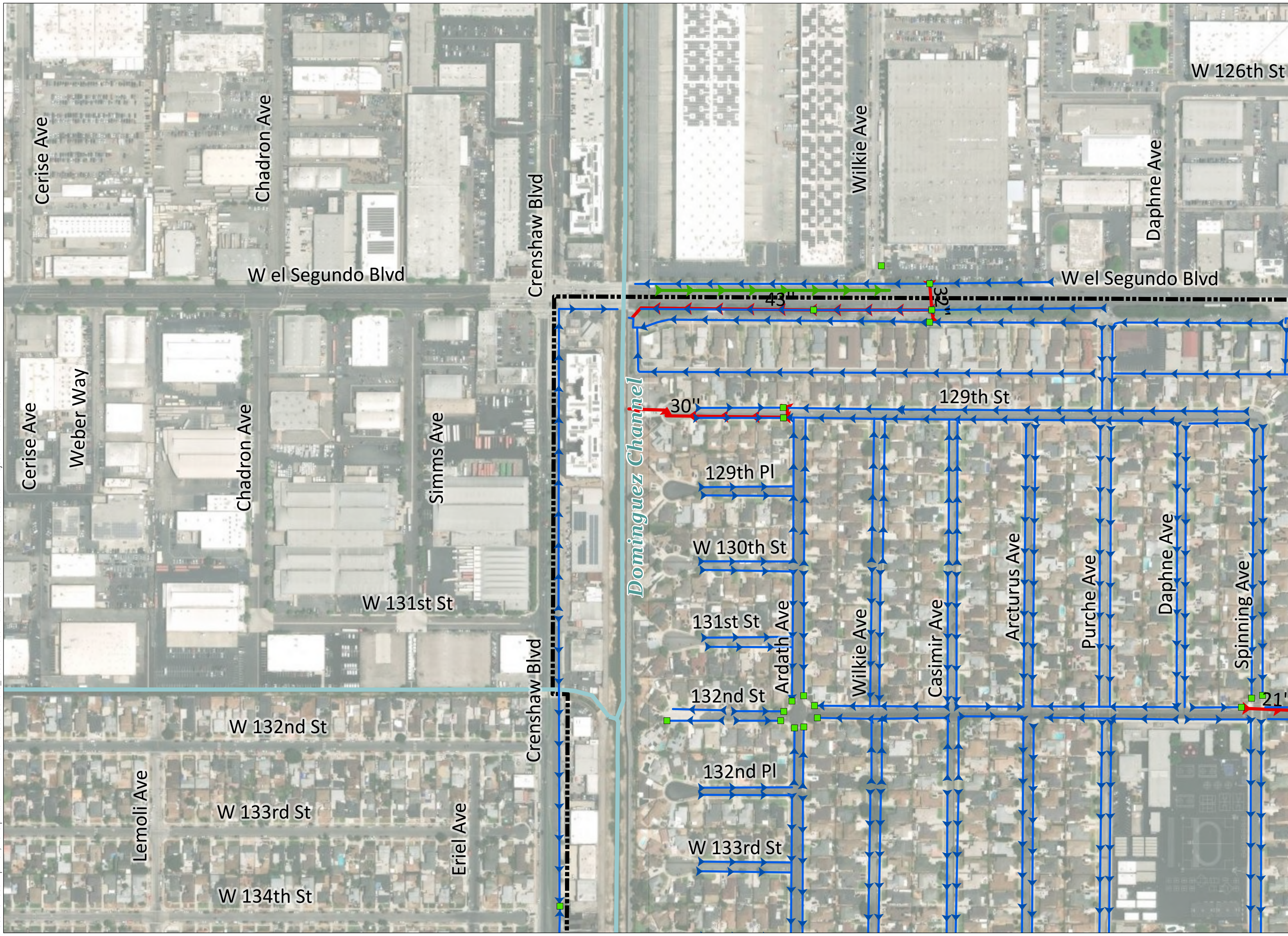


Figure B.3 Gardena Storm Street Flows Direction with Existing System Drains
CITY OF GARDENA



Legend

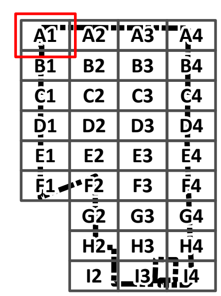
- Catch Basin
- Street Flow Direction
- County Owned Storm Drains
- City Owned Storm Drains
- Gardena City Boundary
- Waterways

Feet: 0, 250, 500

Data Sources: Los Angeles County GIS, City of Gardena GIS, ESRI

Disclaimer: Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.

Vicinity Map



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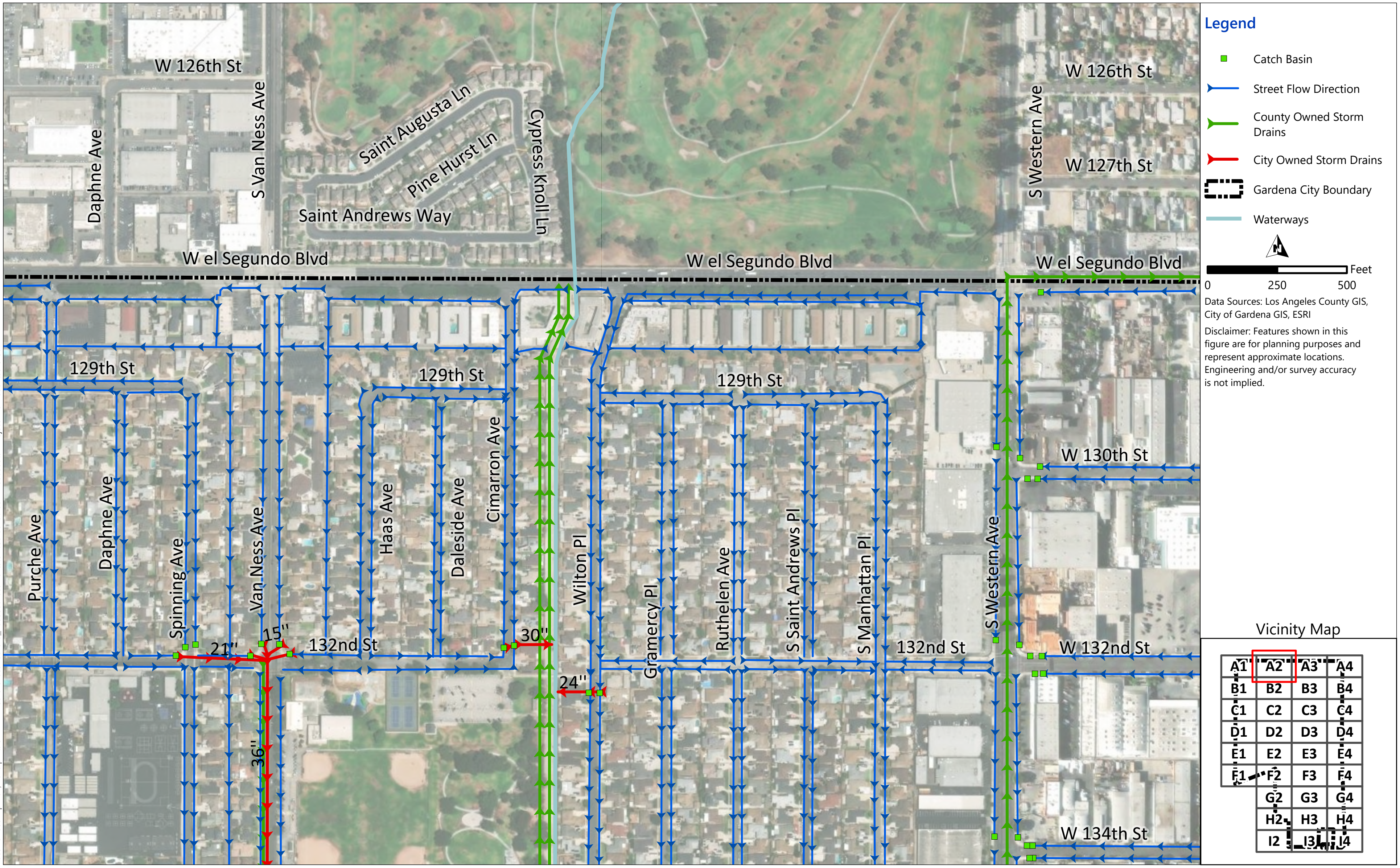
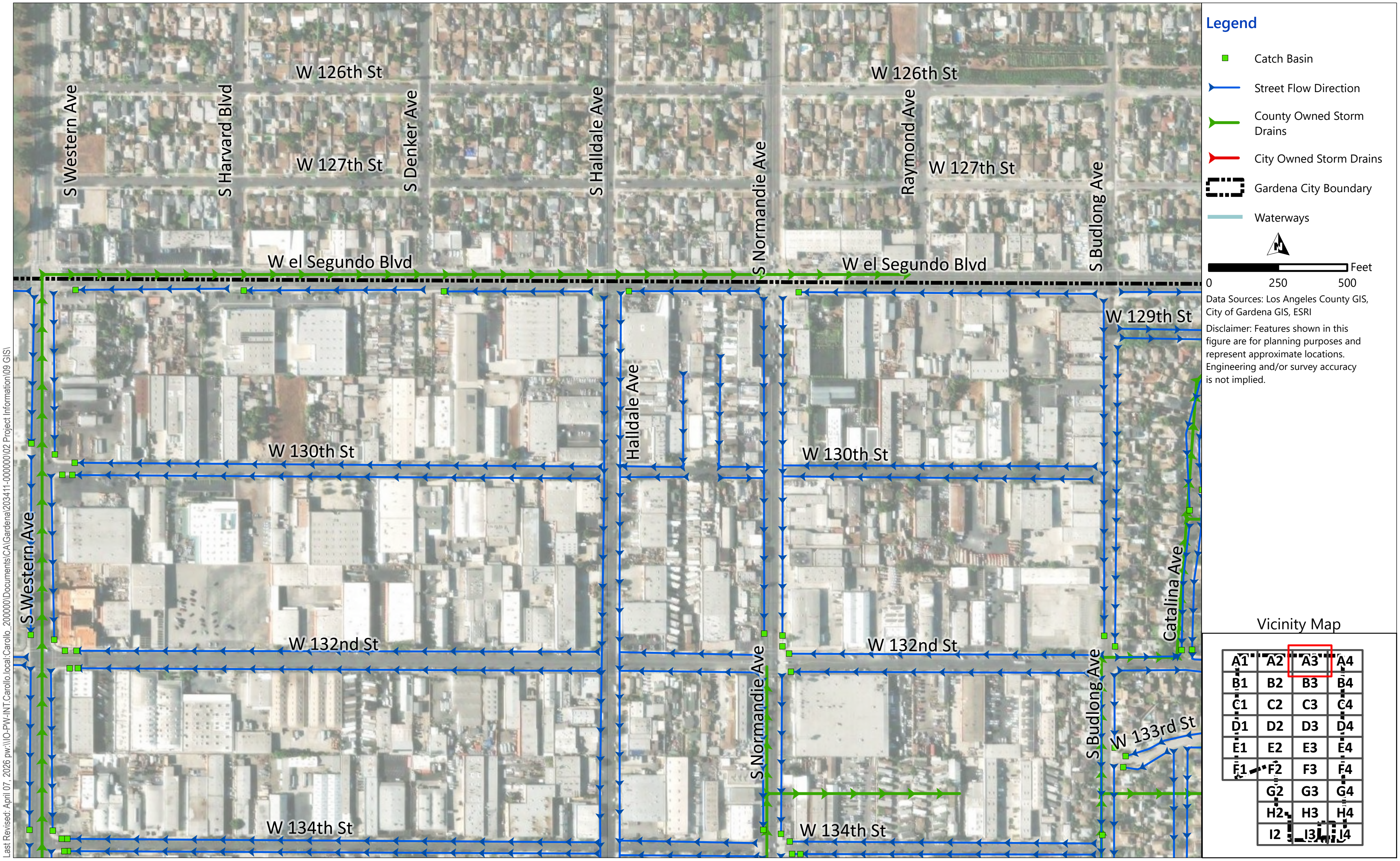
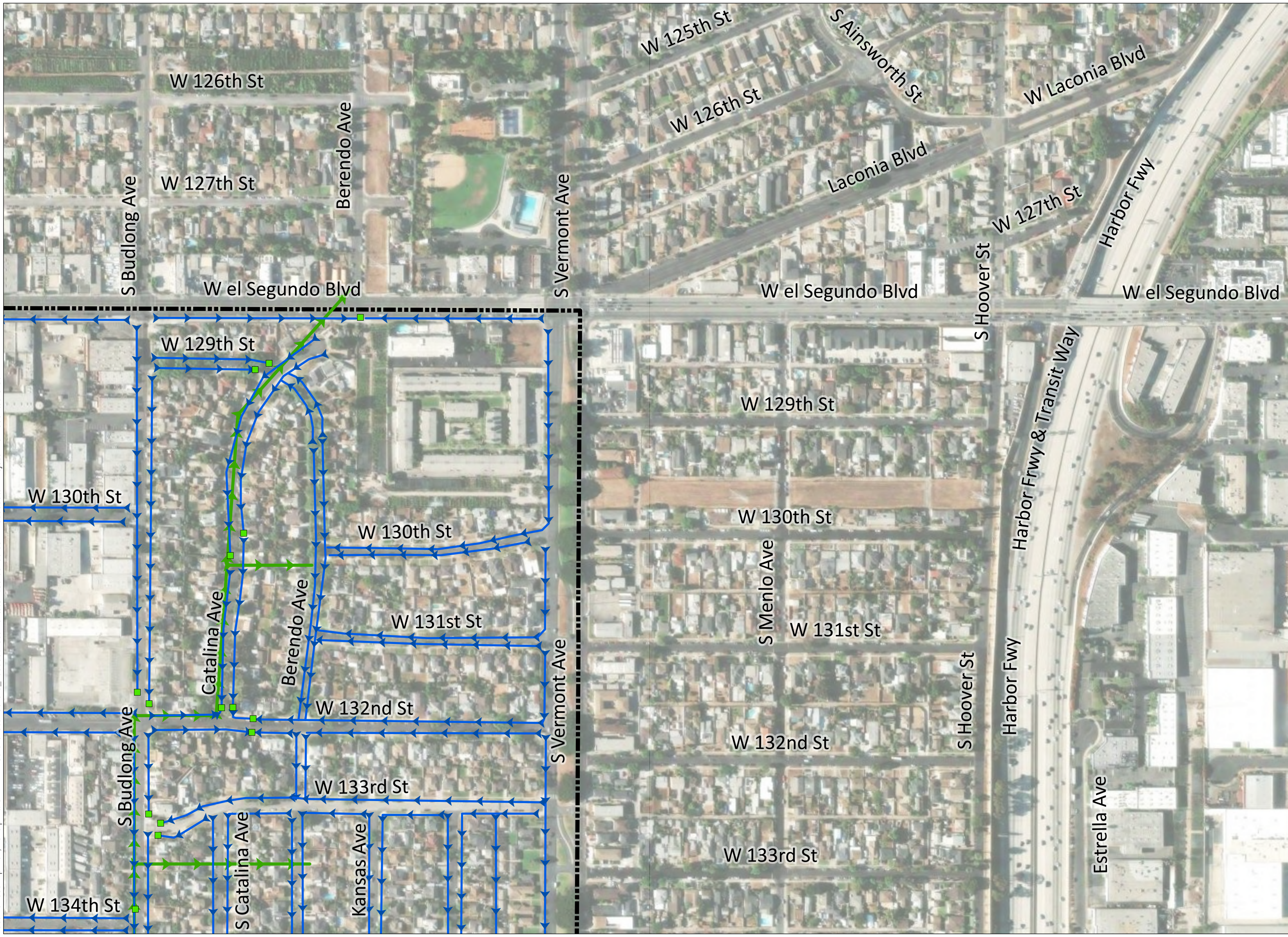


Street Flow Index Page A2



Street Flow Index Page A3

CITY OF GARDENA



Legend

- Catch Basin
- Street Flow Direction
- County Owned Storm Drains
- City Owned Storm Drains
- Gardena City Boundary
- Waterways

Feet
0 250 500

Data Sources: Los Angeles County GIS, City of Gardena GIS, ESRI

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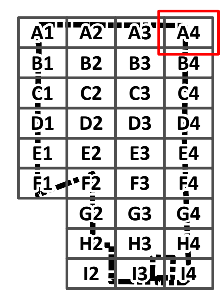
Vicinity Map



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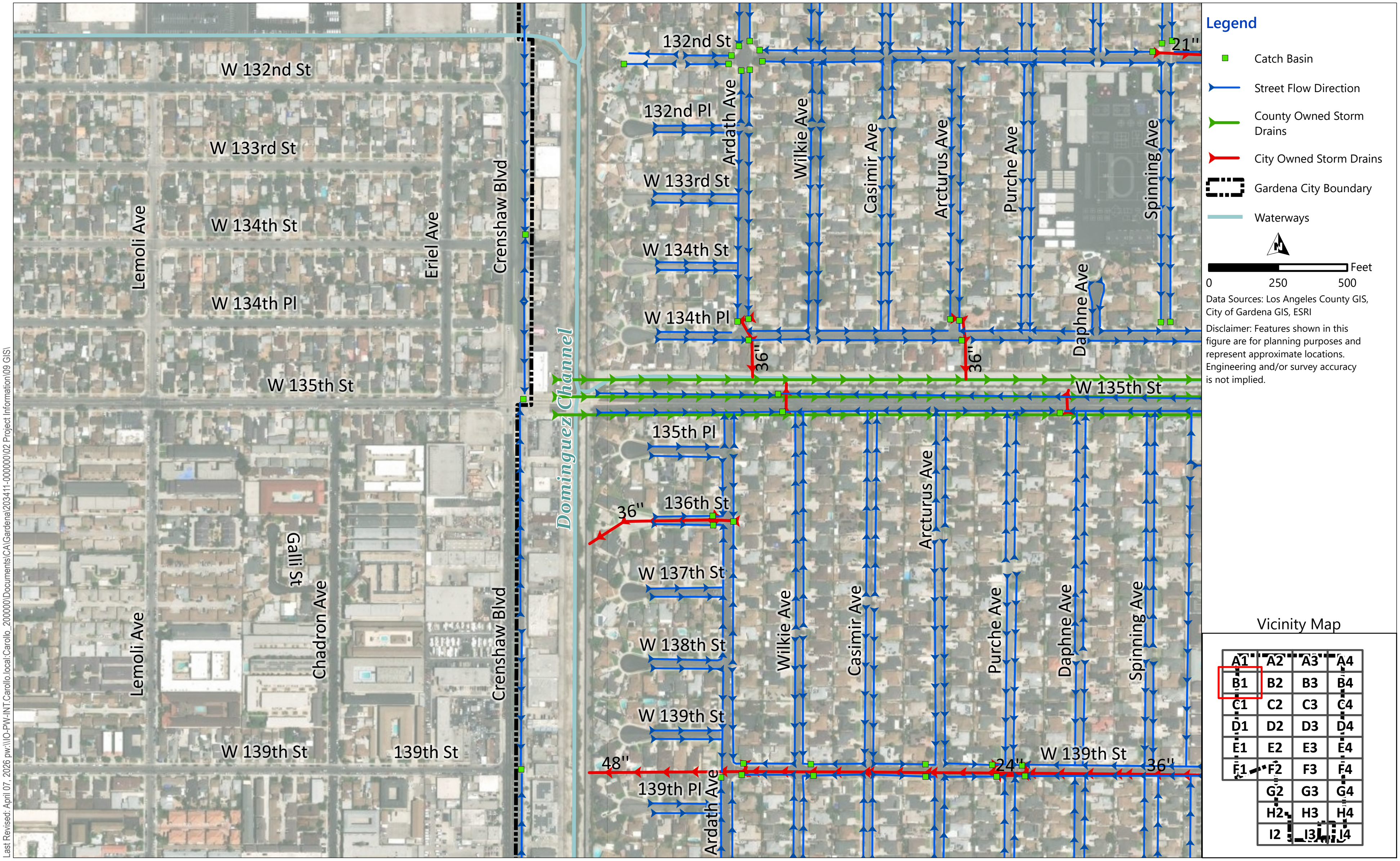
Street Flow Index Page A4

CITY OF GARDENA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W 139th St
139th St
139th Pl
Lemoli Ave
Eriel Ave
Crenshaw Blvd
Galli St
Chadron Ave
Dominguez Channel
Ardath Ave
Wilkie Ave
Casimir Ave
Arcturus Ave
Purche Ave
Daphne Ave
Spinning Ave
21"
36"
48"
24"
Legend
Catch Basin
Street Flow Direction
County Owned Storm Drains
City Owned Storm Drains
Gardena City Boundary
Waterways
Feet
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250
500
Data Sources: Los Angeles County GIS, City of Gardena GIS, ESRI
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Vicinity Map
A1 A2 A3 A4
B1 B2 B3 B4
C1 C2 C3 C4
D1 D2 D3 D4
E1 E2 E3 E4
F1 F2 F3 F4
G2 G3 G4
H2 H3 H4
I2 I3 I4
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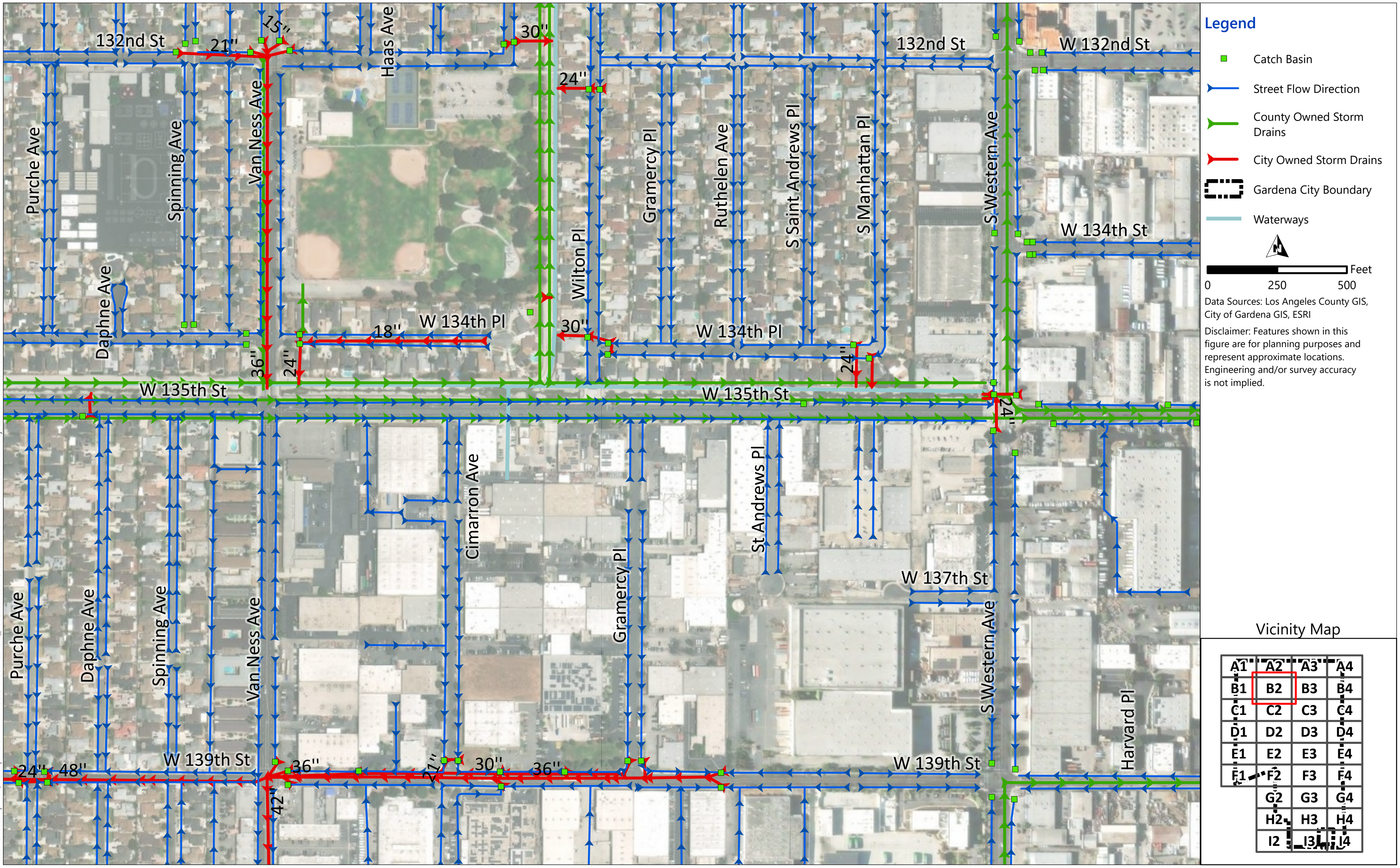

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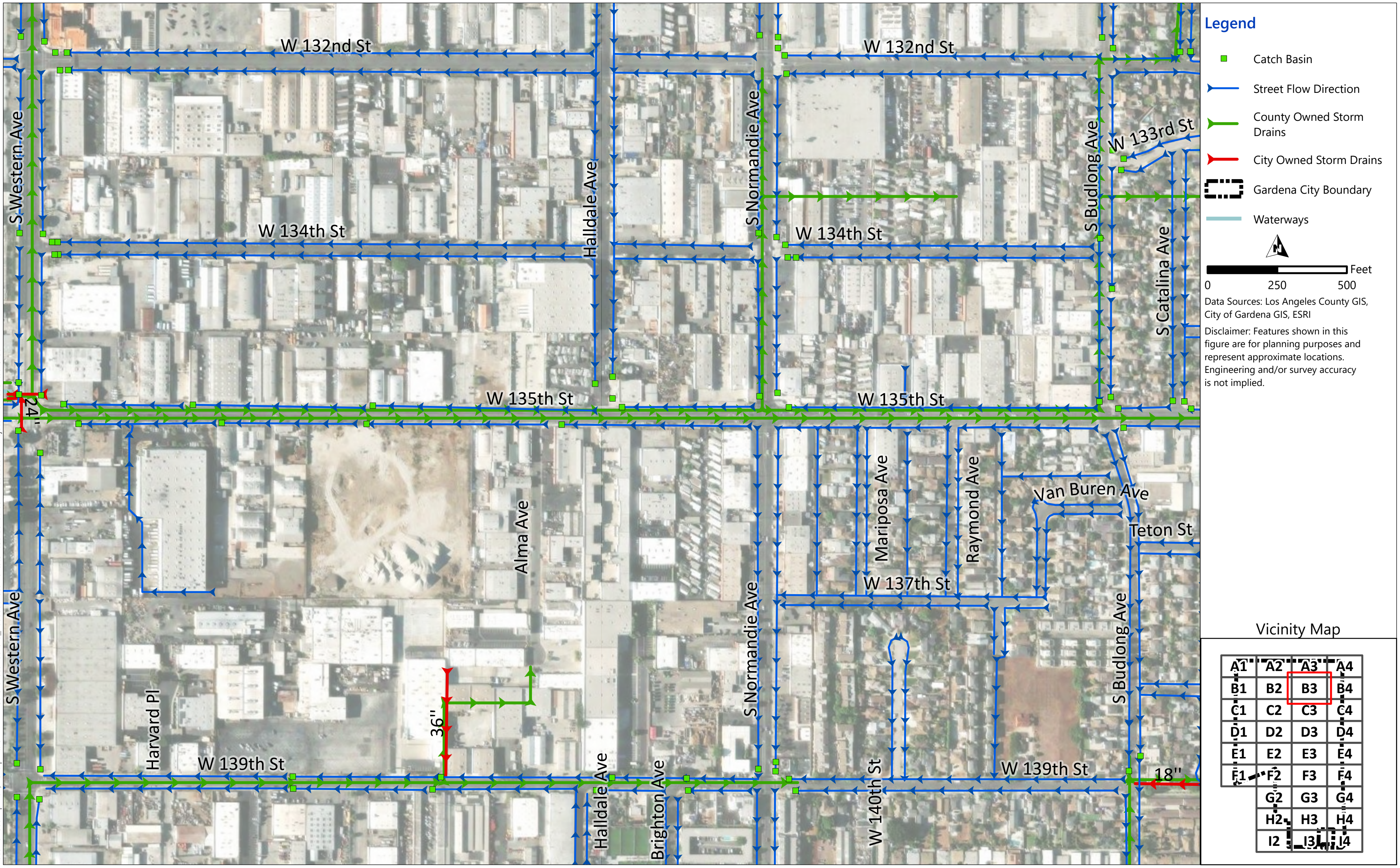
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S Western Ave
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Halldale Ave
Halldale Ave
S Normandie Ave
S Normandie Ave
S Budlong Ave
S Budlong Ave
S Catalina Ave
Mariposa Ave
Raymond Ave
Van Buren Ave
Teton St
Alma Ave
Harvard Pl
Brighton Ave
24"
36"
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Legend
Catch Basin
Street Flow Direction
County Owned Storm Drains
City Owned Storm Drains
Gardena City Boundary
Waterways
Feet
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250
500
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A1 A2 A3 A4
B1 B2 B3 B4
C1 C2 C3 C4
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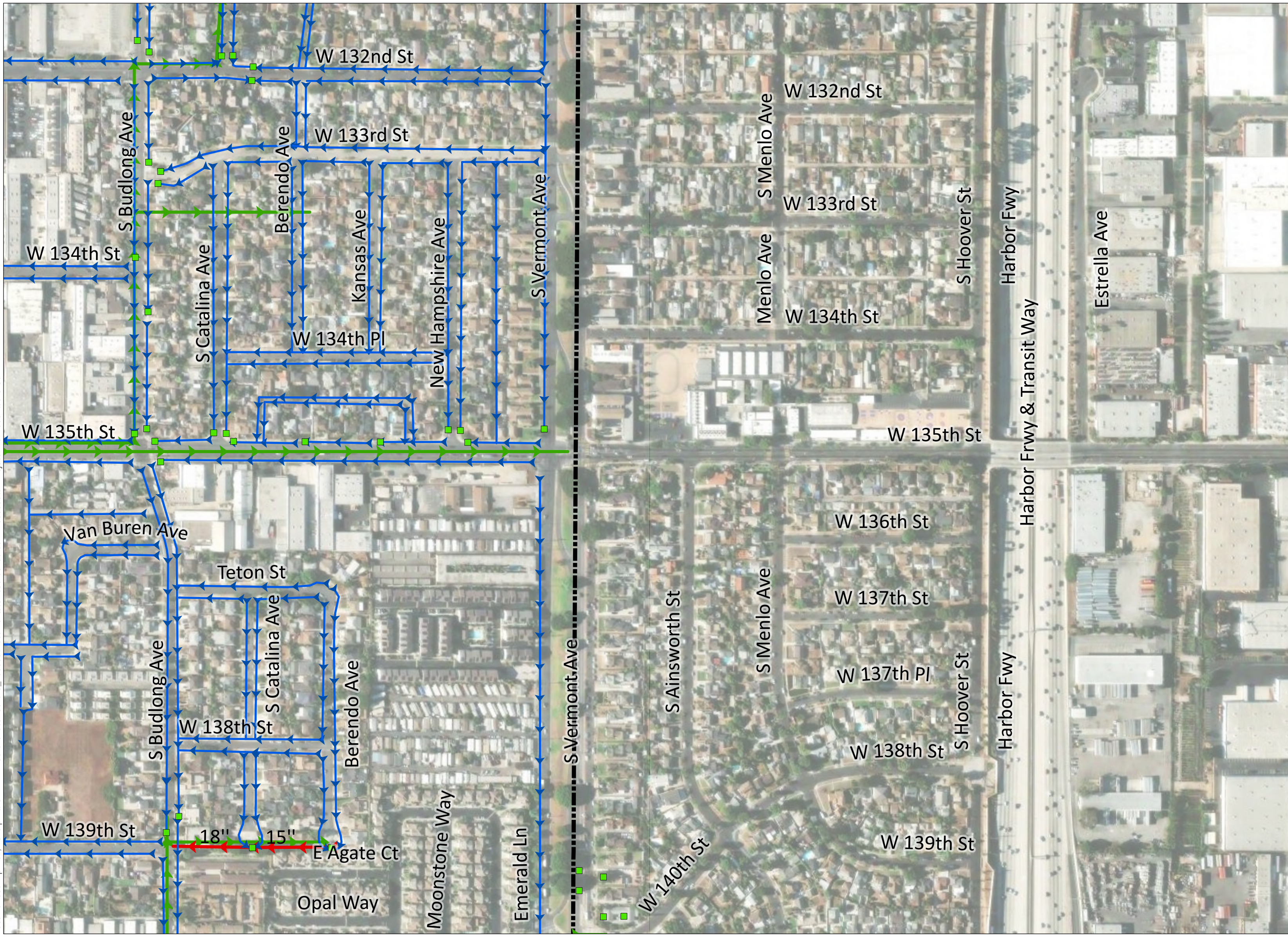

Legend

- Catch Basin
- Street Flow Direction
- County Owned Storm Drains
- City Owned Storm Drains
- Gardena City Boundary
- Waterways

Feet
0 250 500

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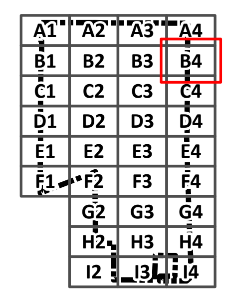

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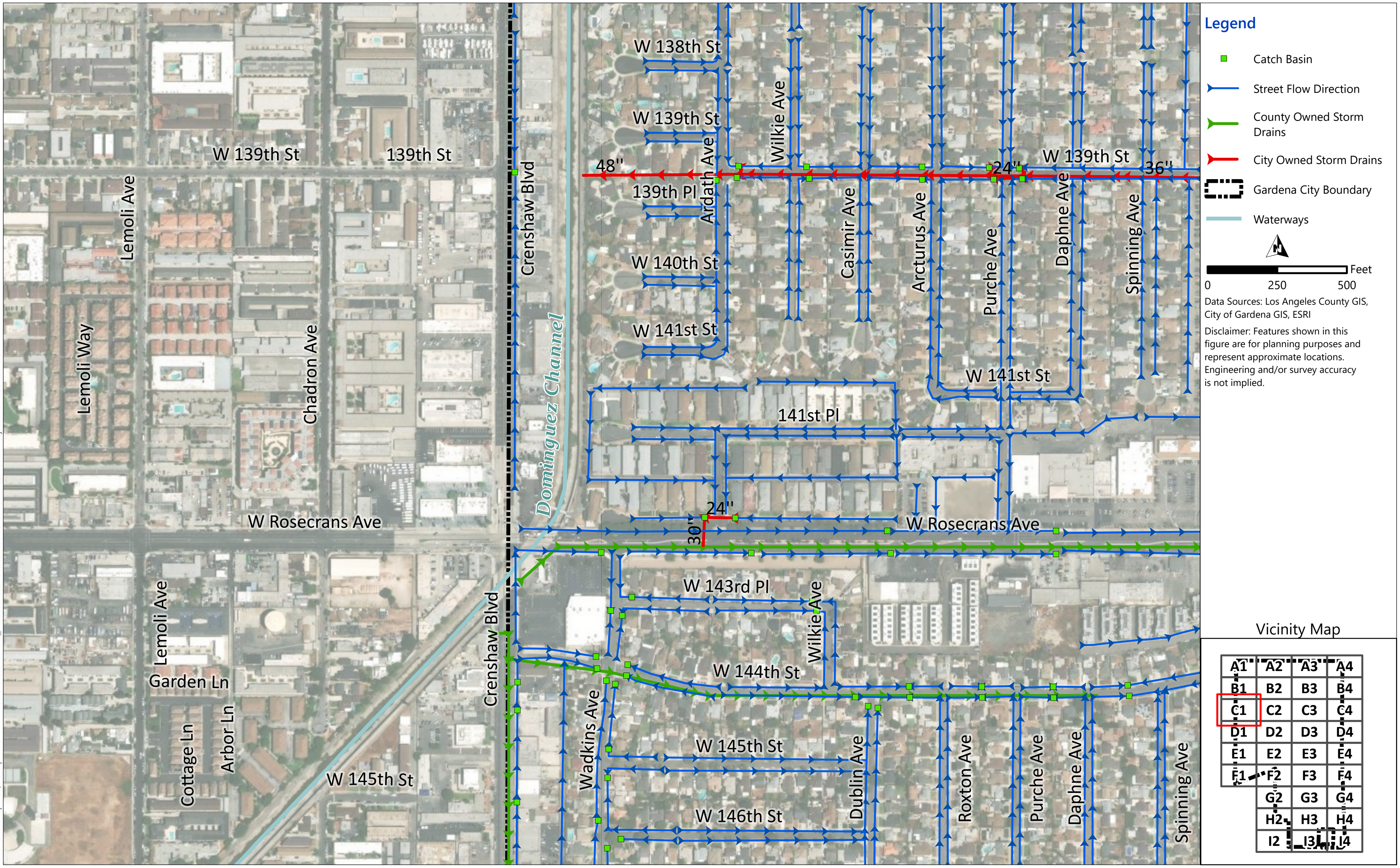
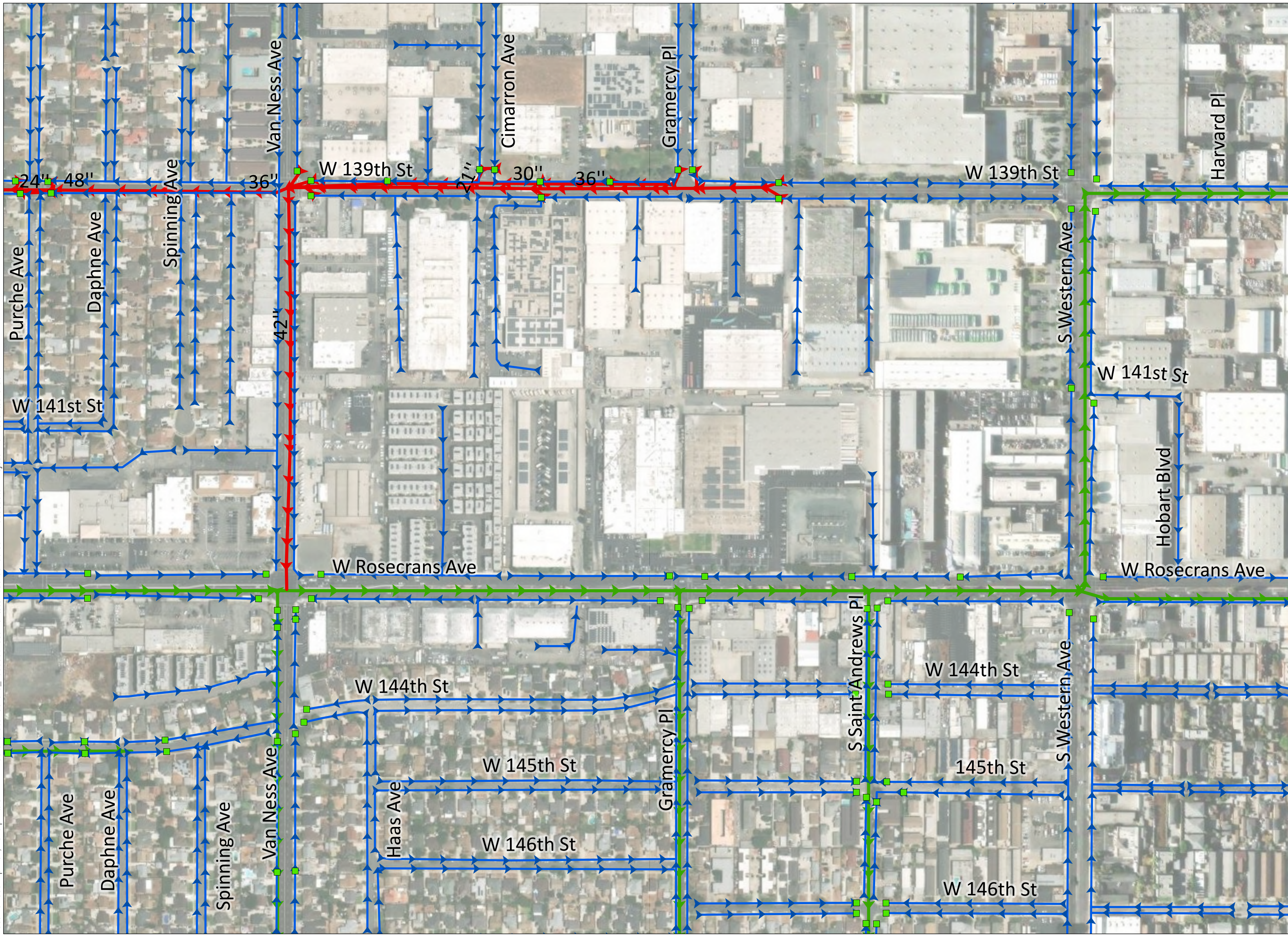


Street Flow Index Page C1

CITY OF GARDENA



Legend

- Catch Basin
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- Waterways

Feet: 0, 250, 500

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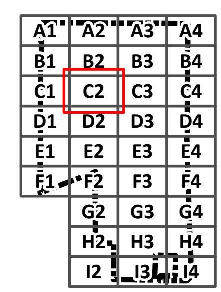

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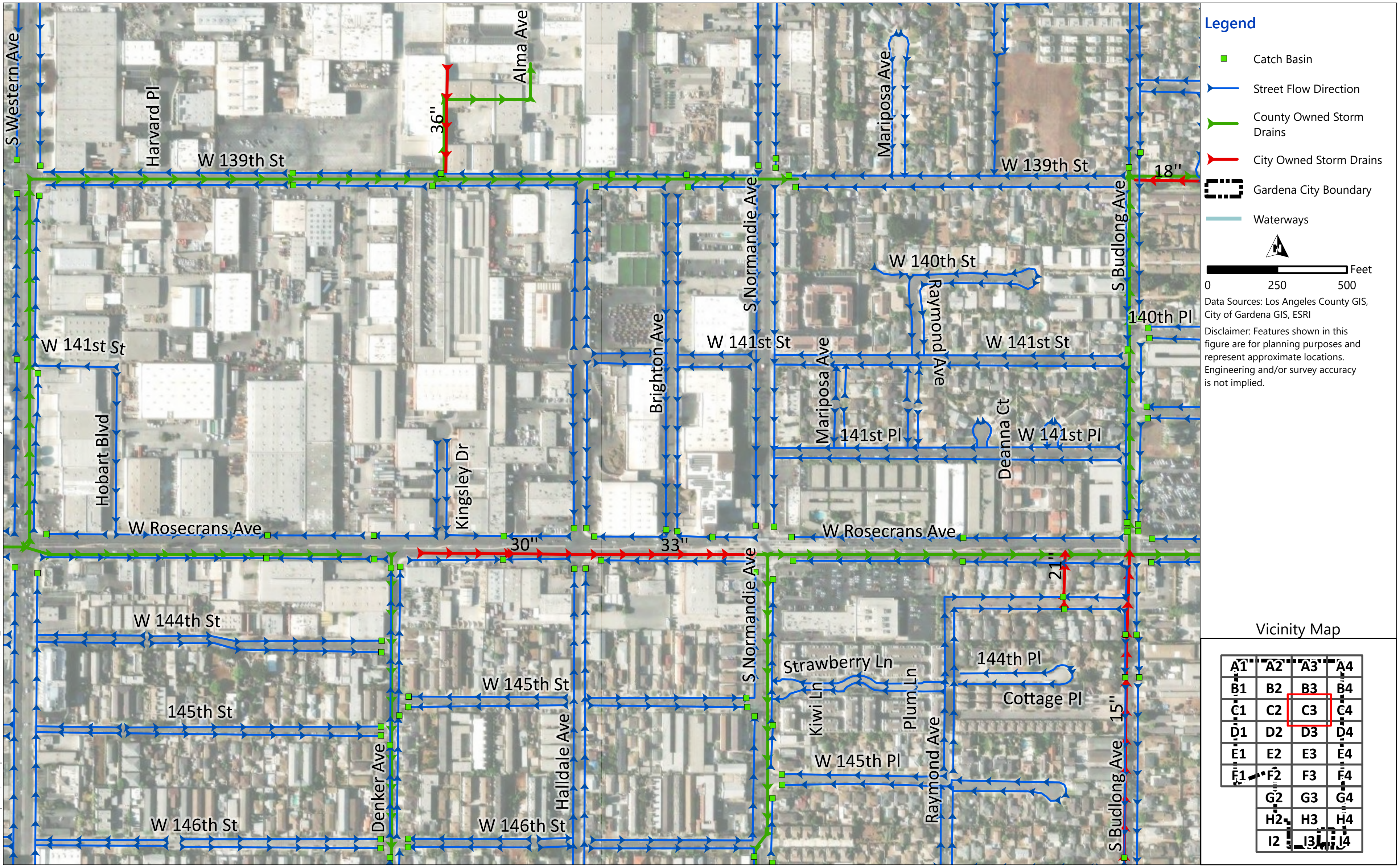
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Brighton Ave
Mariposa Ave
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Hobart Blvd
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W Rosecrans Ave
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33"
21"
W 144th St
144th Pl
Strawberry Ln
Kiwi Ln
Plum Ln
Cottage Pl
W 145th St
145th St
Halldale Ave
S Normandie Ave
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Raymond Ave
Denker Ave
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S Budlong Ave
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Catch Basin
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City Owned Storm Drains
Gardena City Boundary
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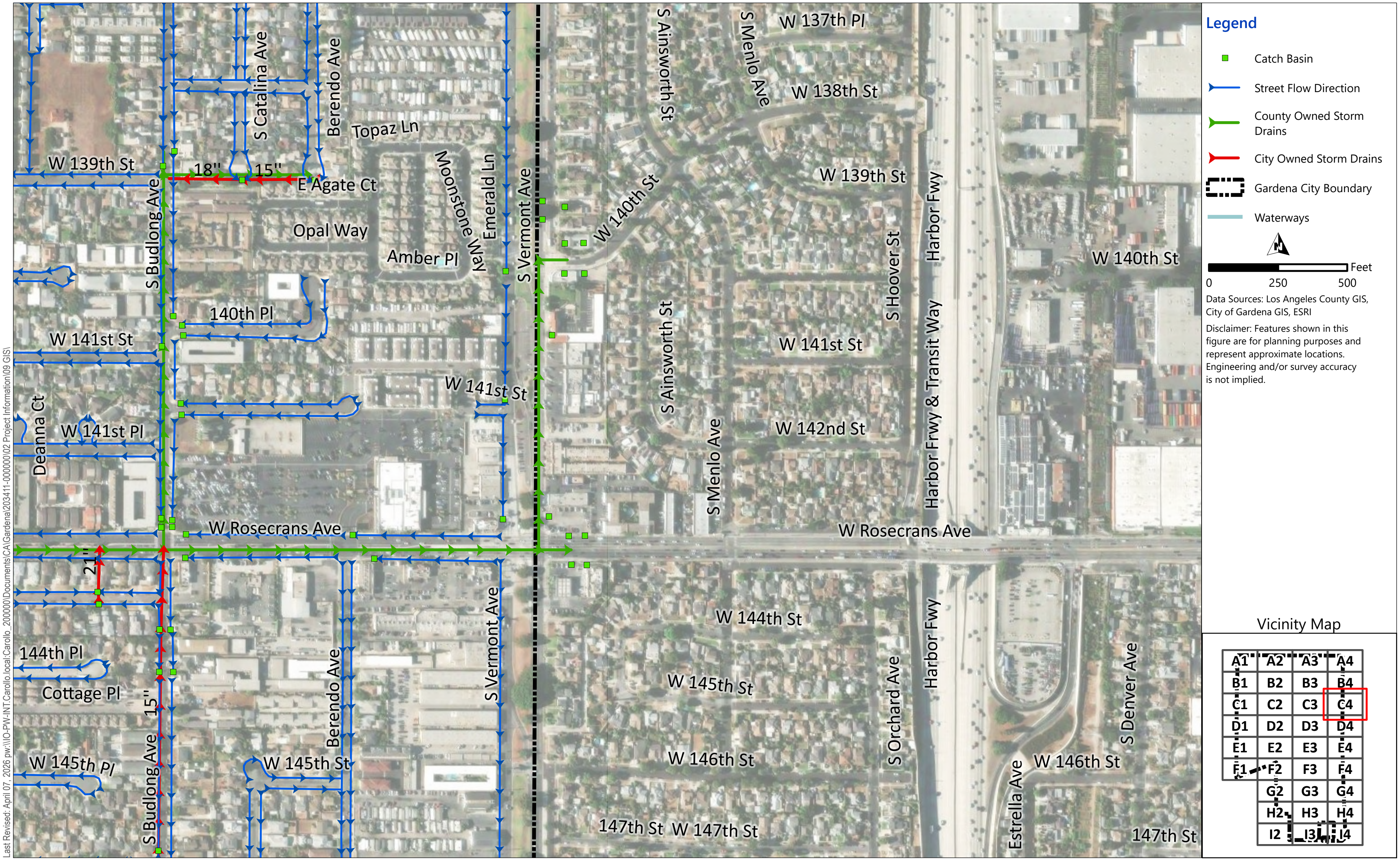
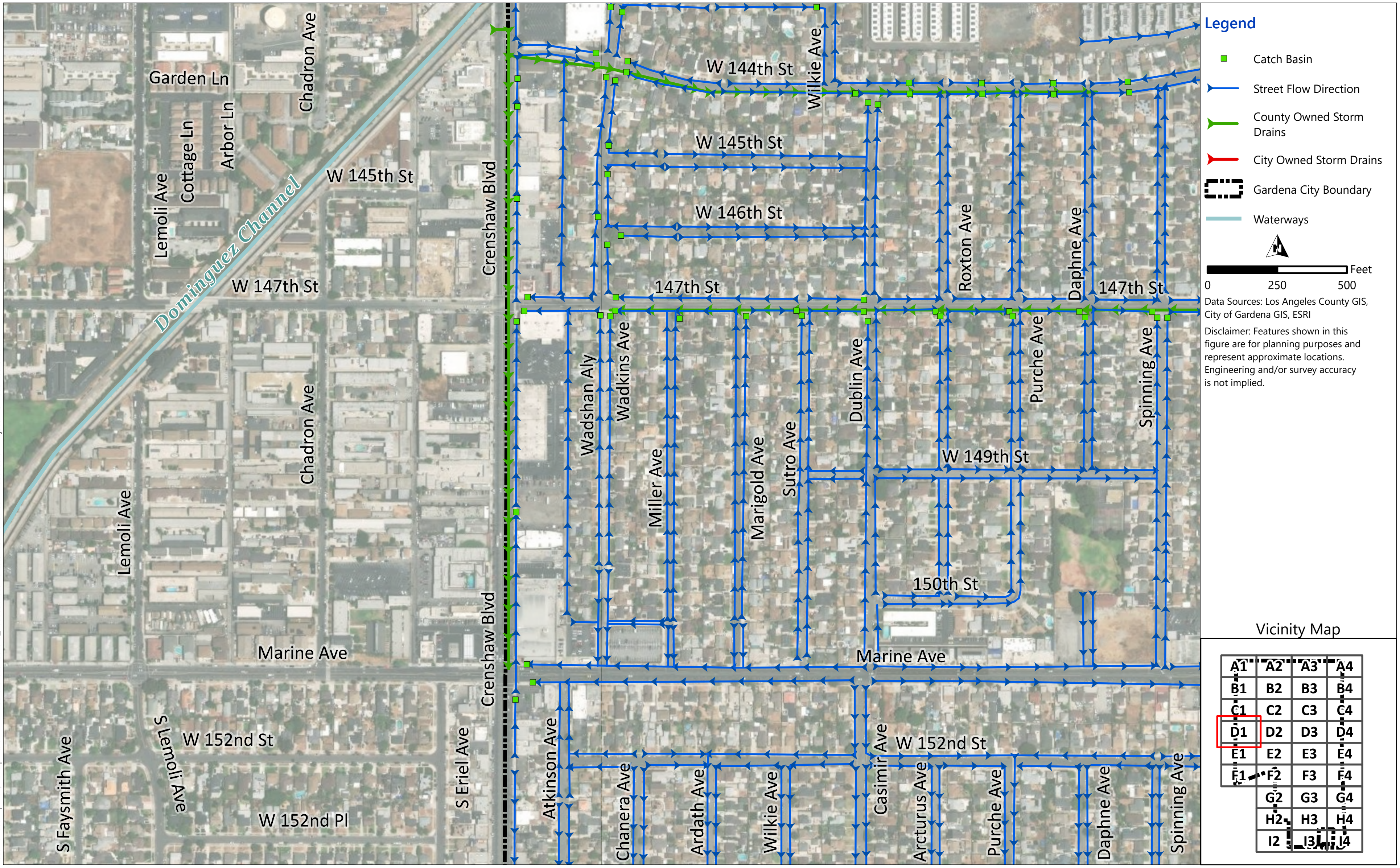


Street Flow Index Page C4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Wadkins Ave
Miller Ave
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Dublin Ave
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Lemoli Ave
Marine Ave
Marine Ave
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Wilkie Ave
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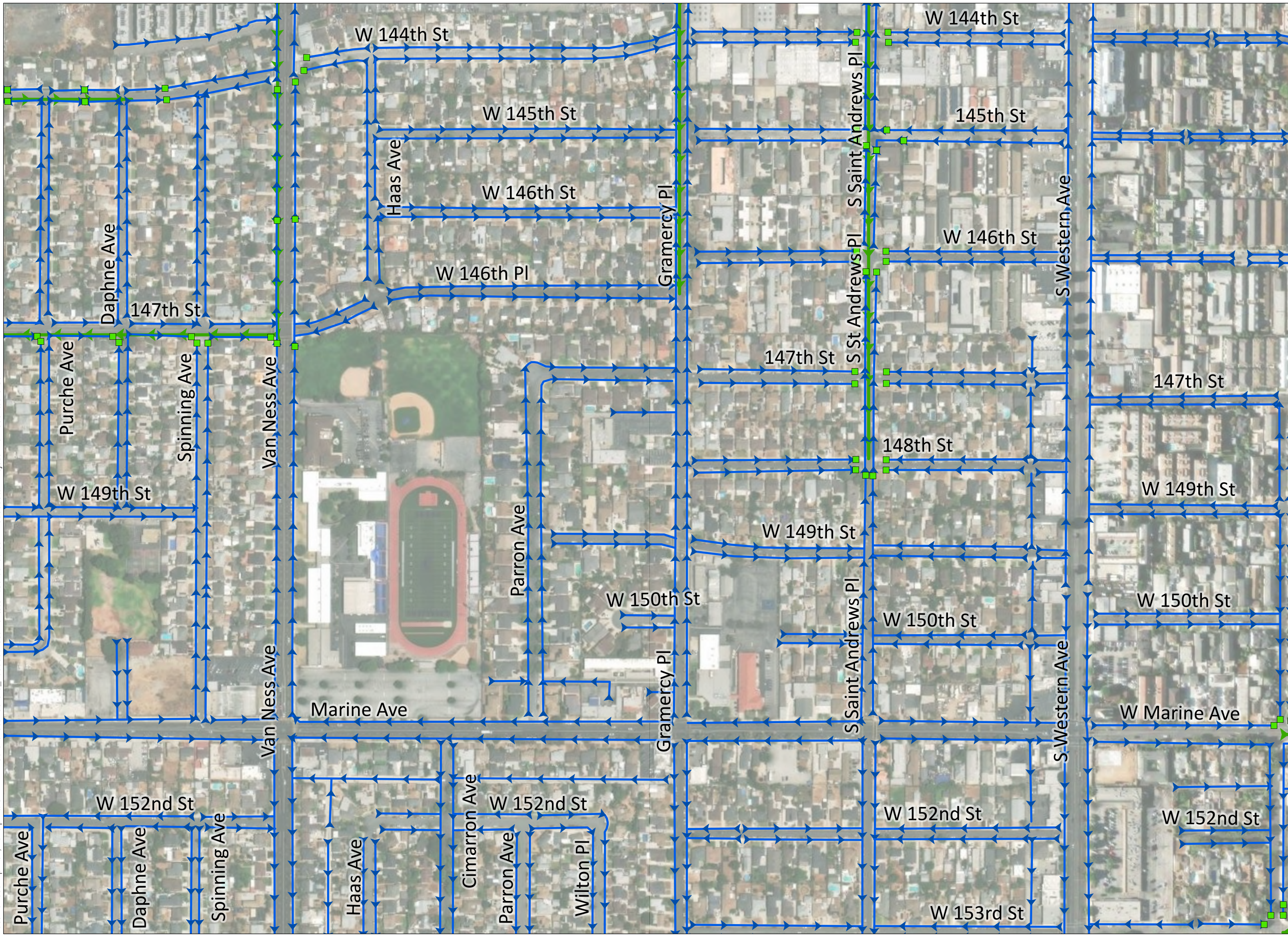

Legend

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Feet
0 250 500

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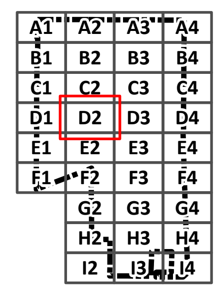

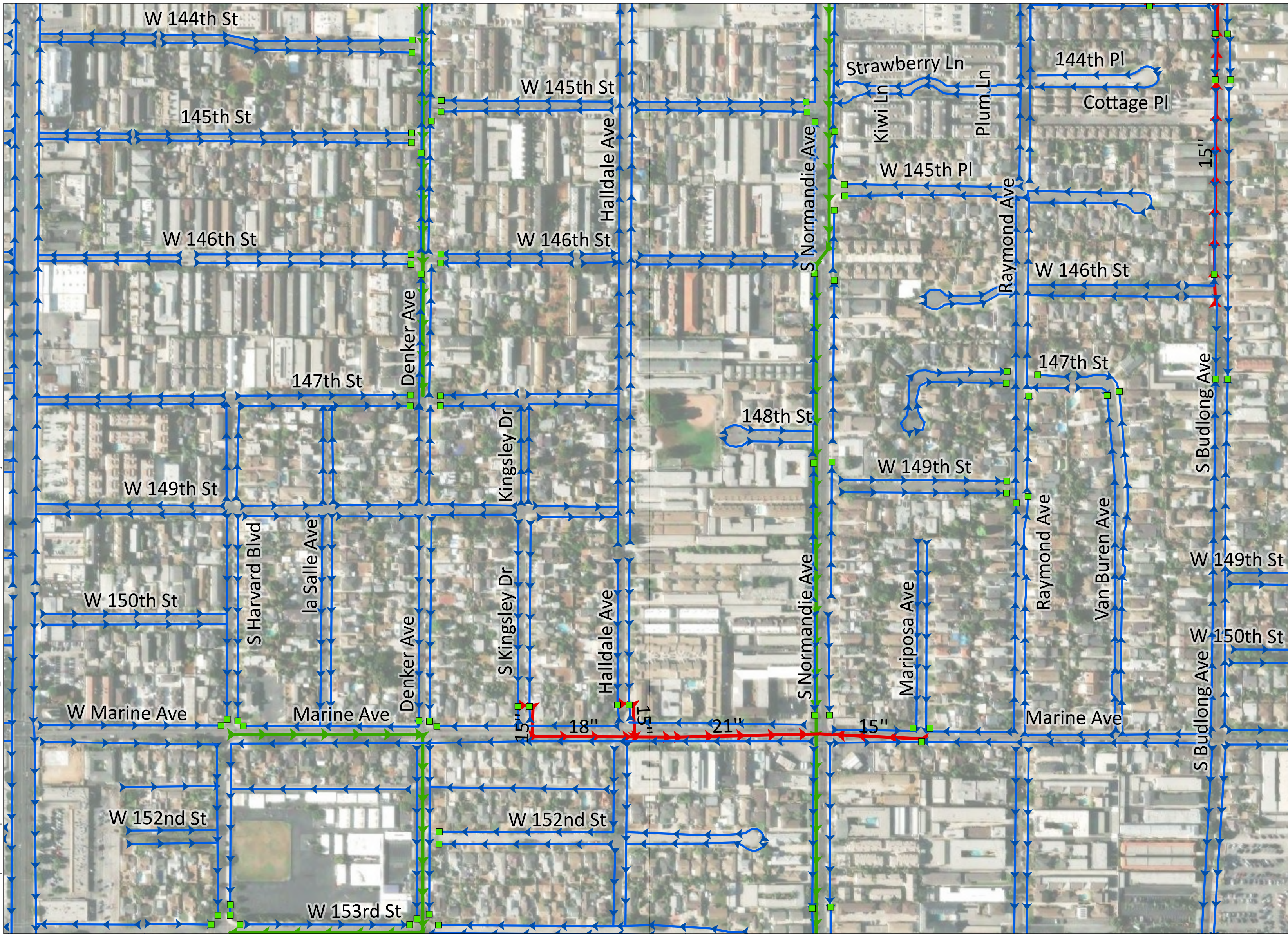

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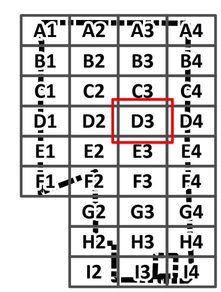

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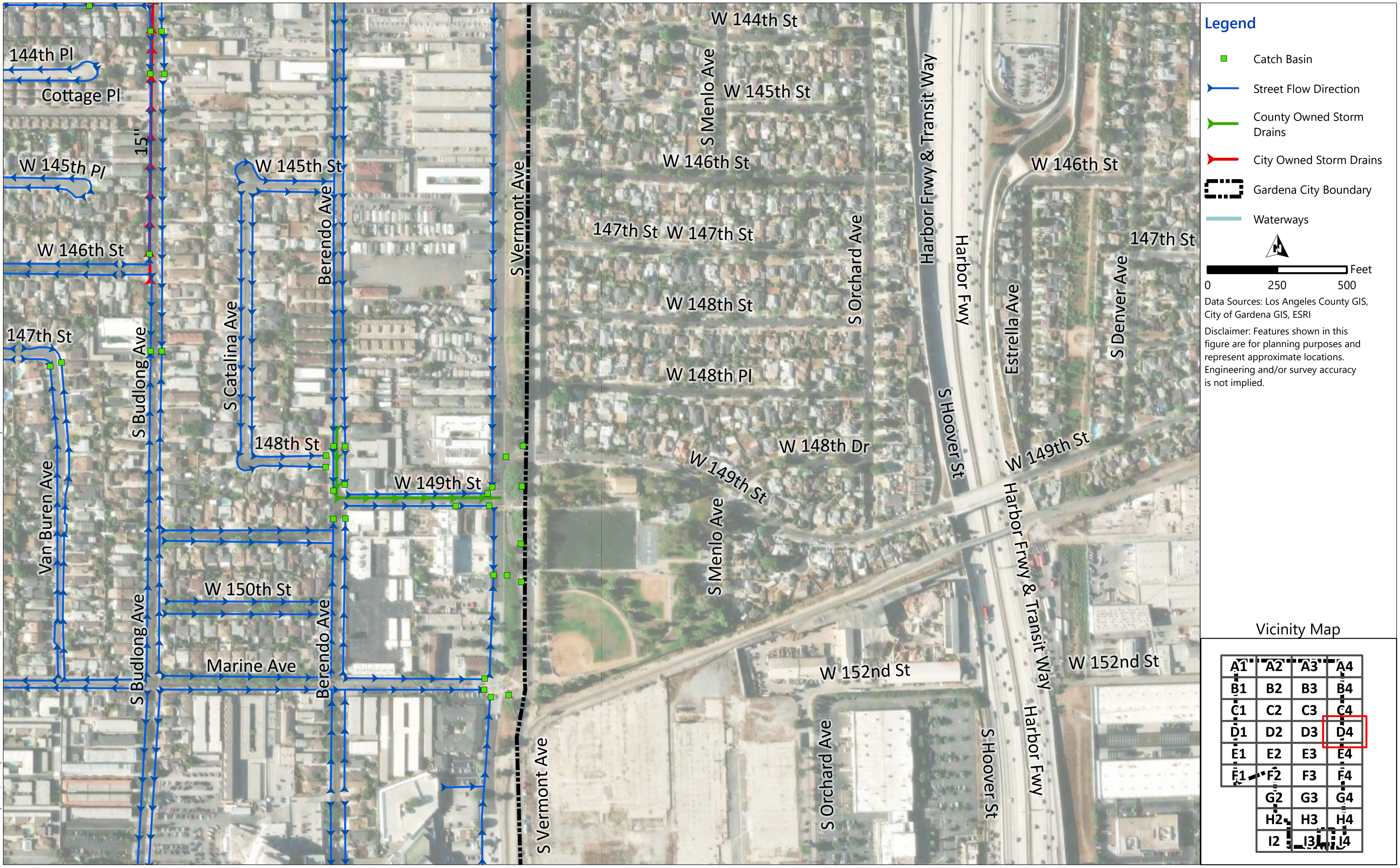

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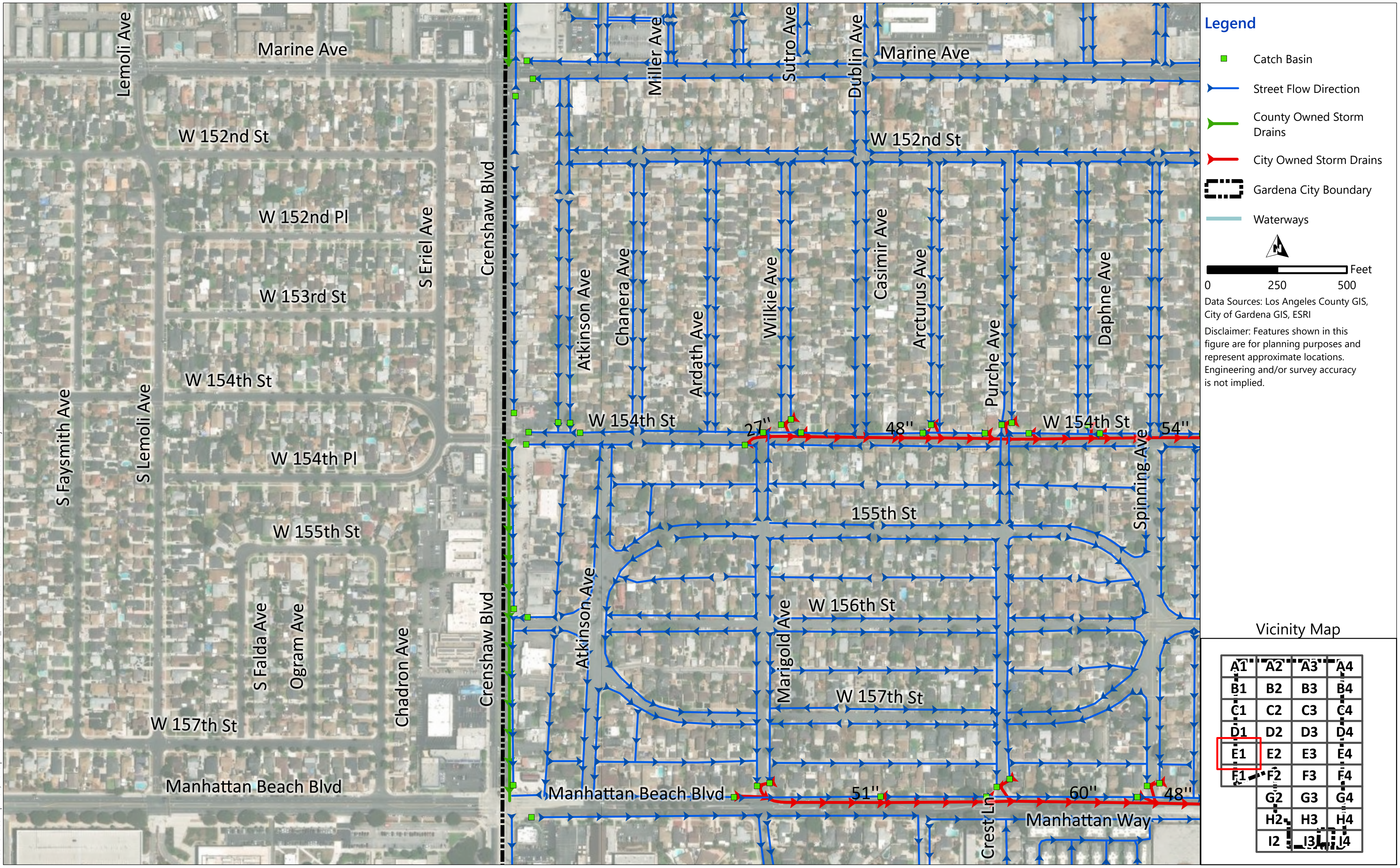
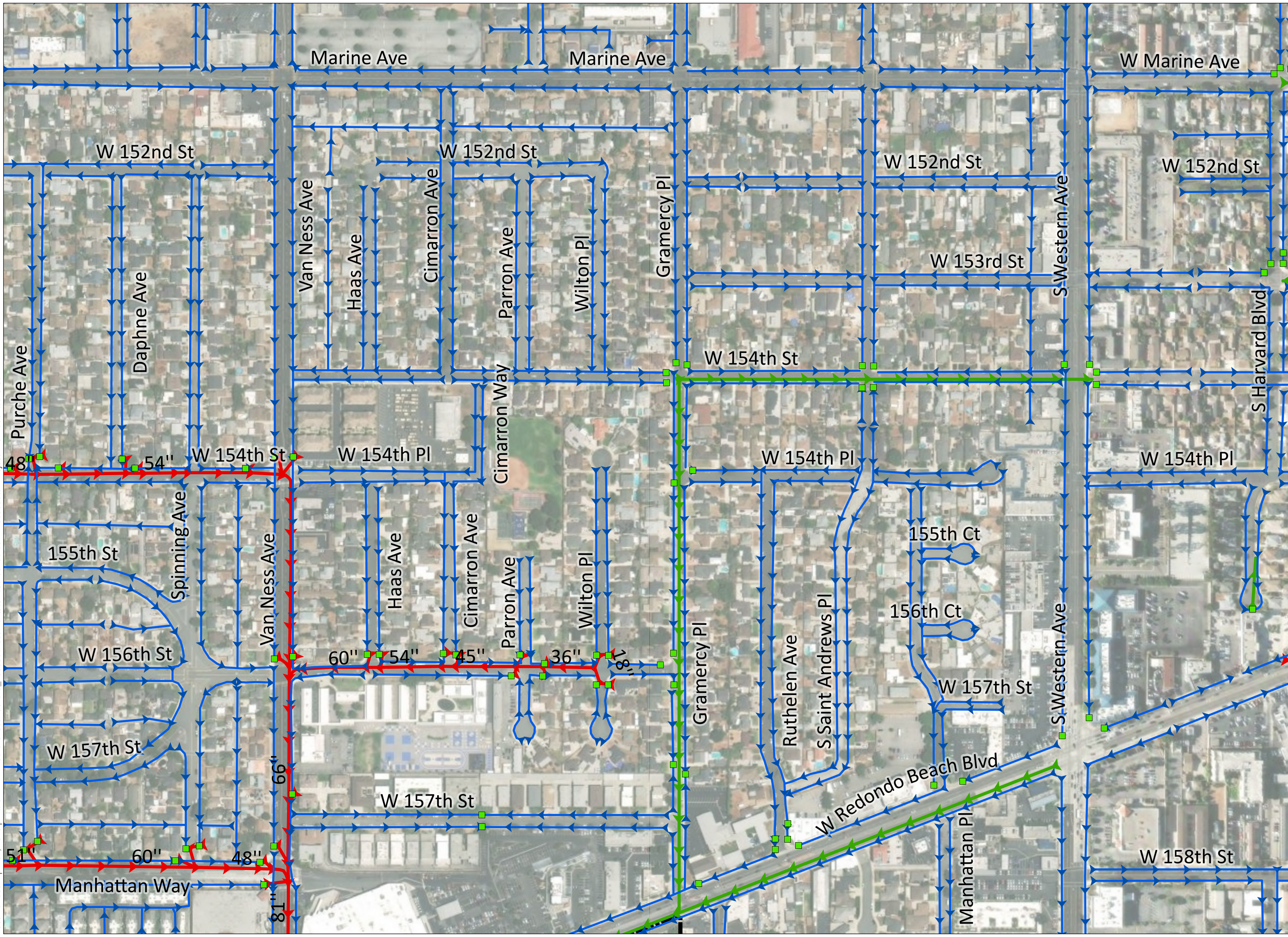


Street Flow Index Page E1



Legend

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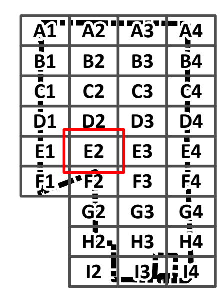
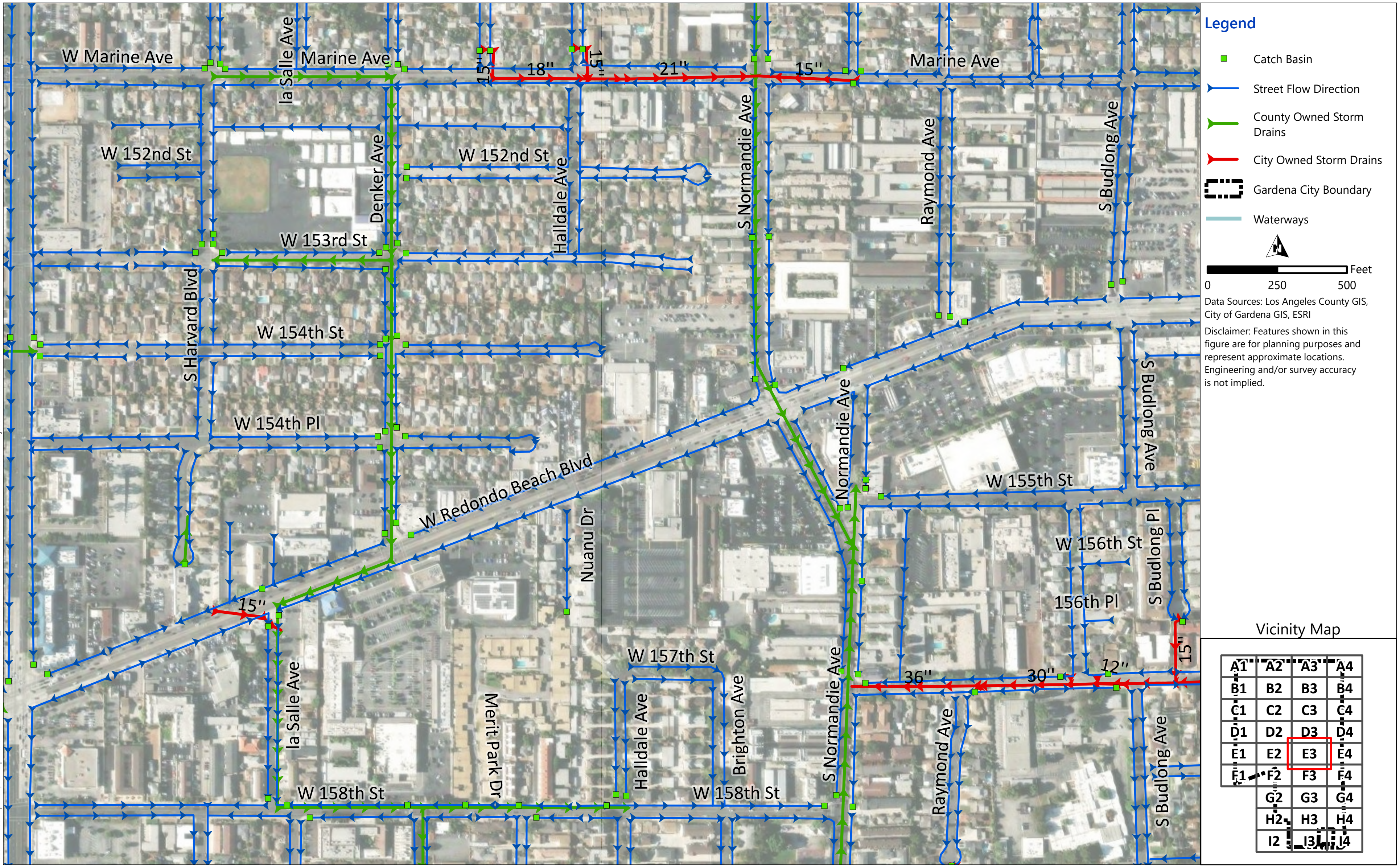
Vicinity Map

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Marine Ave
Marine Ave
la Salle Ave
15"
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W 152nd St
W 152nd St
Denker Ave
Halldale Ave
S Normandie Ave
Raymond Ave
S Budlong Ave
W 153rd St
S Harvard Blvd
W 154th St
W 154th Pl
W Redondo Beach Blvd
Nuanu Dr
Normandie Ave
W 155th St
S Budlong Ave
W 156th St
156th Pl
S Budlong Pl
15"
15"
36"
30"
12"
W 157th St
la Salle Ave
Merit Park Dr
Halldale Ave
Brighton Ave
S Normandie Ave
Raymond Ave
S Budlong Ave
W 158th St
W 158th St
Legend
Catch Basin
Street Flow Direction
County Owned Storm Drains
City Owned Storm Drains
Gardena City Boundary
Waterways
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Feet
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Data Sources: Los Angeles County GIS, City of Gardena GIS, ESRI
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Vicinity Map
A1 A2 A3 A4
B1 B2 B3 B4
C1 C2 C3 C4
D1 D2 D3 D4
E1 E2 E3 E4
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H2 H3 H4
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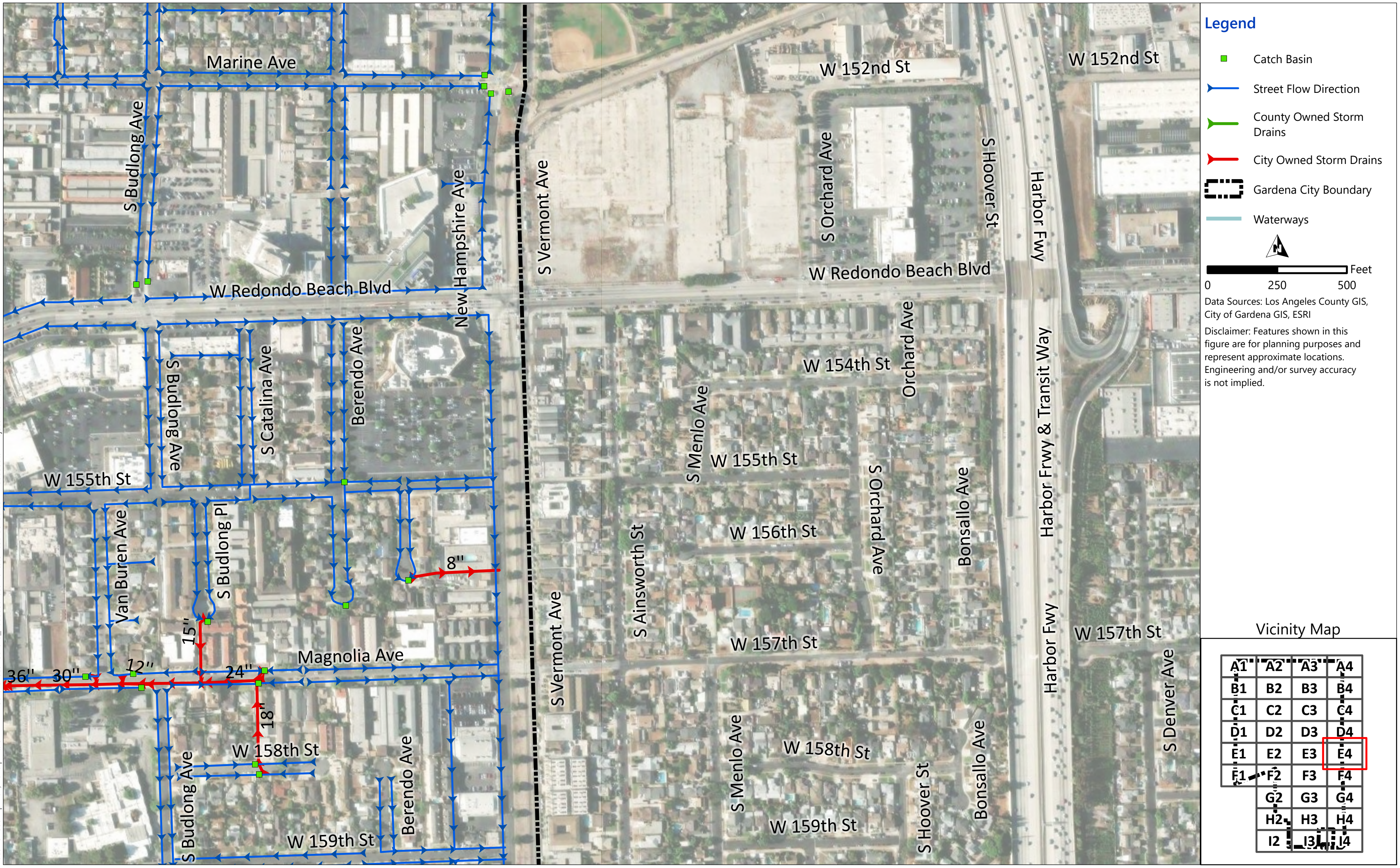
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W 152nd St
S Budlong Ave
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S Vermont Ave
S Orchard Ave
S Hoover St
Harbor Fwy
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W Redondo Beach Blvd
S Budlong Ave
S Catalina Ave
Berendo Ave
W 154th St
Orchard Ave
S Menlo Ave
W 155th St
W 155th St
S Orchard Ave
Bonsallo Ave
Harbor Frwy & Transit Way
Van Buren Ave
S Budlong Pl
S Ainsworth St
W 156th St
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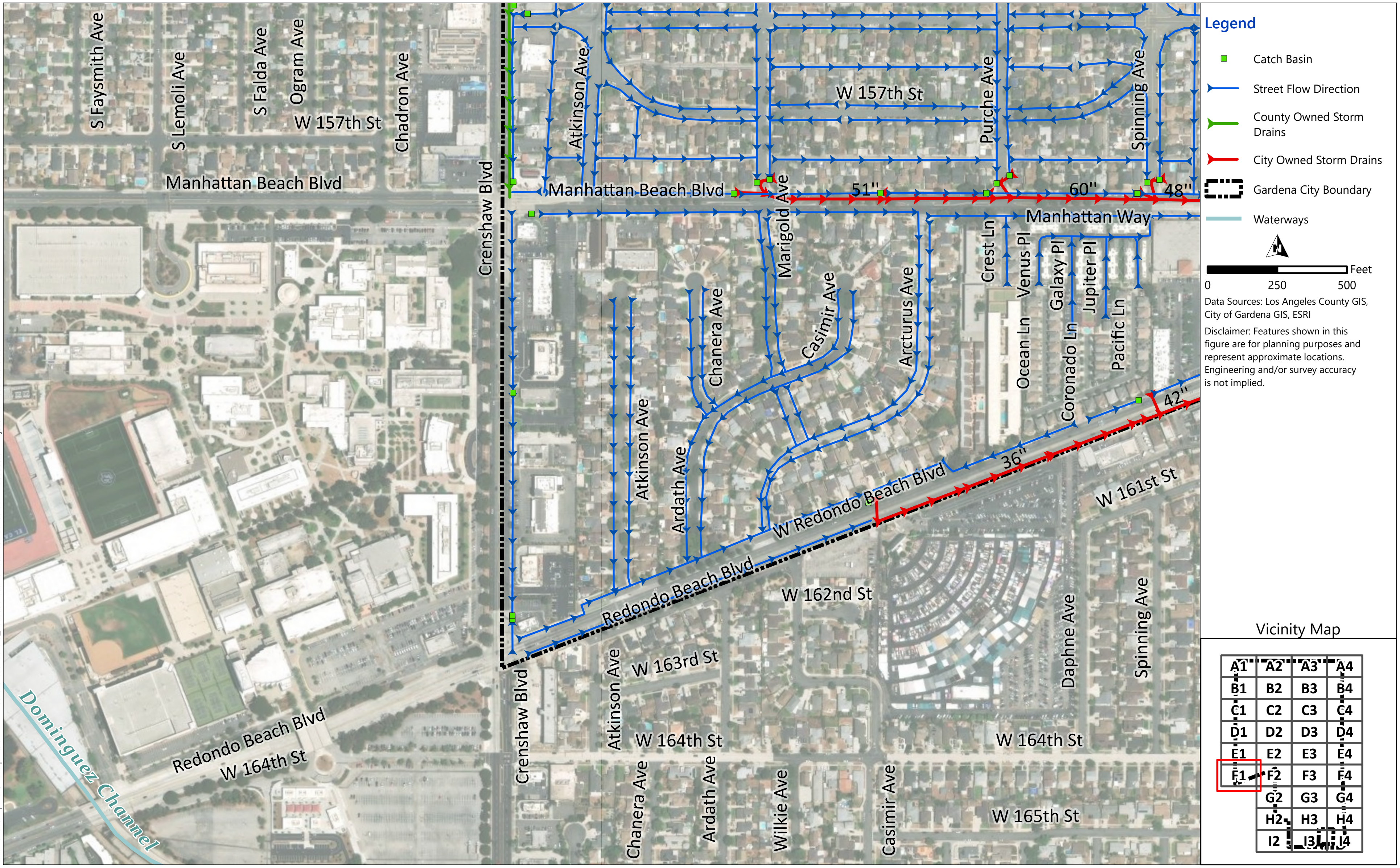
15"
S Vermont Ave
W 157th St
W 157th St
Harbor Fwy
Magnolia Ave
36"
30"
12"
24"
18"
S Denver Ave
W 158th St
W 158th St
S Budlong Ave
Berendo Ave
S Menlo Ave
S Hoover St
Bonsallo Ave
W 159th St
W 159th St
Legend
Catch Basin
Street Flow Direction
County Owned Storm Drains
City Owned Storm Drains
Gardena City Boundary
Waterways
Feet
0
250
500
Data Sources: Los Angeles County GIS, City of Gardena GIS, ESRI
Disclaimer: Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.
Vicinity Map
A1 A2 A3 A4
B1 B2 B3 B4
C1 C2 C3 C4
D1 D2 D3 D4
E1 E2 E3 E4
F1 F2 F3 F4
G2 G3 G4
H2 H3 H4
I2 I3 I4



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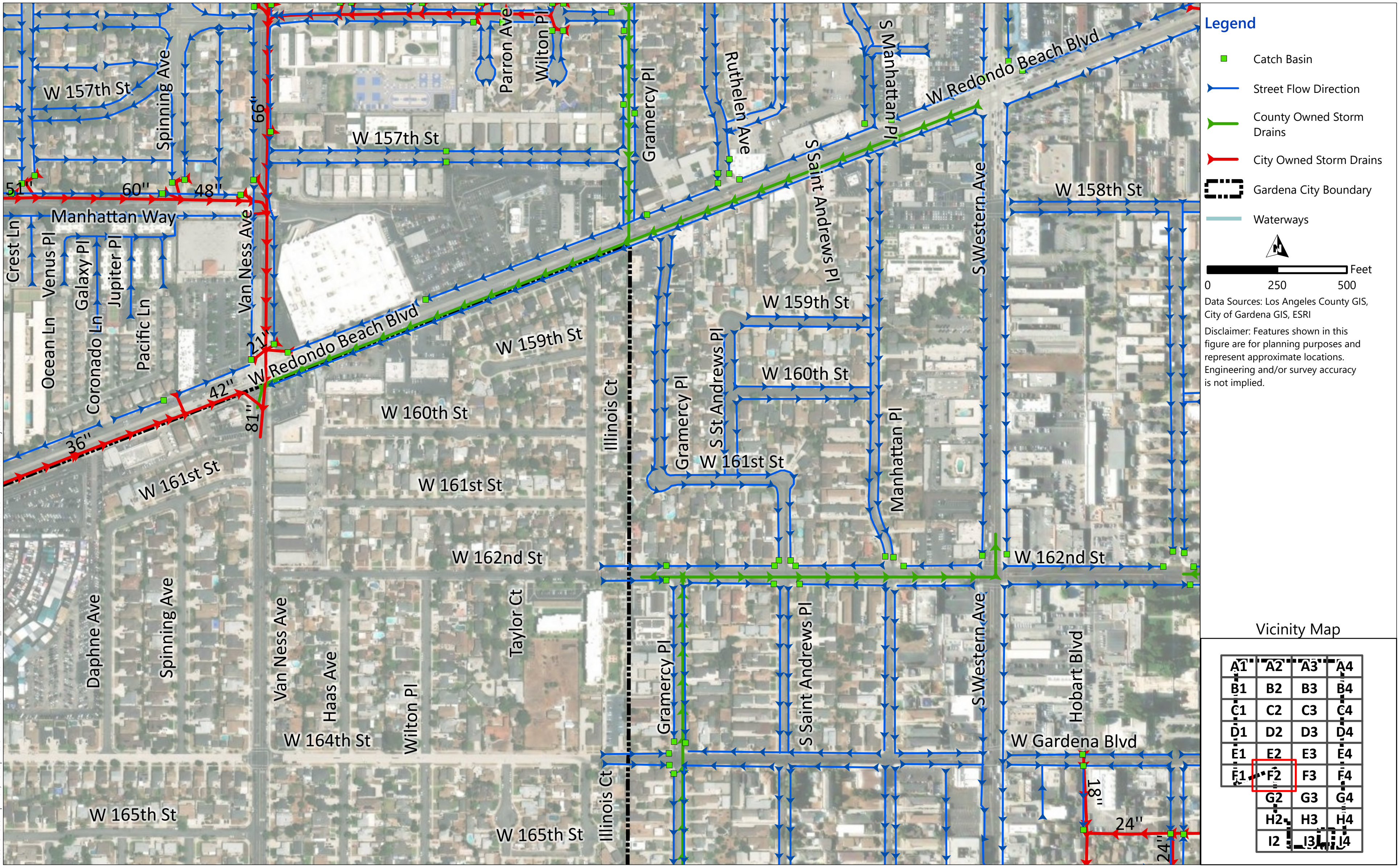
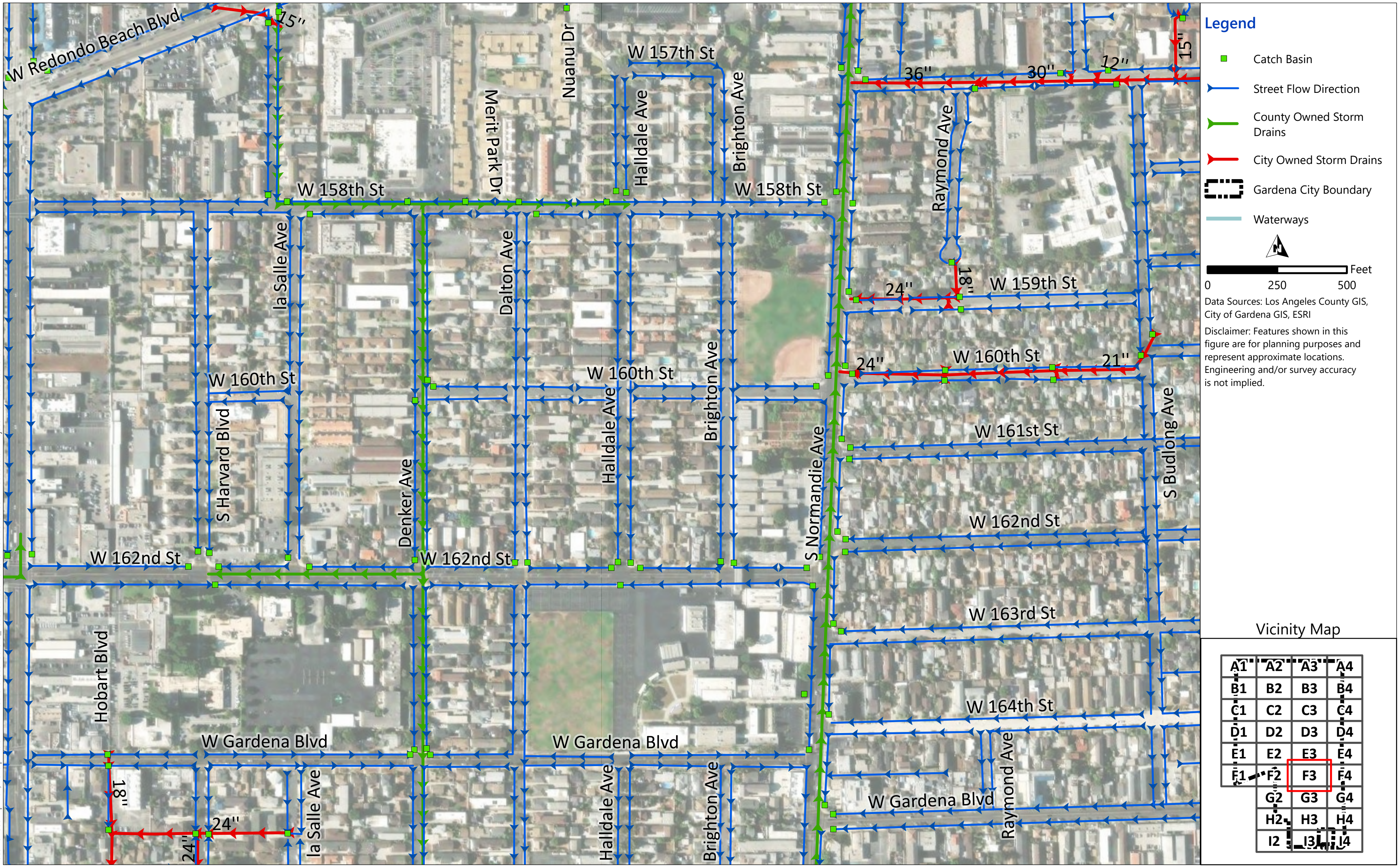


Last Revised: April 07, 2026 pw:\\IO-PW-INT.Carollo.local:Carollo_200000\Documents\CA\Gardena\203411-000000\02 Project Information\09 GIS\



Data Sources: Los Angeles County GIS, City of Gardena GIS, ESRI

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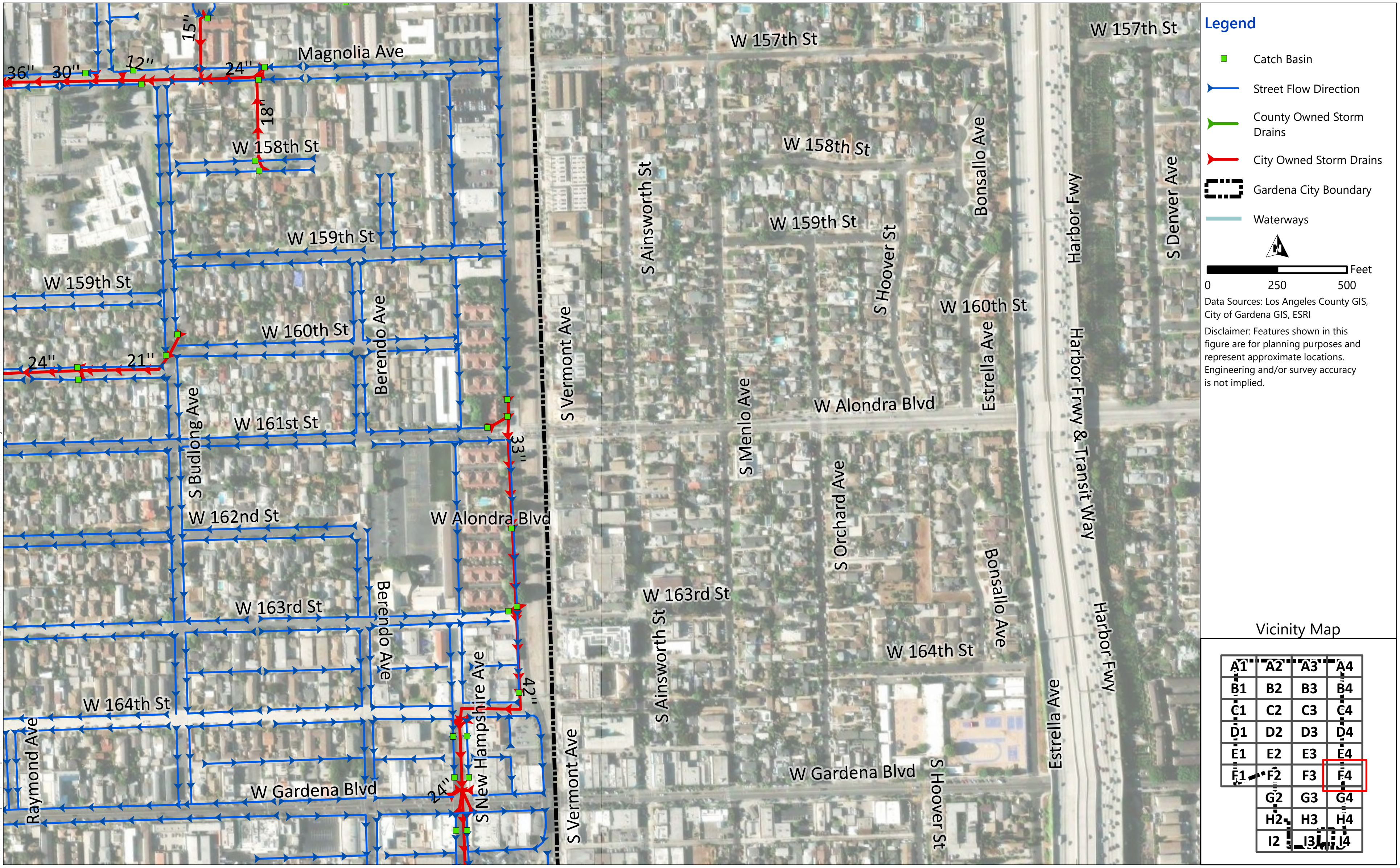
Last Revised: April 07, 2026 pw:\\IO-PW-INT.Carollo.local:Carollo_200000\Documents\CA\Gardena\203411-000000\02 Project Information\09 GIS\

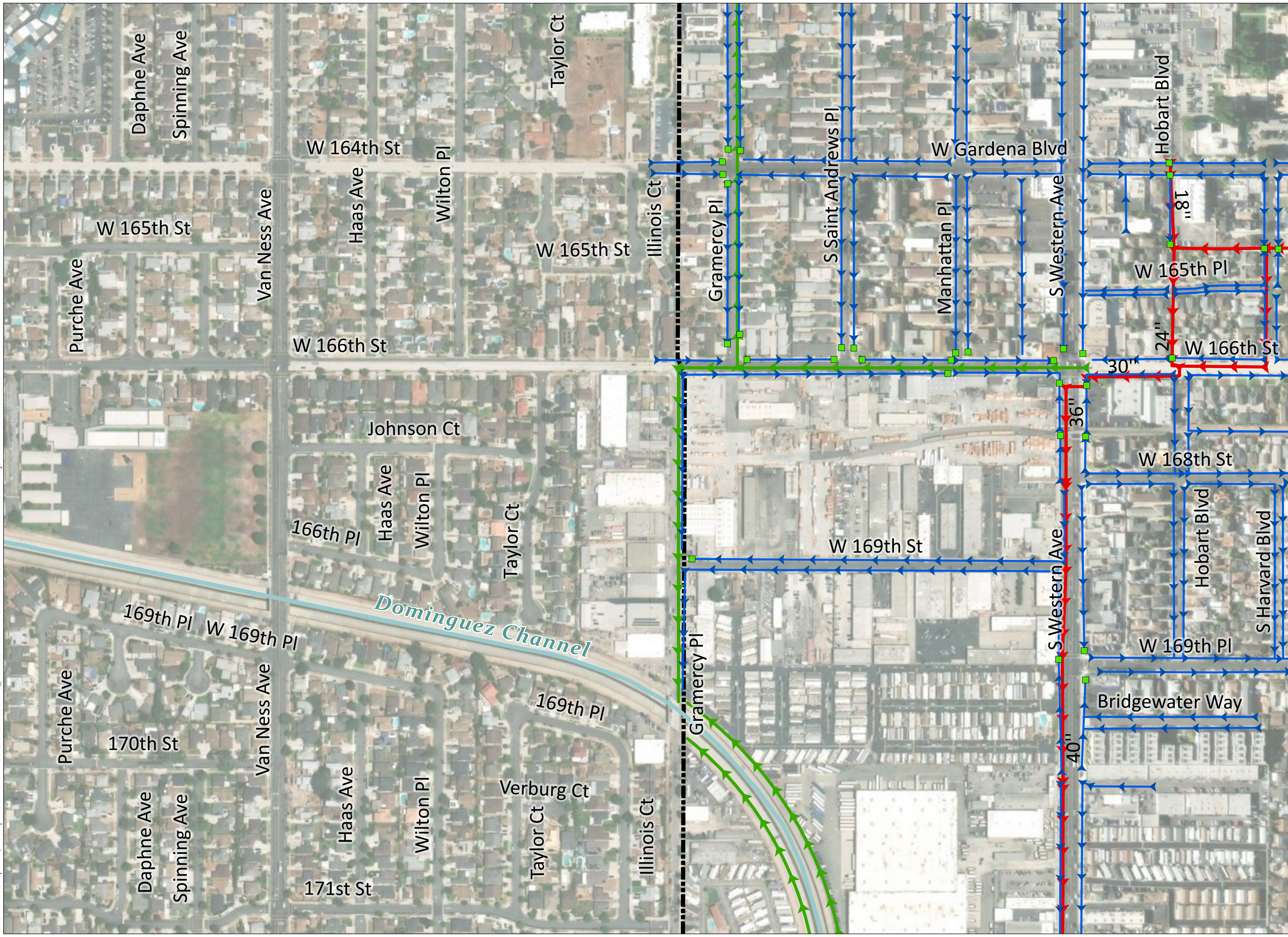


Data Sources: Los Angeles County GIS, City of Gardena GIS, ESRI

Disclaimer: Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.

Last Revised: April 07, 2026 pw:\\IO-PW-INT.Carollo.local:Carollo_200000\Documents\CA\Gardena\203411-000000\02 Project Information\09 GIS\

Street Flow Index Page F4



Legend

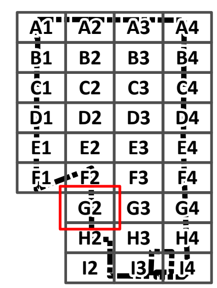
- Catch Basin
- Street Flow Direction
- County Owned Storm Drains
- City Owned Storm Drains
- Gardena City Boundary
- Waterways

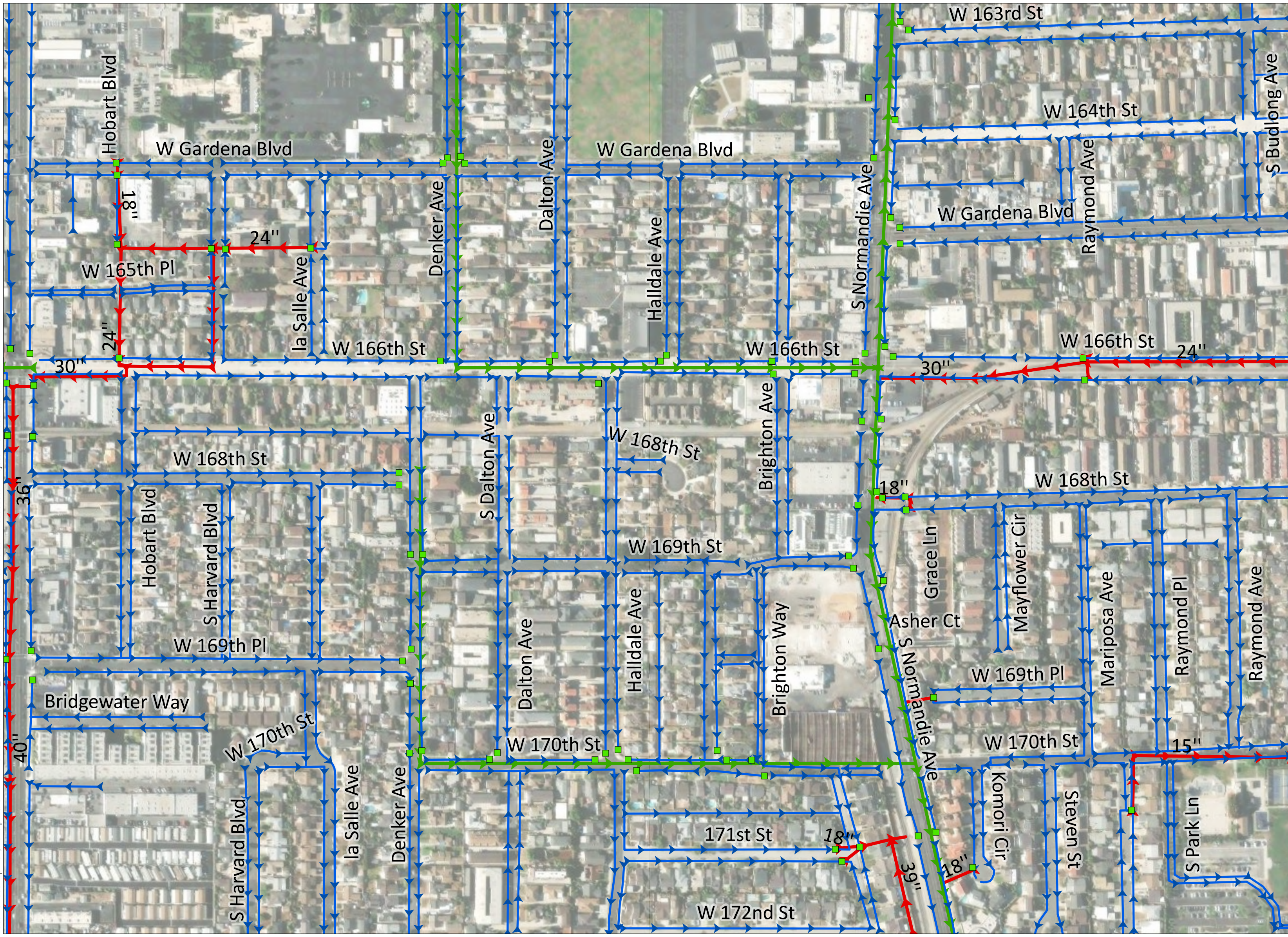
Feet: 0, 250, 500

Data Sources: Los Angeles County GIS, City of Gardena GIS, ESRI

Disclaimer: Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.

Vicinity Map





Legend

- Catch Basin
- Street Flow Direction
- County Owned Storm Drains
- City Owned Storm Drains
- Gardena City Boundary
- Waterways

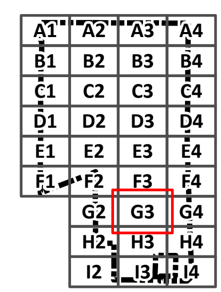
N

Feet
0 250 500

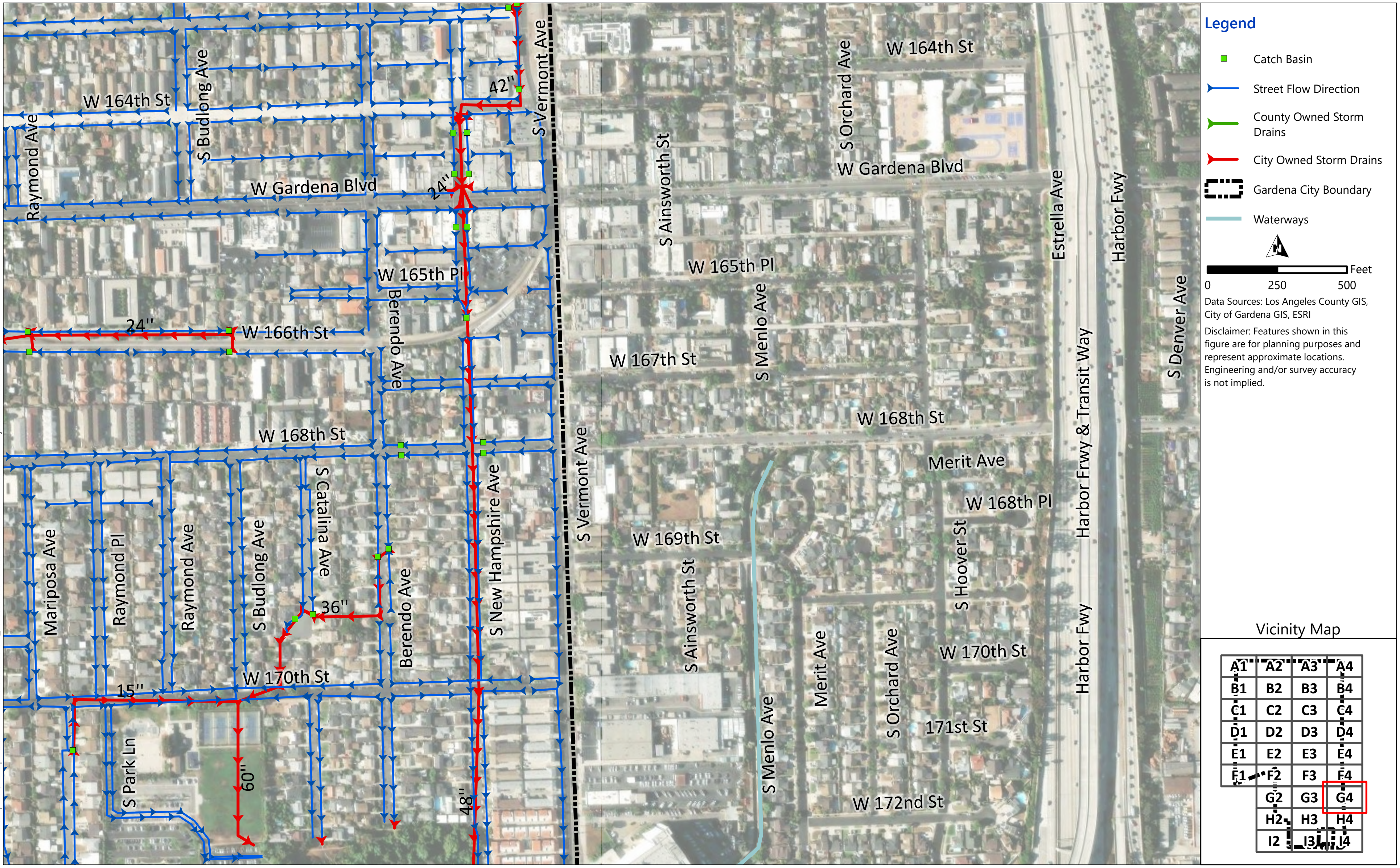
Data Sources: Los Angeles County GIS, City of Gardena GIS, ESRI

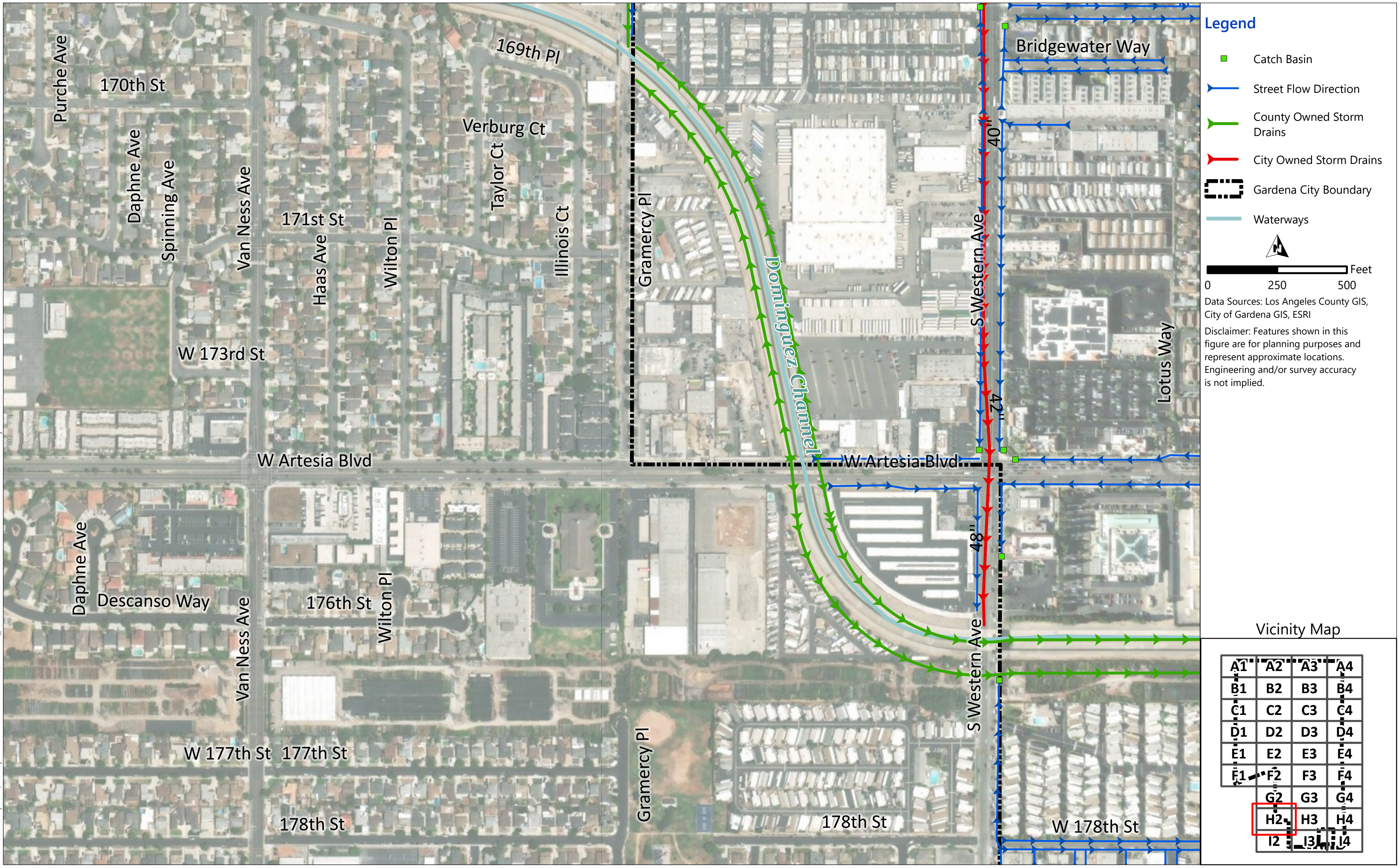
Disclaimer: Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.

Vicinity Map



Last Revised: April 07, 2026 pw:\\IO-PW-INT.Carollo.local:Carollo_200000\Documents\CA\Gardena\203411-000000\02 Project Information\09 GIS\


W 164th St
S Budlong Ave
Raymond Ave
W Gardena Blvd
42"
24"
S Vermont Ave
W 165th Pl
Berendo Ave
24"
W 166th St
W 168th St
S Catalina Ave
Mariposa Ave
Raymond Pl
Raymond Ave
S Budlong Ave
36"
Berendo Ave
S New Hampshire Ave
S Vermont Ave
15"
W 170th St
S Park Ln
60"
48"
S Ainsworth St
S Orchard Ave
W 164th St
W Gardena Blvd
W 165th Pl
S Menlo Ave
W 167th St
W 168th St
Merit Ave
W 168th Pl
W 169th St
S Ainsworth St
S Hoover St
W 170th St
S Menlo Ave
Merit Ave
S Orchard Ave
171st St
W 172nd St
Estrella Ave
Harbor Fwy
Harbor Frwy & Transit Way
Harbor Fwy
S Denver Ave
Legend
Catch Basin
Street Flow Direction
County Owned Storm Drains
City Owned Storm Drains
Gardena City Boundary
Waterways
N
Feet
0
250
500
Data Sources: Los Angeles County GIS, City of Gardena GIS, ESRI
Disclaimer: Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.
Vicinity Map
A1 A2 A3 A4
B1 B2 B3 B4
C1 C2 C3 C4
D1 D2 D3 D4
E1 E2 E3 E4
F1 F2 F3 F4
G2 G3 G4
H2 H3 H4
I2 I3 I4


169th Pl
170th St
Purche Ave
Verburg Ct
Taylor Ct
Daphne Ave
Spinning Ave
Van Ness Ave
171st St
Haas Ave
Wilton Pl
Illinois Ct
Gramercy Pl
Dominguez Channel
Bridgewater Way
40"
S Western Ave
Lotus Way
W 173rd St
42"
W Artesia Blvd
48"
Descanso Way
176th St
W 177th St
177th St
178th St
W 178th St
Legend
Catch Basin
Street Flow Direction
County Owned Storm Drains
City Owned Storm Drains
Gardena City Boundary
Waterways
Feet
0
250
500
Data Sources: Los Angeles County GIS, City of Gardena GIS, ESRI
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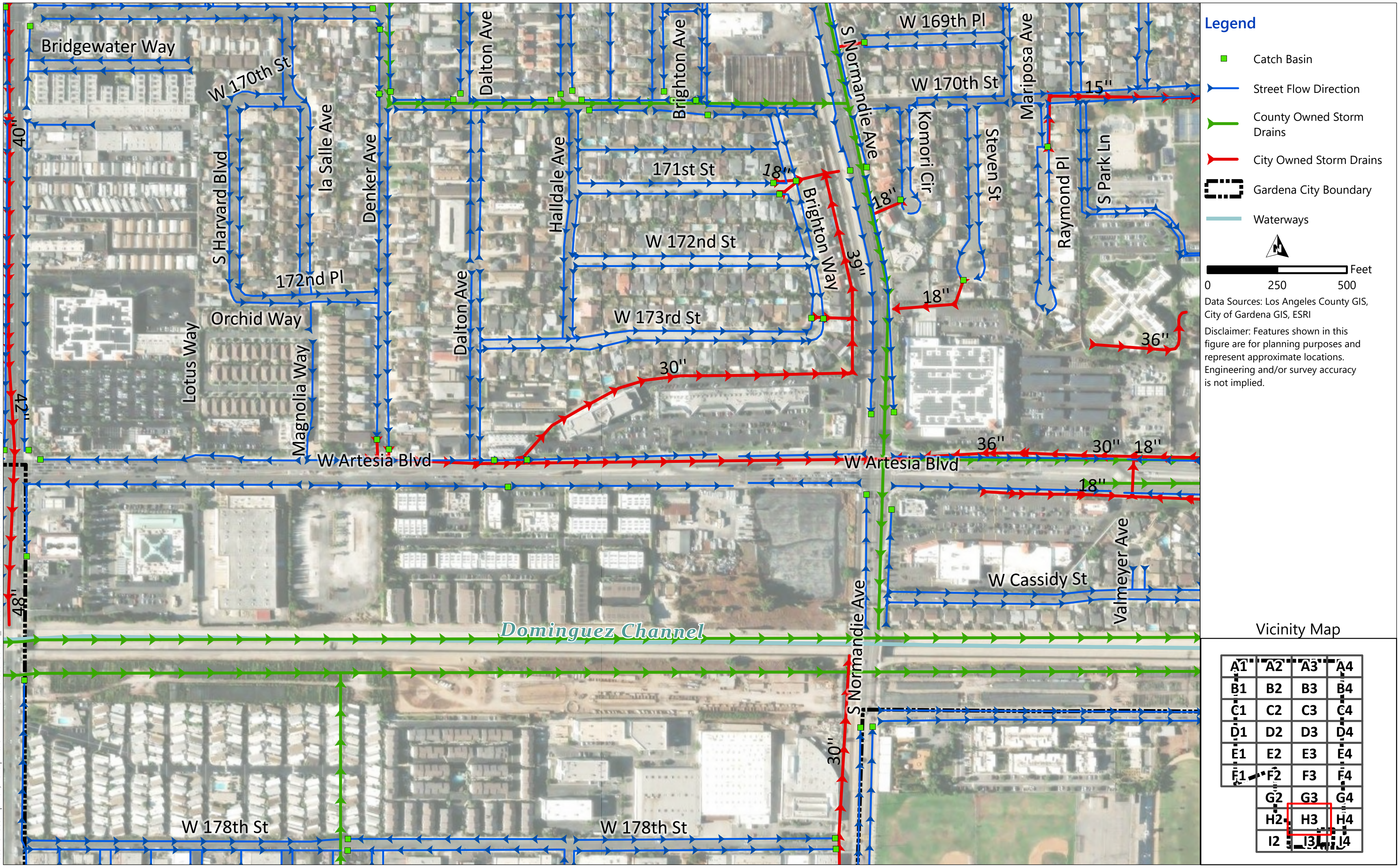
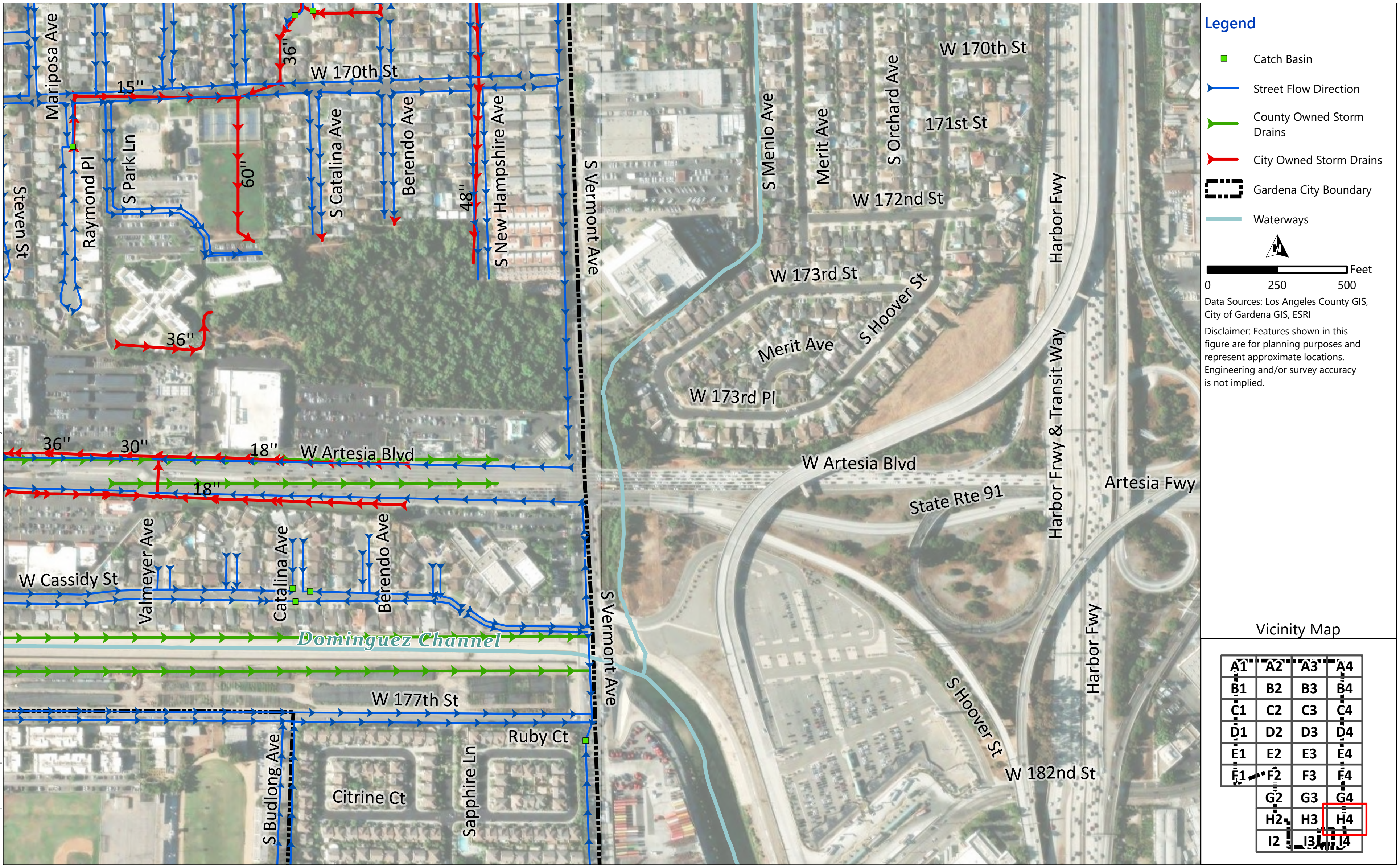
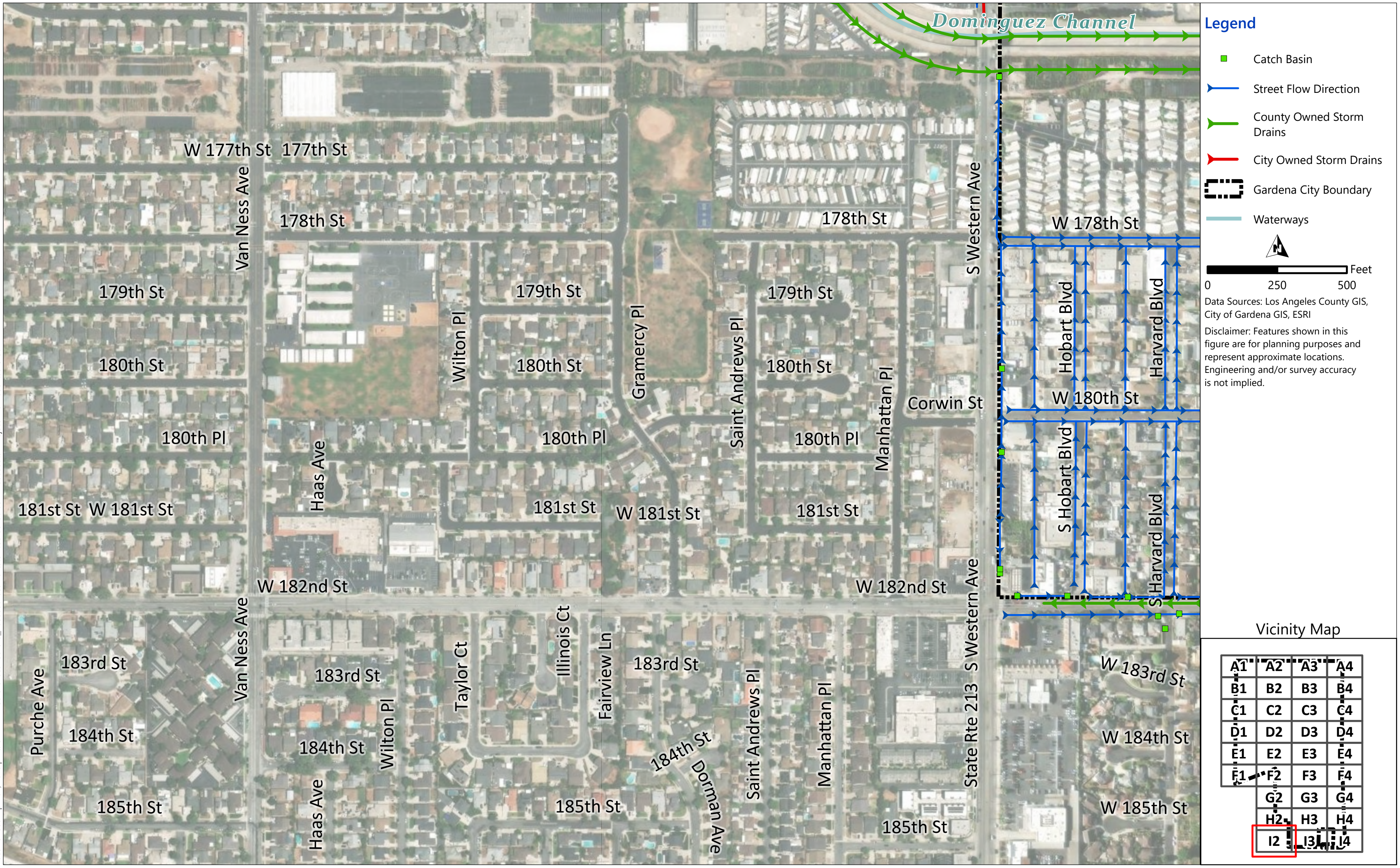
A1 A2 A3 A4
B1 B2 B3 B4
C1 C2 C3 C4
D1 D2 D3 D4
E1 E2 E3 E4
F1 F2 F3 F4
G2 G3 G4
H2 H3 H4
I2 I3 I4



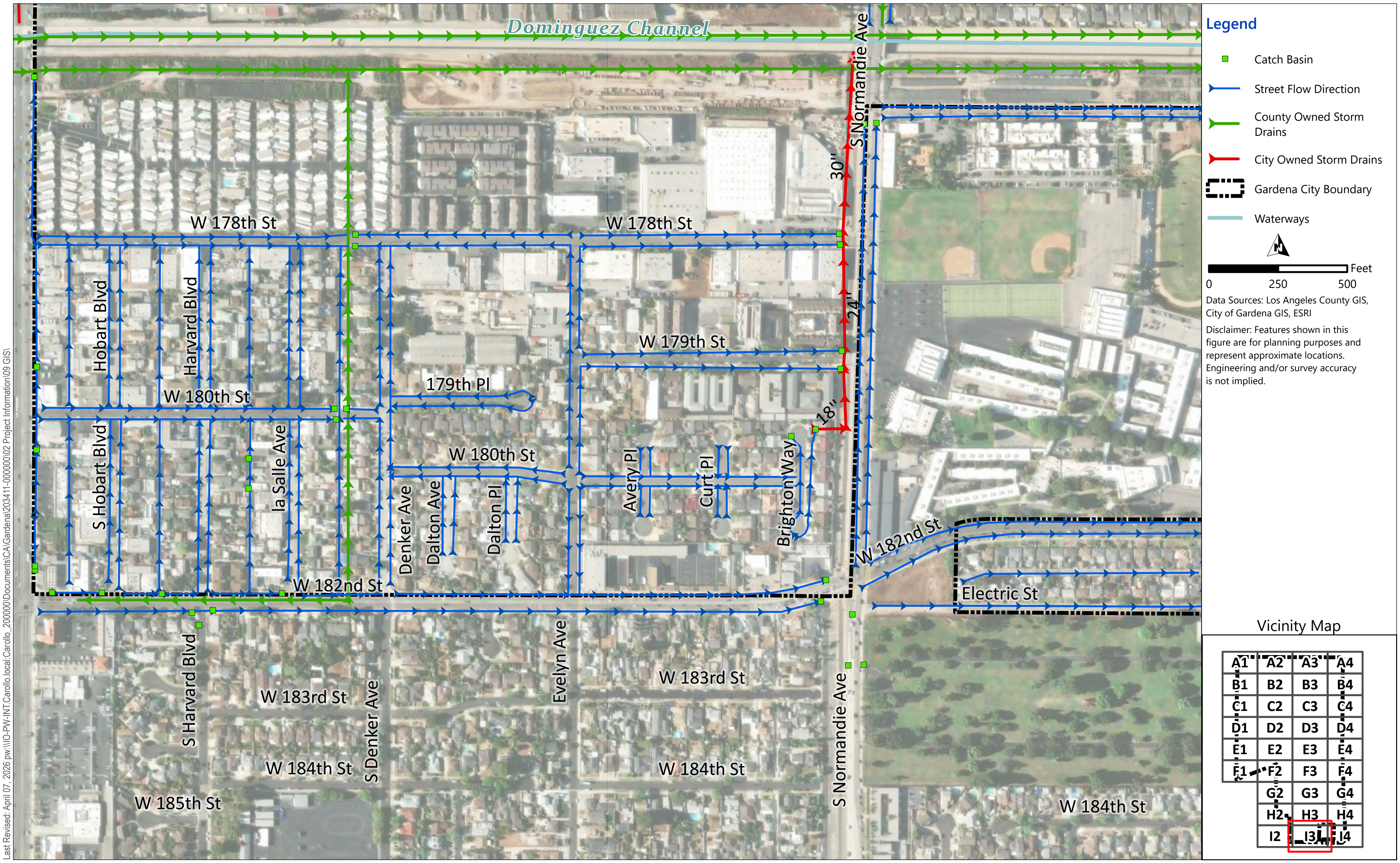
Last Revised: April 07, 2026 pw:\\IO-PW-INT.Carollo.local:Carollo_200000\Documents\CA\Gardena\203411-000000\02 Project Information\09 GIS\

Street Flow Index Page H3

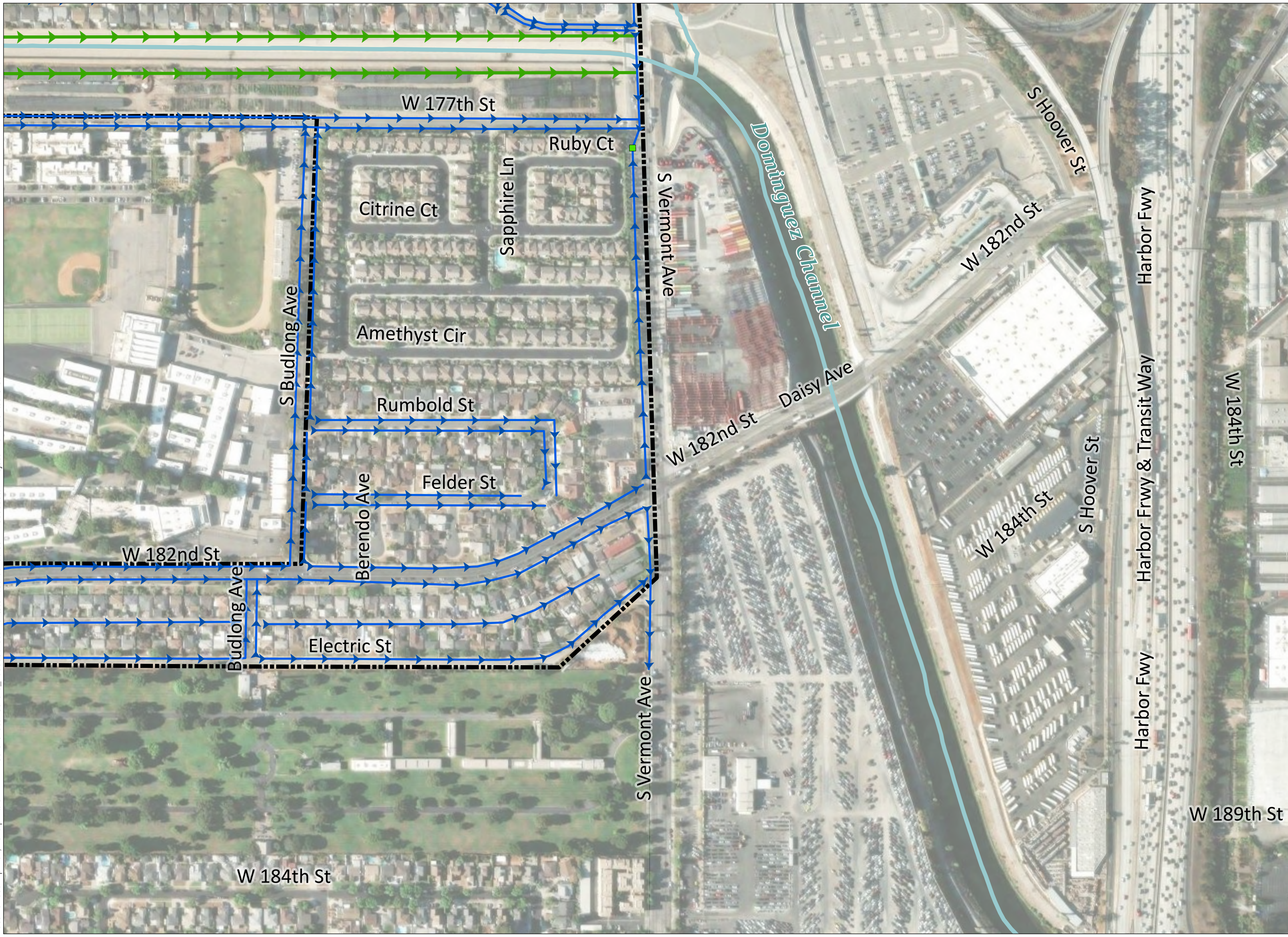

Legend
Catch Basin
Street Flow Direction
County Owned Storm Drains
City Owned Storm Drains
Gardena City Boundary
Waterways
Feet
0
250
500
Data Sources: Los Angeles County GIS, City of Gardena GIS, ESRI
Disclaimer: Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.
Vicinity Map
A1 A2 A3 A4
B1 B2 B3 B4
C1 C2 C3 C4
D1 D2 D3 D4
E1 E2 E3 E4
F1 F2 F3 F4
G2 G3 G4
H2 H3 H4
I2 I3 I4
Mariposa Ave
W 170th St
15''
36''
60''
48''
S Park Ln
S Catalina Ave
Berendo Ave
S New Hampshire Ave
Steven St
Raymond Pl
36''
36''
30''
18''
W Artesia Blvd
18''
S Vermont Ave
Valmeyer Ave
Catalina Ave
Berendo Ave
W Cassidy St
Dominguez Channel
W 177th St
Ruby Ct
S Budlong Ave
Citrine Ct
Sapphire Ln
S Vermont Ave
W 170th St
S Menlo Ave
Merit Ave
S Orchard Ave
171st St
W 172nd St
Harbor Fwy
W 173rd St
S Hoover St
Merit Ave
W 173rd Pl
W Artesia Blvd
Harbor Frwy & Transit Way
Artesia Fwy
State Rte 91
Harbor Fwy
S Hoover St
W 182nd St



Last Revised: April 07, 2026 pw:\\IO-PW-INT.Carollo.local:Carollo_200000\Documents\CA\Gardena\203411-000000\02 Project Information\09 GIS\



Street Flow Index Page I3



Legend

Catch Basin

Street Flow Direction

County Owned Storm Drains

City Owned Storm Drains

Gardena City Boundary

Waterways

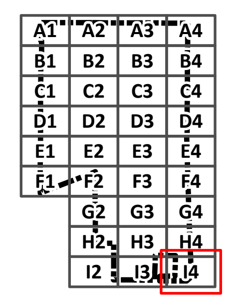
Feet

0 250 500

Data Sources: Los Angeles County GIS, City of Gardena GIS, ESRI

Disclaimer: Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.

Vicinity Map



Last Revised: April 07, 2026 pw:\\IO-PW-INT.Carollo.local:Carollo_200000\Documents\CA\Gardena\203411-000000\02 Project Information\09 GIS\

APPENDIX C EXHIBIT MAPS

Project Number: SD-01

Project Name: S New Hampshire Ave

Project Description:

Replacing approximately 3,545 feet of 18 to 33-inch diameter pipelines along S New Hampshire Ave with 33 to 48-inch diameter pipelines.

Project Detail:

Project Details:

Project Element	Existing Diameter (in)	Proposed Diameter (in)	Length (ft)	Unit Cost ($/LF)	Baseline Construction Cost(1)(2)	Estimated Construction Cost(3)	Capital Improvement Cost(4)(5)	Project Schedule
SD-01A	18	33	25	1,264	$31,700	$41,300	$52,600	
SD-01B	18	24	155	897	$139,100	$180,900	$230,600	
SD-01C	24	30	85	1,178	$100,200	$130,300	$166,100	
SD-01D	33	42	1,535	1,557	$2,389,300	$3,106,100	$3,960,300	
SD-01E	33	48	1,745	1,792	$3,127,200	$4,065,400	$5,183,400	
Total	-	-	3,545	-	$5,787,500	$7,524,000	$9,593,000	

Notes:

(1) Engineering News Report (ENR) Greater LA Construction Cost Index for May 2025 is 15,977.

(2) Baseline Construction Cost is based on multiplying the unit cost by length of each proposed diameter.

(3) Estimated Construction Cost includes a 30% contingency of the baseline construction cost.

(4) Total project costs includes a 10% markup for engineering, and a 10% markup for construction management and a 7.5% markup for project administration of the estimated construction cost.

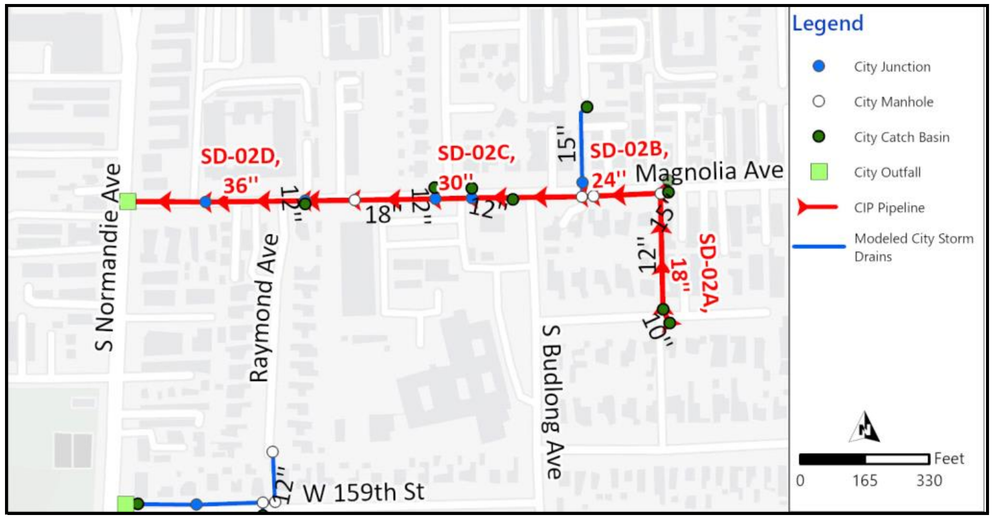
Project Number: SD-02

Project Name: Magnolia Ave

Project Description:

Replacing approximately 1,715 feet of 10 to 18-inch diameter pipelines along Magnolia Avenue with 18 to 36-inch diameter pipelines.

Project Detail:



Project Details:

Project Element	Existing Diameter (in)	Proposed Diameter (in)	Length (ft)	Unit Cost ($/LF)	Baseline Construction Cost(1)(2)	Estimated Construction Cost(3)	Capital Improvement Cost(4)(5)	Project Schedule
SD-02A	10, 12	18	340	696	$236,700	$307,800	$392,400	
SD-02B	18	24	205	897	$184,000	$239,200	$305,000	
SD-02C	18	30	585	1,178	$689,000	$895,700	$1,142,100	
SD-02D	18	36	585	1,352	$790,800	$1,028,100	$1,310,800	
Total	-	-	1,715	-	$1,900,800	$2,471,200	$3,150,800	

Notes:

(1) Engineering News Report (ENR) Greater LA Construction Cost Index for May 2025 is 15,977.

(2) Baseline Construction Cost is based on multiplying the unit cost by length of each proposed diameter.

(3) Estimated Construction Cost includes a 30% contingency of the baseline construction cost.

(4) Total project costs includes a 10% markup for engineering, and a 10% markup for construction management and a 7.5% markup for project administration of the estimated construction cost.

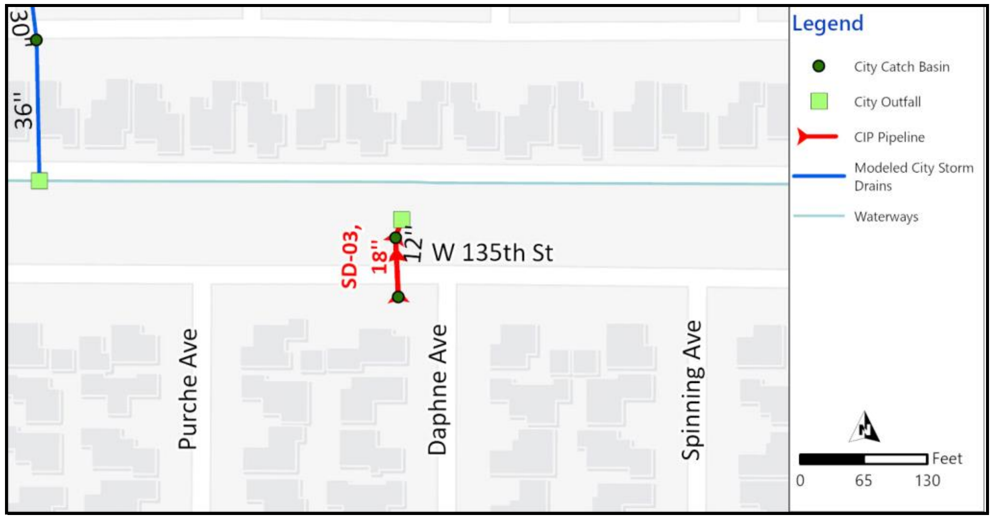
Project Number: SD-03

Project Name: W 135th St

Project Description:

Replacing approximately 80 feet of 12-inch diameter pipelines along W 135th St with 18-inch diameter pipelines.

Project Detail:



Project Details:

Project Element	Existing Diameter (in)	Proposed Diameter (in)	Length (ft)	Unit Cost ($/LF)	Baseline Construction Cost(1)(2)	Estimated Construction Cost(3)	Capital Improvement Cost(4)(5)	Project Schedule
SD-03	12	18	80	696	$55,700	$72,500	$92,400	
Total	-	-	80	-	$55,700	$72,500	$92,400	

Notes:

(1) Engineering News Report (ENR) Greater LA Construction Cost Index for May 2025 is 15,977.

(2) Baseline Construction Cost is based on multiplying the unit cost by length of each proposed diameter.

(3) Estimated Construction Cost includes a 30% contingency of the baseline construction cost.

(4) Total project costs includes a 10% markup for engineering, and a 10% markup for construction management and a 7.5% markup for project administration of the estimated construction cost.

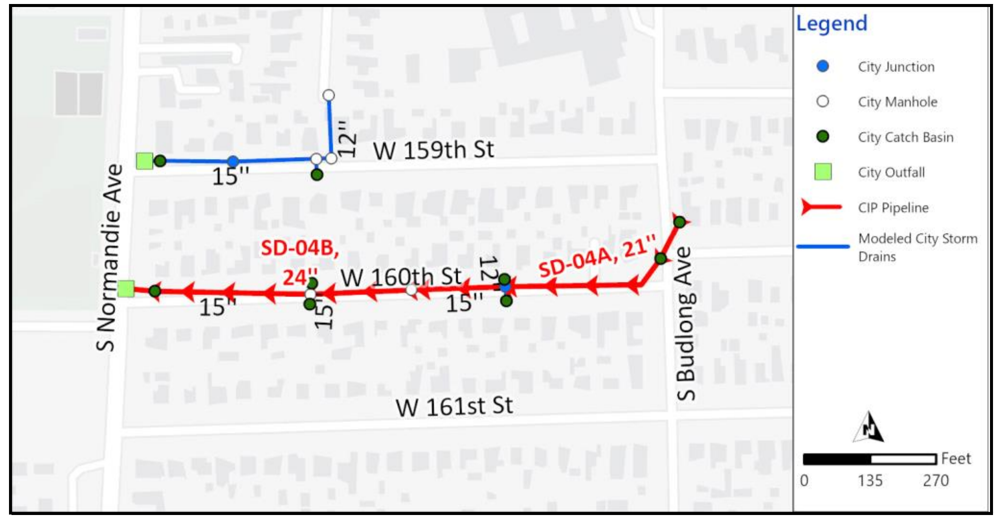
Project Number: SD-04

Project Name: W 160th St

Project Description:

Replacing approximately 1,210 feet of 15-inch diameter pipelines along W 160th St with 21 and 24-inch diameter pipelines.

Project Detail:



Project Details:

Project Element	Existing Diameter (in)	Proposed Diameter (in)	Length (ft)	Unit Cost ($/LF)	Baseline Construction Cost(1)(2)	Estimated Construction Cost(3)	Capital Improvement Cost(4)(5)	Project Schedule
SD-04A	15	21	430	773	$332,400	$432,200	$551,000	
SD-04B	15	24	780	897	$699,900	$909,900	$1,160,100	
Total	-	-	1,715	-	$1,900,800	$2,471,200	$3,150,800	

Notes:

(1) Engineering News Report (ENR) Greater LA Construction Cost Index for May 2025 is 15,977.

(2) Baseline Construction Cost is based on multiplying the unit cost by length of each proposed diameter.

(3) Estimated Construction Cost includes a 30% contingency of the baseline construction cost.

(4) Total project costs includes a 10% markup for engineering, and a 10% markup for construction management and a 7.5% markup for project administration of the estimated construction cost.

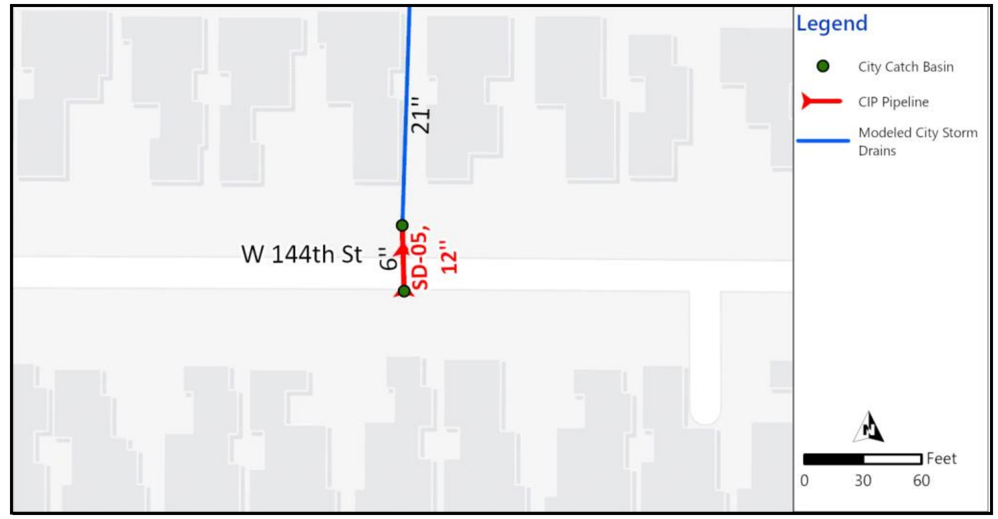
Project Number: SD-05

Project Name: W 144th St

Project Description:

Replacing approximately 35 feet of 6-inch diameter pipelines along W 144th St with 12-inch diameter pipelines.

Project Detail:



Project Details:

Project Element	Existing Diameter (in)	Proposed Diameter (in)	Length (ft)	Unit Cost ($/LF)	Baseline Construction Cost(1)(2)	Estimated Construction Cost(3)	Capital Improvement Cost(4)(5)	Project Schedule
SD-05	6	12	35	460	$16,200	$21,100	$26,900	
Total	-	-	35	-	$16,200	$21,100	$26,900	

Notes:

(1) Engineering News Report (ENR) Greater LA Construction Cost Index for May 2025 is 15,977.

(2) Baseline Construction Cost is based on multiplying the unit cost by length of each proposed diameter.

(3) Estimated Construction Cost includes a 30% contingency of the baseline construction cost.

(4) Total project costs includes a 10% markup for engineering, and a 10% markup for construction management and a 7.5% markup for project administration of the estimated construction cost.

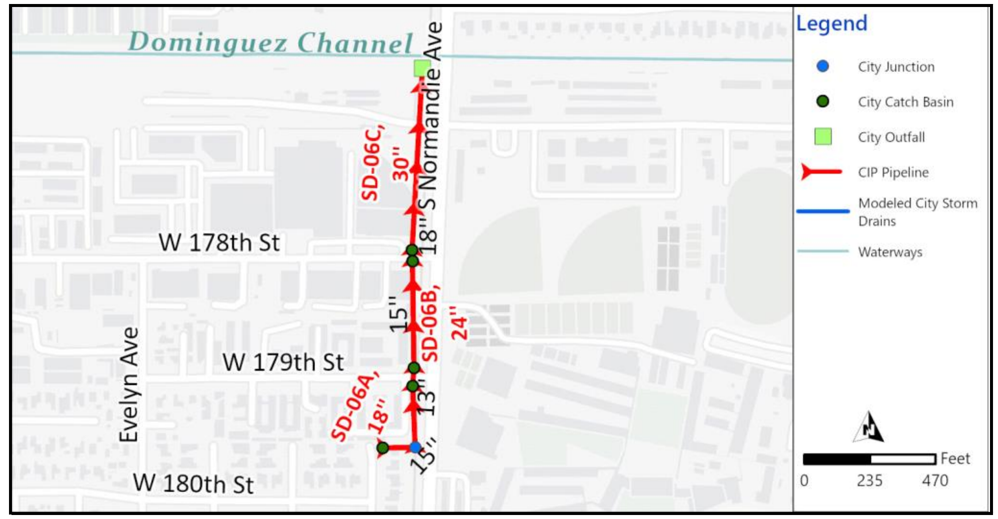
Project Number: SD-06

Project Name: S Normandie Ave

Project Description:

Replacing approximately 1,490 feet of 15 to 18-inch diameter pipelines along S Normandie Avenue with 18 to 30-inch diameter pipelines. The improvement is intended to upgrade the capacity of the existing system.

Project Detail:



Project Details:

Project Element	Existing Diameter (in)	Proposed Diameter (in)	Length (ft)	Unit Cost ($/LF)	Baseline Construction Cost[1][2]	Estimated Construction Cost[3]	Capital Improvement Cost[4][5]	Project Schedule
SD-06A	15	18	340	696	$236,700	$307,800	$392,400	
SD-06B	13,15	24	455	897	$408,300	$530,800	$676,800	
SD-06C	18	30	695	1,178	$818,600	$1,064,200	$1,356,900	
Total	-	-	1,490	-	$1,463,600	$1,902,800	$2,426,100	

Notes:

(1) Engineering News Report (ENR) Greater LA Construction Cost Index for May 2025 is 15,977.

(2) Baseline Construction Cost is based on multiplying the unit cost by length of each proposed diameter.

(3) Estimated Construction Cost includes a 30% contingency of the baseline construction cost.

(4) Total project costs includes a 10% markup for engineering, and a 10% markup for construction management and a 7.5% markup for project administration of the estimated construction cost.

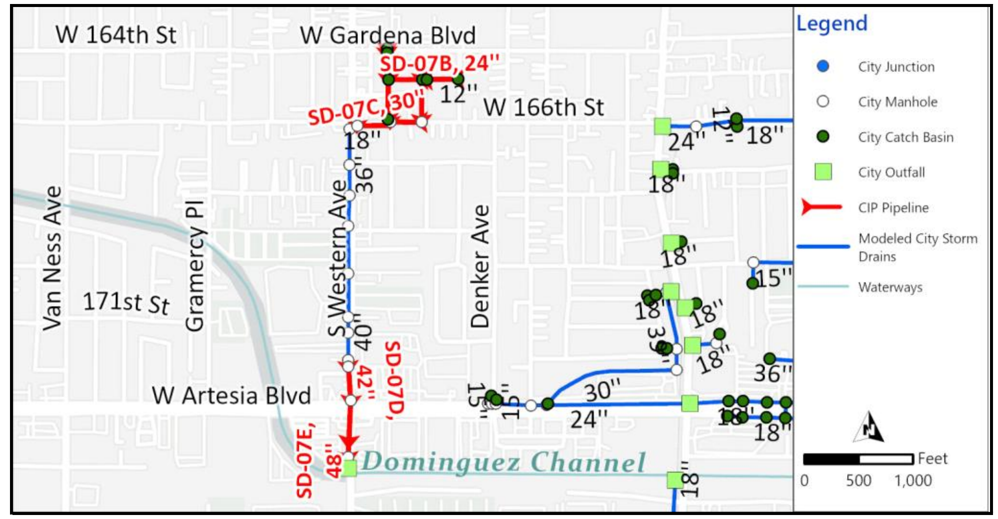
Project Number: SD-07

Project Name: S Western Ave

Project Description:

Replacing approximately 2,135 feet of 12 to 40-inch diameter pipelines along S Western Avenue with 18 to 48-inch diameter pipelines

Project Detail:



Project Details:

Project Element	Existing Diameter (in)	Proposed Diameter (in)	Length (ft)	Unit Cost ($/LF)	Baseline Construction Cost(1)(2)	Estimated Construction Cost(3)	Capital Improvement Cost(4)(5)	Project Schedule
SD-07A	12	18	300	696	$208,800	$271,500	$346,100	
SD-07B	12,15	24	450	897	$403,800	$525,000	$669,300	
SD-07C	18,24	30	450	1,178	$530,000	$689,000	$878,500	
SD-07D	40	42	320	1,557	$498,100	$647,600	$825,700	
SD-07E	40	48	630	1,792	$1,129,000	$1,467,700	$1,871,400	
Total	-	-	2,150	-	$2,769,700	$3,600,800	$4,591,000	

Notes:

(1) Engineering News Report (ENR) Greater LA Construction Cost Index for May 2025 is 15,977.

(2) Baseline Construction Cost is based on multiplying the unit cost by length of each proposed diameter.

(3) Estimated Construction Cost includes a 30% contingency of the baseline construction cost.

(4) Total project costs includes a 10% markup for engineering, and a 10% markup for construction management and a 7.5% markup for project administration of the estimated construction cost.

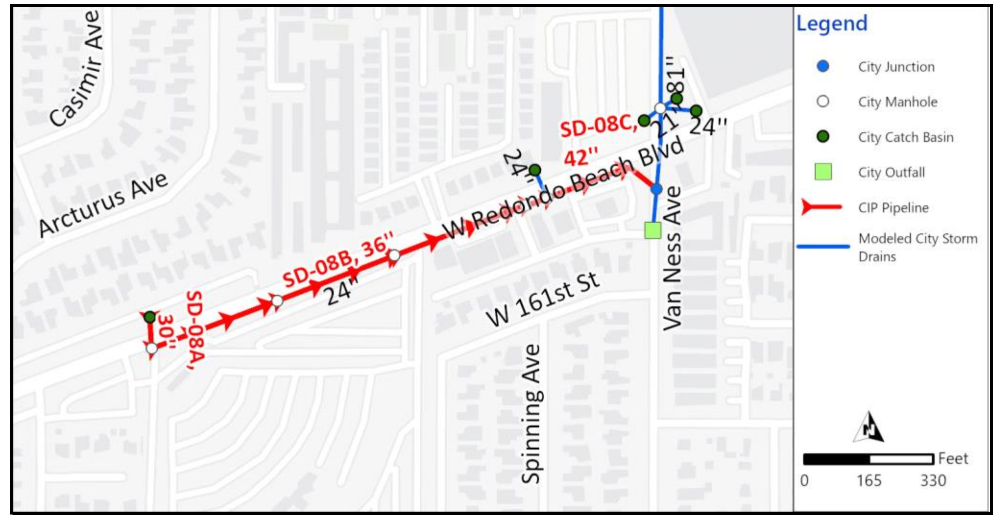
Project Number: SD-08

Project Name: W Redondo Beach Blvd

Project Description:

Replacing approximately 1,490 feet of 24-inch diameter pipelines along W Artesia Blvd with 30 to 42-inch diameter pipelines.

Project Detail:



Project Details:

Project Element	Existing Diameter (in)	Proposed Diameter (in)	Length (ft)	Unit Cost ($/LF)	Baseline Construction Cost(1)(2)	Estimated Construction Cost(3)	Capital Improvement Cost(4)(5)	Project Schedule
SD-08A	24	30	85	1,178	$100,200	$130,300	$166,100	
SD-08B	24	36	1,090	1,352	$1,473,400	$1,915,500	$2,442,200	
SD-08C	24	42	315	1,557	$490,400	$637,600	$812,900	
Total	-	-	1,490	-	$2,064,000	$2,683,400	$3,421,200	

Notes:

(1) Engineering News Report (ENR) Greater LA Construction Cost Index for May 2025 is 15,977.

(2) Baseline Construction Cost is based on multiplying the unit cost by length of each proposed diameter.

(3) Estimated Construction Cost includes a 30% contingency of the baseline construction cost.

(4) Total project costs includes a 10% markup for engineering, and a 10% markup for construction management and a 7.5% markup for project administration of the estimated construction cost.

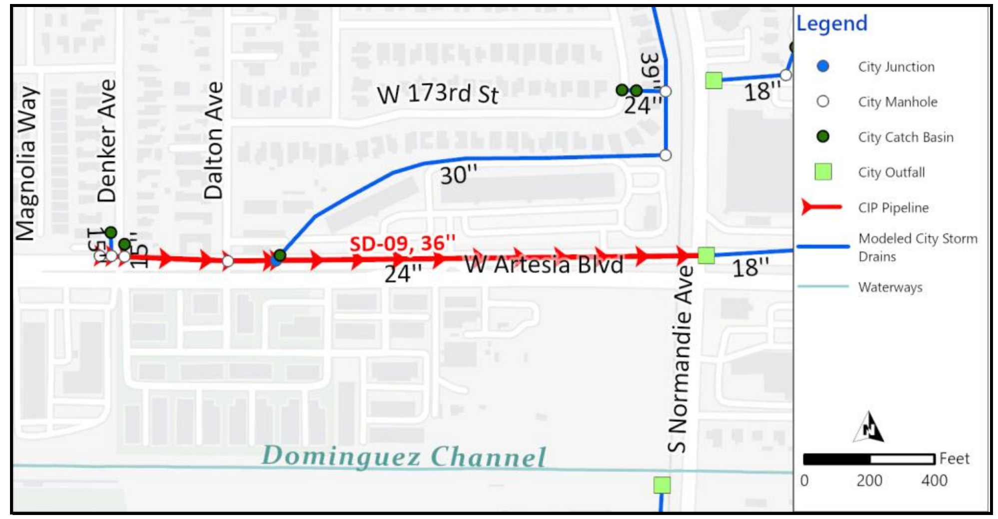
Project Number: SD-09

Project Name: W Artesia Blvd

Project Description:

Replacing approximately 1,865 feet of 24-inch diameter pipelines along W Artesia Blvd with 36-inch diameter pipelines.

Project Detail:



Project Details:

Project Element	Existing Diameter (in)	Proposed Diameter (in)	Length (ft)	Unit Cost ($/LF)	Baseline Construction Cost(1)(2)	Estimated Construction Cost(3)	Capital Improvement Cost(4)(5)	Project Schedule
SD-09	24	36	1,865	1,352	$2,521,000	$3,277,300	$4,178,600	
Total	-	-	1,865	-	$2,521,000	$3,277,300	$4,178,600	

Notes:

(1) Engineering News Report (ENR) Greater LA Construction Cost Index for May 2025 is 15,977.

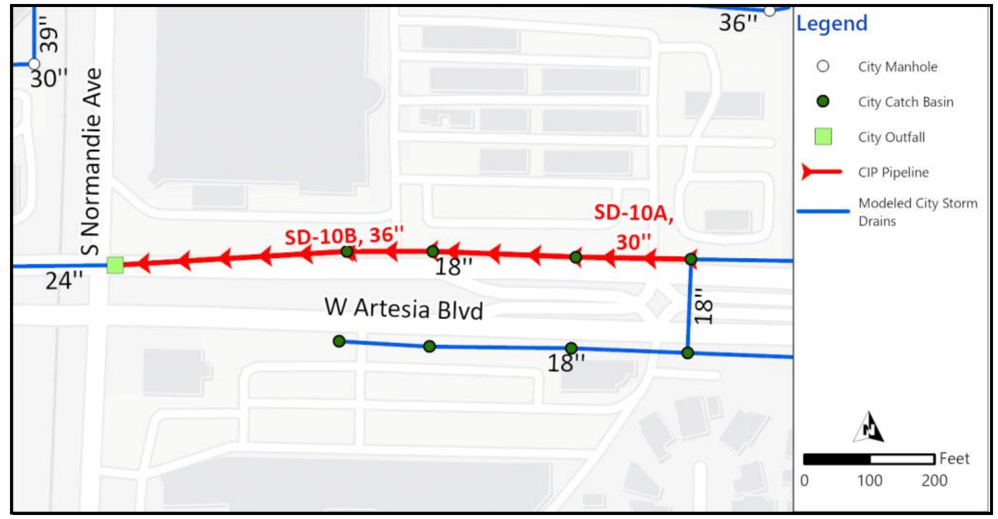
(2) Baseline Construction Cost is based on multiplying the unit cost by length of each proposed diameter.

(3) Estimated Construction Cost includes a 30% contingency of the baseline construction cost.

(4) Total project costs includes a 10% markup for engineering, and a 10% markup for construction management and a 7.5% markup for project administration of the estimated construction cost.

Project Number: SD-10
Project Name: W Artesia Blvd
Project Description:
Replacing approximately 890 feet of 18-inch diameter pipelines along W Artesia Blvd with 30 to 36-inch diameter pipelines

Project Detail:



Project Details:

Project Element	Existing Diameter (in)	Proposed Diameter (in)	Length (ft)	Unit Cost ($/LF)	Baseline Construction Cost(1)(2)	Estimated Construction Cost(3)	Capital Improvement Cost(4)(5)	Project Schedule
SD-10A	18	30	180	1,178	$212,000	$275,600	$351,400	
SD-10B	18	36	710	1,352	$959,800	$1,247,800	$1,590,900	
Total	-	-	1,715	-	$1,900,800	$2,471,200	$3,150,800	

Notes:

(1) Engineering News Report (ENR) Greater LA Construction Cost Index for May 2025 is 15,977.

(2) Baseline Construction Cost is based on multiplying the unit cost by length of each proposed diameter.

(3) Estimated Construction Cost includes a 30% contingency of the baseline construction cost.

(4) Total project costs includes a 10% markup for engineering, and a 10% markup for construction management and a 7.5% markup for project administration of the estimated construction cost.

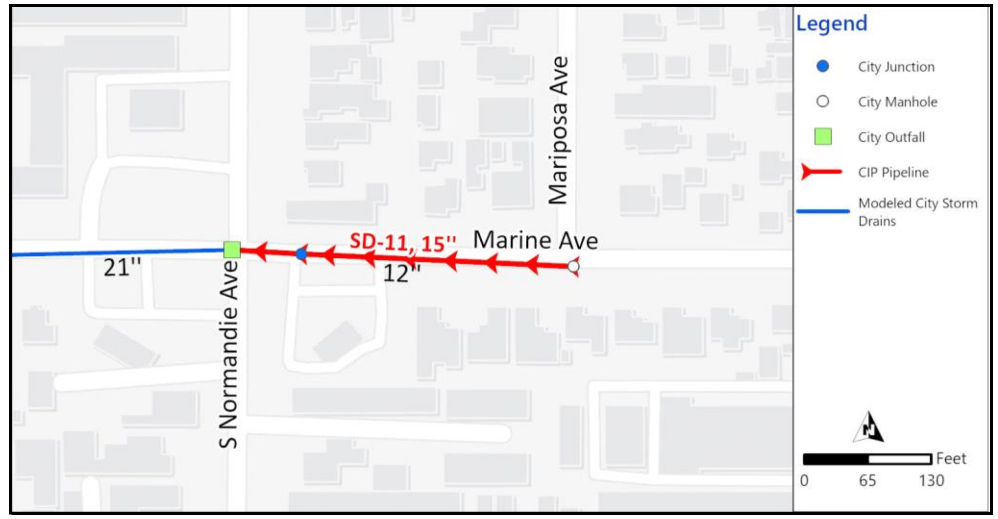
Project Number: SD-11

Project Name: Marine Ave

Project Description:

Replacing approximately 350 feet of 12-inch diameter pipelines along Marine Avenue with 15-inch diameter pipelines

Project Detail:



Project Details:

Project Element	Existing Diameter (in)	Proposed Diameter (in)	Length (ft)	Unit Cost ($/LF)	Baseline Construction Cost(1)(2)	Estimated Construction Cost(3)	Capital Improvement Cost(4)(5)	Project Schedule
SD-11	12	15	350	585	$204,700	$266,200	$339,300	
Total	-	-	350	-	$204,700	$266,200	$339,300	

Notes:

(1) Engineering News Report (ENR) Greater LA Construction Cost Index for May 2025 is 15,977.

(2) Baseline Construction Cost is based on multiplying the unit cost by length of each proposed diameter.

(3) Estimated Construction Cost includes a 30% contingency of the baseline construction cost.

(4) Total project costs includes a 10% markup for engineering, and a 10% markup for construction management and a 7.5% markup for project administration of the estimated construction cost.

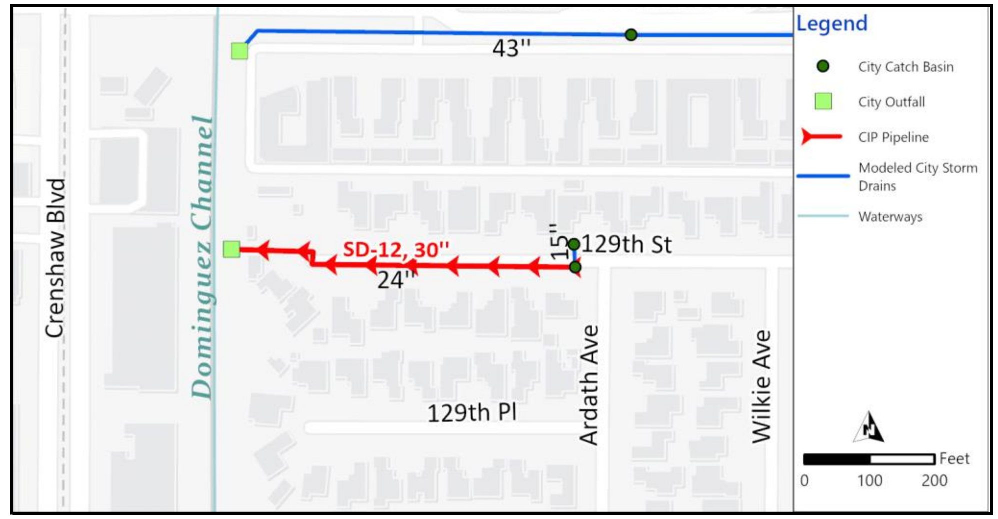
Project Number: SD-12

Project Name: 129th St

Project Description:

Replacing approximately 550 feet of 24-inch diameter pipelines along 129th St with 30-inch diameter pipelines.

Project Detail:



Project Details:

Project Element	Existing Diameter (in)	Proposed Diameter (in)	Length (ft)	Unit Cost ($/LF)	Baseline Construction Cost[(1)(2)]	Estimated Construction Cost[(3)]	Capital Improvement Cost[(4)(5)]	Project Schedule
SD-12	24	30	50	1,178	$58,900	$76,600	$97,700	
Total	-	-	50	-	$58,900	$76,600	$97,700	

Notes:

(1) Engineering News Report (ENR) Greater LA Construction Cost Index for May 2025 is 15,977.

(2) Baseline Construction Cost is based on multiplying the unit cost by length of each proposed diameter.

(3) Estimated Construction Cost includes a 30% contingency of the baseline construction cost.

(4) Total project costs includes a 10% markup for engineering, and a 10% markup for construction management and a 7.5% markup for project administration of the estimated construction cost.

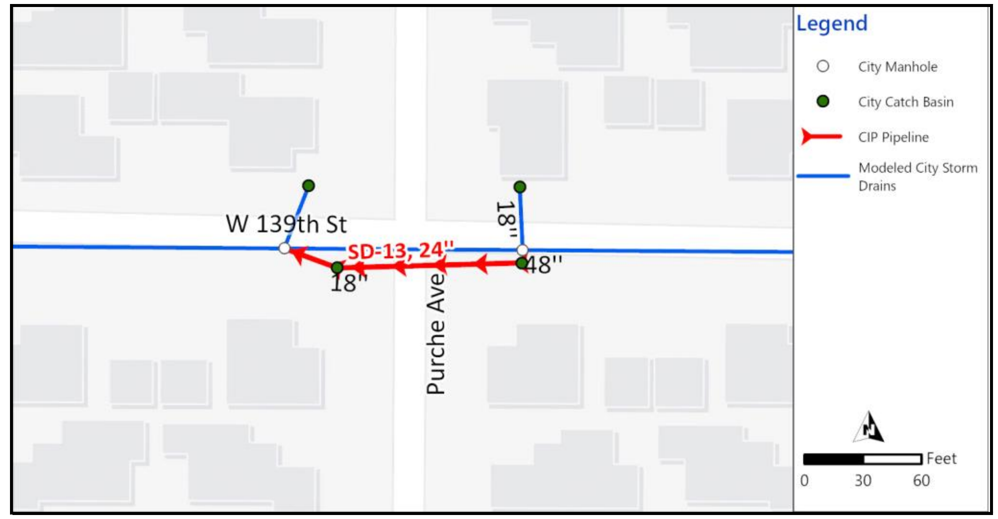
Project Number: SD-13

Project Name: W 139th St

Project Description:

Replacing approximately 125 feet of 18-inch diameter pipelines along W 139th St with 24-inch diameter pipelines.

Project Detail:



Project Details:

Project Element	Existing Diameter (in)	Proposed Diameter (in)	Length (ft)	Unit Cost ($/LF)	Baseline Construction Cost(1)(2)	Estimated Construction Cost(3)	Capital Improvement Cost(4)(5)	Project Schedule
SD-13	18	24	125	897	$112,200	$145,900	$186,000	
Total	-	-	125	-	$112,200	$145,900	$186,000	

Notes:

(1) Engineering News Report (ENR) Greater LA Construction Cost Index for May 2025 is 15,977.

(2) Baseline Construction Cost is based on multiplying the unit cost by length of each proposed diameter.

(3) Estimated Construction Cost includes a 30% contingency of the baseline construction cost.

(4) Total project costs includes a 10% markup for engineering, and a 10% markup for construction management and a 7.5% markup for project administration of the estimated construction cost.

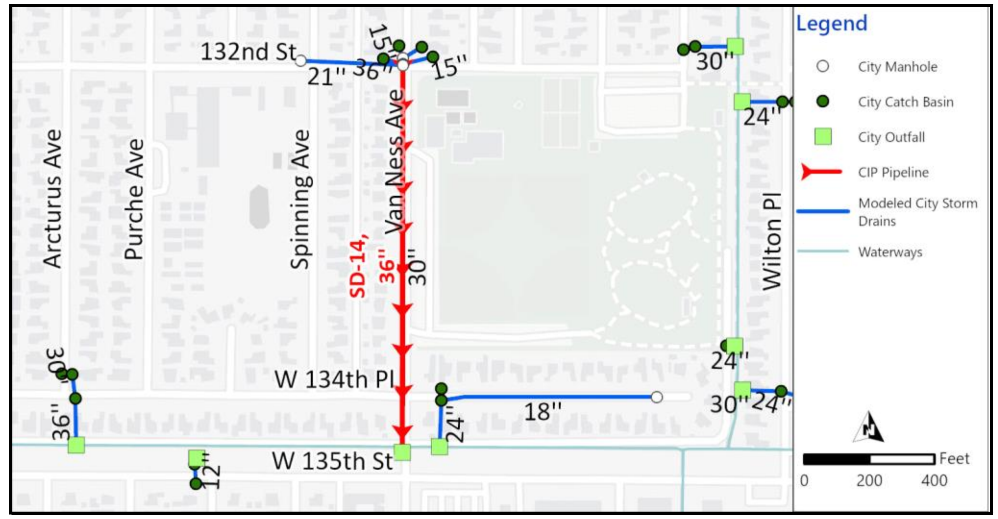
Project Number: SD-14

Project Name: Van Ness Ave

Project Description:

Replacing approximately 1,195 feet of 30-inch diameter pipelines along Van Ness Avenue with 36-inch diameter pipelines.

Project Detail:



Project Details:

Project Element	Existing Diameter (in)	Proposed Diameter (in)	Length (ft)	Unit Cost ($/LF)	Baseline Construction Cost[1][2]	Estimated Construction Cost[3]	Capital Improvement Cost[4][5]	Project Schedule
SD-14	30	36	1,195	1,352	$1,615,400	$2,100,100	$2,677,600	
Total	-	-	1,195	-	$1,615,400	$2,100,100	$2,677,600	

Notes:

(1) Engineering News Report (ENR) Greater LA Construction Cost Index for May 2025 is 15,977.

(2) Baseline Construction Cost is based on multiplying the unit cost by length of each proposed diameter.

(3) Estimated Construction Cost includes a 30% contingency of the baseline construction cost.

(4) Total project costs includes a 10% markup for engineering, and a 10% markup for construction management and a 7.5% markup for project administration of the estimated construction cost.

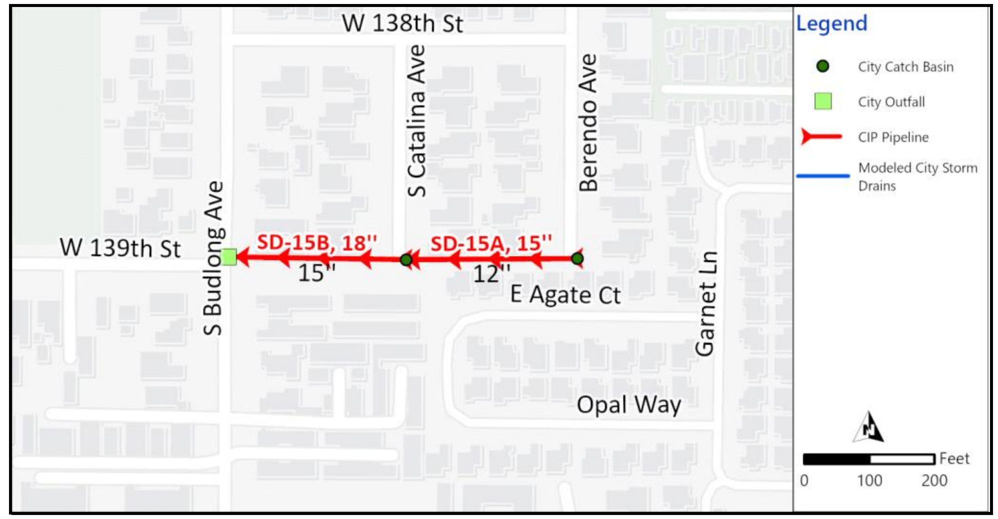
Project Number: SD-15

Project Name: W 139th St

Project Description:

Replacing approximately 540 feet of 12 and 15-inch diameter pipelines along W 139th St with 15 and 18-inch diameter pipelines

Project Detail:



Project Details:

Project Element	Existing Diameter (in)	Proposed Diameter (in)	Length (ft)	Unit Cost ($/LF)	Baseline Construction Cost(1)(2)	Estimated Construction Cost(3)	Capital Improvement Cost(4)(5)	Project Schedule
SD-15A	12	15	265	585	$155,000	$201,500	$257,000	
SD-15B	15	18	275	696	$191,400	$248,900	$317,300	
Total	-	-	1,715	-	$1,900,800	$2,471,200	$3,150,800	

Notes:

(1) Engineering News Report (ENR) Greater LA Construction Cost Index for May 2025 is 15,977.

(2) Baseline Construction Cost is based on multiplying the unit cost by length of each proposed diameter.

(3) Estimated Construction Cost includes a 30% contingency of the baseline construction cost.

(4) Total project costs includes a 10% markup for engineering, and a 10% markup for construction management and a 7.5% markup for project administration of the estimated construction cost.

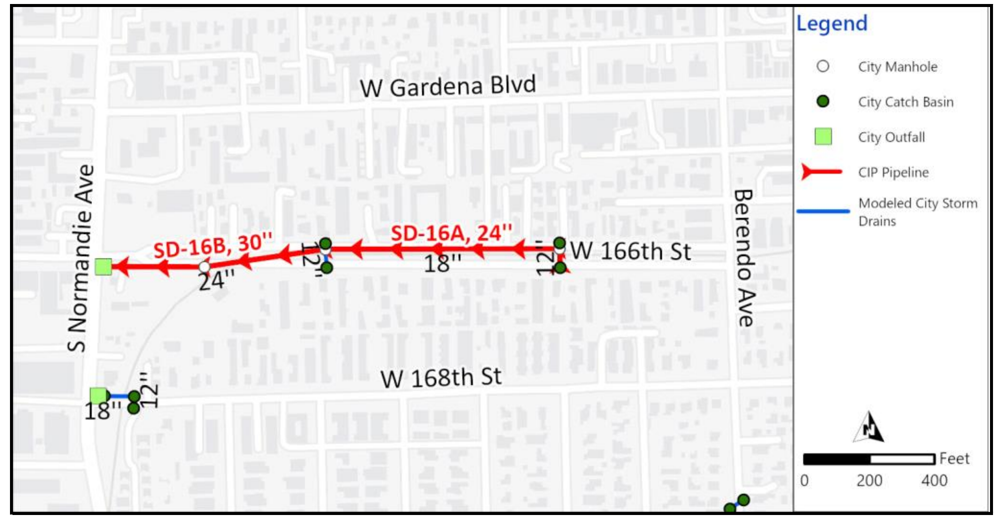
Project Number: SD-16

Project Name: W 166th St

Project Description:

Replacing approximately 1,475 feet of 12 to 24-inch diameter pipelines along W 166th St with 24 and 30-inch diameter pipelines

Project Detail:



Project Details:

Project Element	Existing Diameter (in)	Proposed Diameter (in)	Length (ft)	Unit Cost ($/LF)	Baseline Construction Cost(1)(2)	Estimated Construction Cost(3)	Capital Improvement Cost(4)(5)	Project Schedule
SD-16A	12,18	24	785	897	$704,400	$915,800	$1,167,600	
SD-16B	24	30	690	1,178	$812,700	$1,056,600	$1,347,100	
Total	-	-	1,715	-	$1,900,800	$2,471,200	$3,150,800	

Notes:

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(2) Baseline Construction Cost is based on multiplying the unit cost by length of each proposed diameter.

(3) Estimated Construction Cost includes a 30% contingency of the baseline construction cost.

(4) Total project costs includes a 10% markup for engineering, and a 10% markup for construction management and a 7.5% markup for project administration of the estimated construction cost.

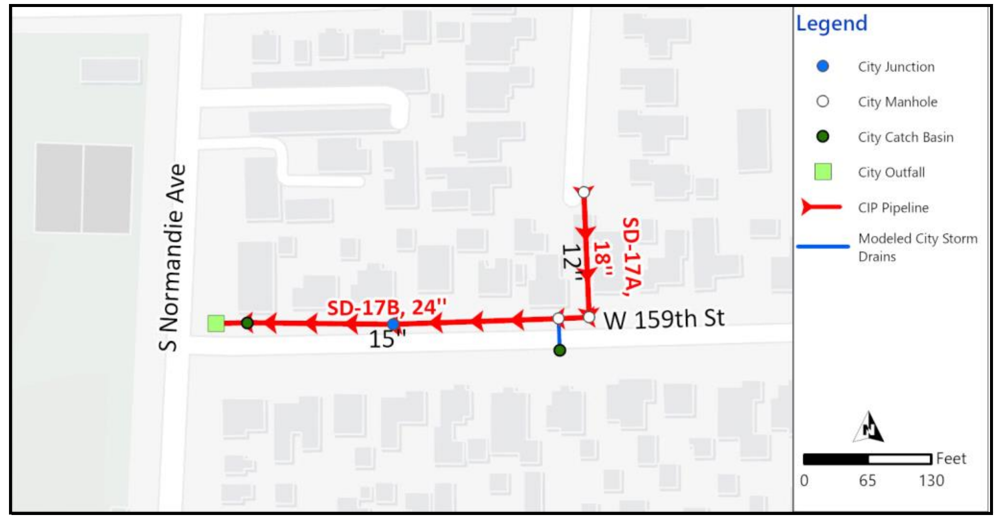
Project Number: SD-17

Project Name: W 159th St

Project Description:

Replacing approximately 515 feet of 12 and 15-inch diameter pipelines along W 159th St with 18 and 24-inch diameter pipelines

Project Detail:



Project Details:

Project Element	Existing Diameter (in)	Proposed Diameter (in)	Length (ft)	Unit Cost ($/LF)	Baseline Construction Cost(1)(2)	Estimated Construction Cost(3)	Capital Improvement Cost(4)(5)	Project Schedule
SD-17A	12	18	160	696	$111,400	$144,900	$184,700	
SD-17B	15	24	355	897	$318,600	$414,200	$528,100	
Total	-	-	1,715	-	$1,900,800	$2,471,200	$3,150,800	

Notes:

(1) Engineering News Report (ENR) Greater LA Construction Cost Index for May 2025 is 15,977.

(2) Baseline Construction Cost is based on multiplying the unit cost by length of each proposed diameter.

(3) Estimated Construction Cost includes a 30% contingency of the baseline construction cost.

(4) Total project costs includes a 10% markup for engineering, and a 10% markup for construction management and a 7.5% markup for project administration of the estimated construction cost.