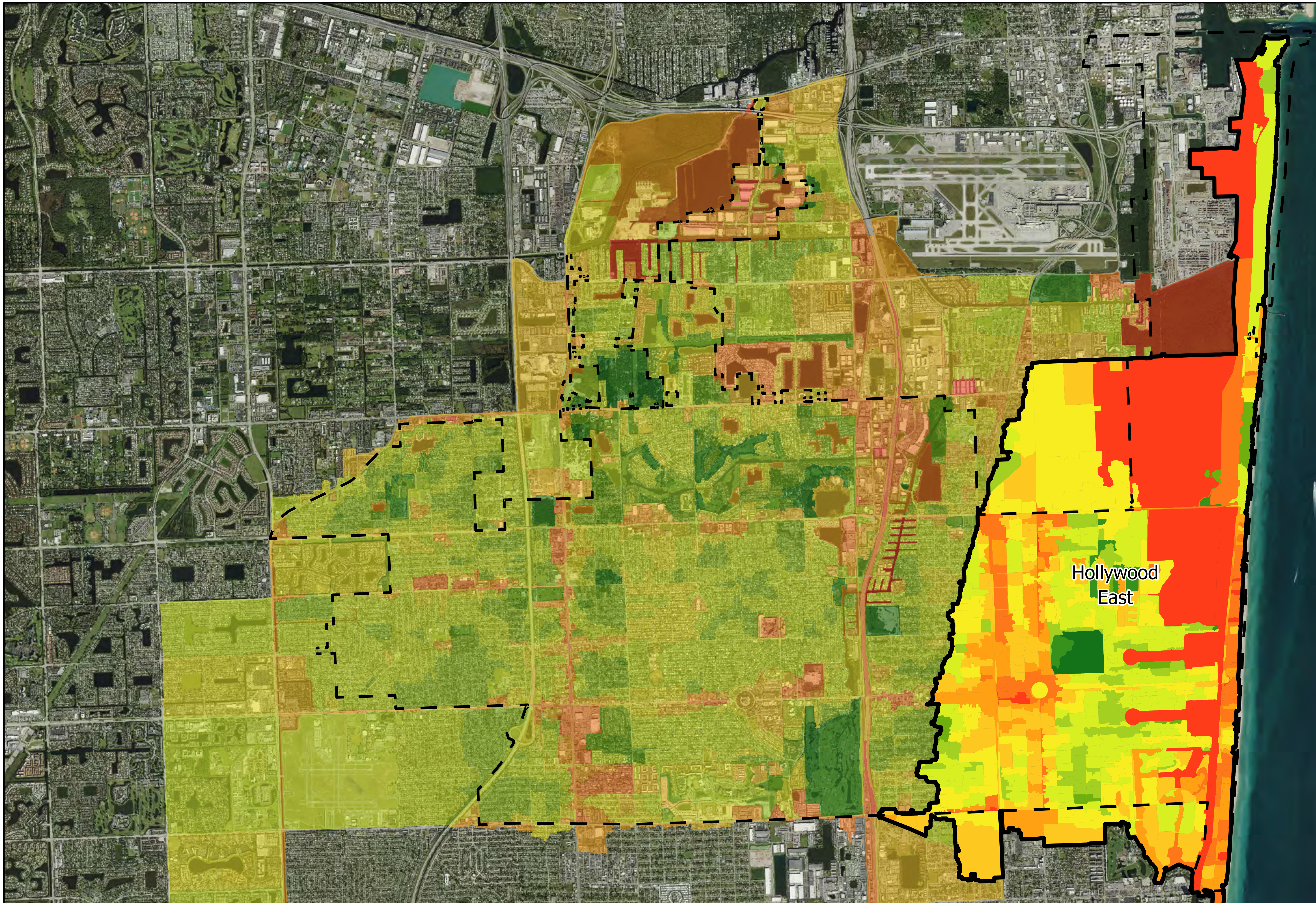


Legend

- Hollywood City Limits
- Hollywood East

Impervious %

- 0% - 10%
- 11% - 20%
- 21% - 30%
- 31% - 40%
- 41% - 50%
- 51% - 60%
- 61% - 70%
- 71% - 80%
- 81% - 90%
- 91% - 99%
- 100%

N

CDM Smith

CITY OF Hollywood FLORIDA

Total Impervious Percentage for the Hollywood East Basin

0 2,000 4,000 8,000 Feet

Scale: 1:53,000

City of Hollywood Stormwater Master Plan

Figure 2.2-5

08/10/2022

Figure 2.2-6 Landuse Category Breakdown for the HE Basin

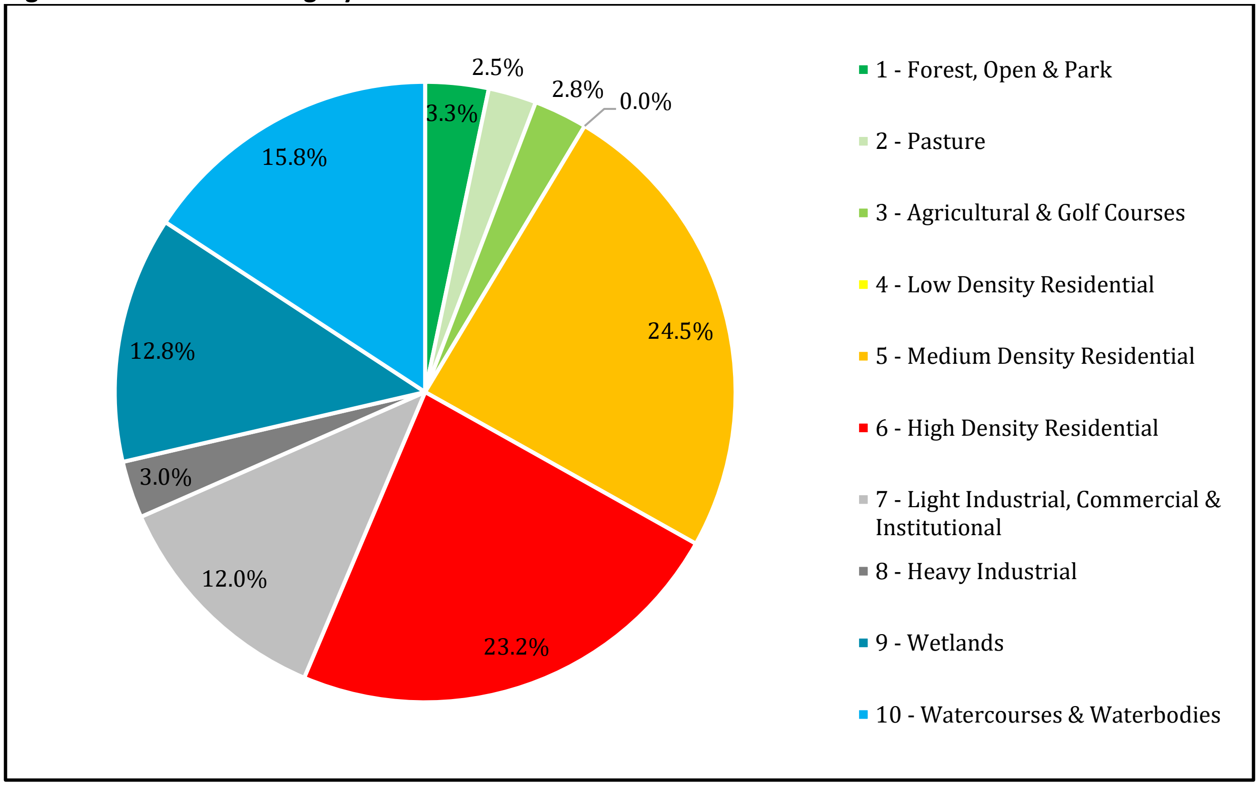


Figure 2.2-7 Breakdown of Impervious Cover for the HE Basin

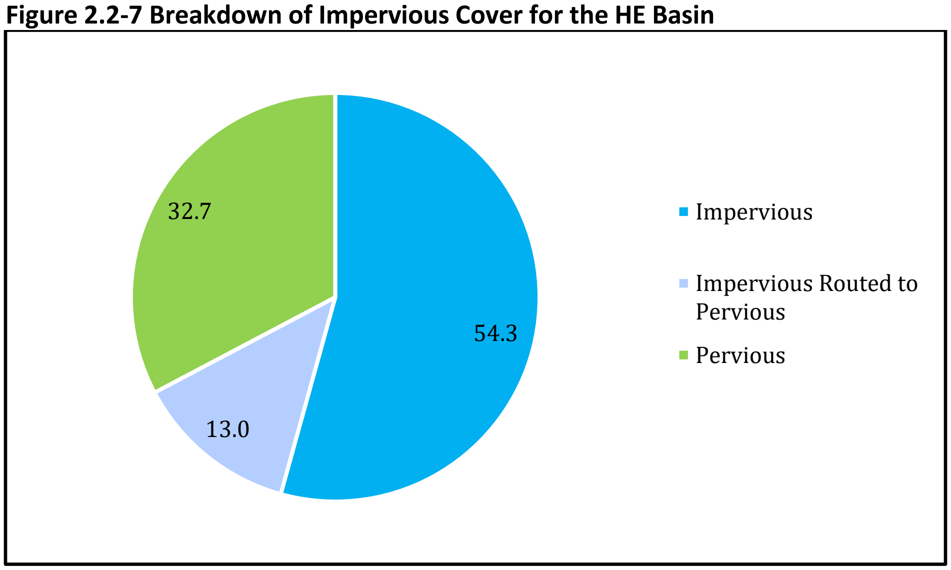
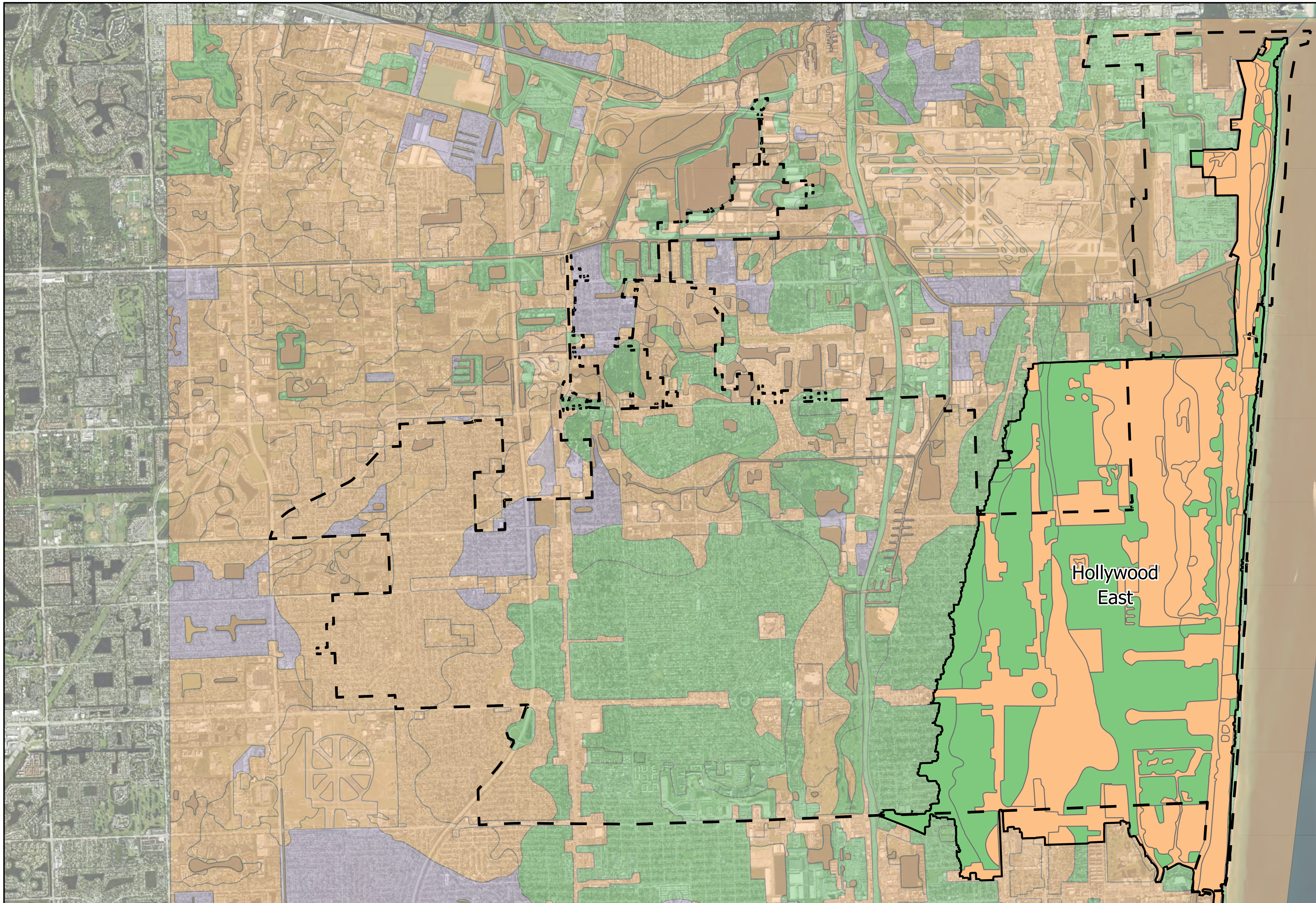


Table 2.2-1 HE Basin Design Storm Volumes and Intensities

Storm	East		Beach	
	Rainfall Depth (inches)	Peak Hour (inches)	Rainfall Depth (inches)	Peak Hour (inches)
5-year, 24-hour	7.4	3.0	7.4	3.0
10-year, 24-hour	9.0	3.7	9.1	3.7
25-year, 72-hour	15.5	4.7	15.6	4.8
100-year, 72-hour	21.2	6.5	21.3	6.5

Surface soils in the HE Basin are primarily composed of HSG Type A or Dual Class (A/D, or B/D) soils in the NRCS soils map included as shown on **Figure 2.2-8**. One of the soil types found in the HE Basin is classified as Urban Land, which again is classified as Type D for this project. Dual class soils were provided the lower infiltration capacity Type D classification in the HE Basin. **Figure 2.2-9** displays the HSG classifications deployed in the HE Basin model. The Model Development TM describes how the different soils types are converted to Green-Ampt model parameters.



Legend

Hollywood City Limits

Hollywood East

NRCS Soil HSG Group

- A
- B
- D

CDM Smith

City of Hollywood Florida

NRCS Soils Map for the Hollywood East Basin

0 2,000 4,000 8,000 Feet

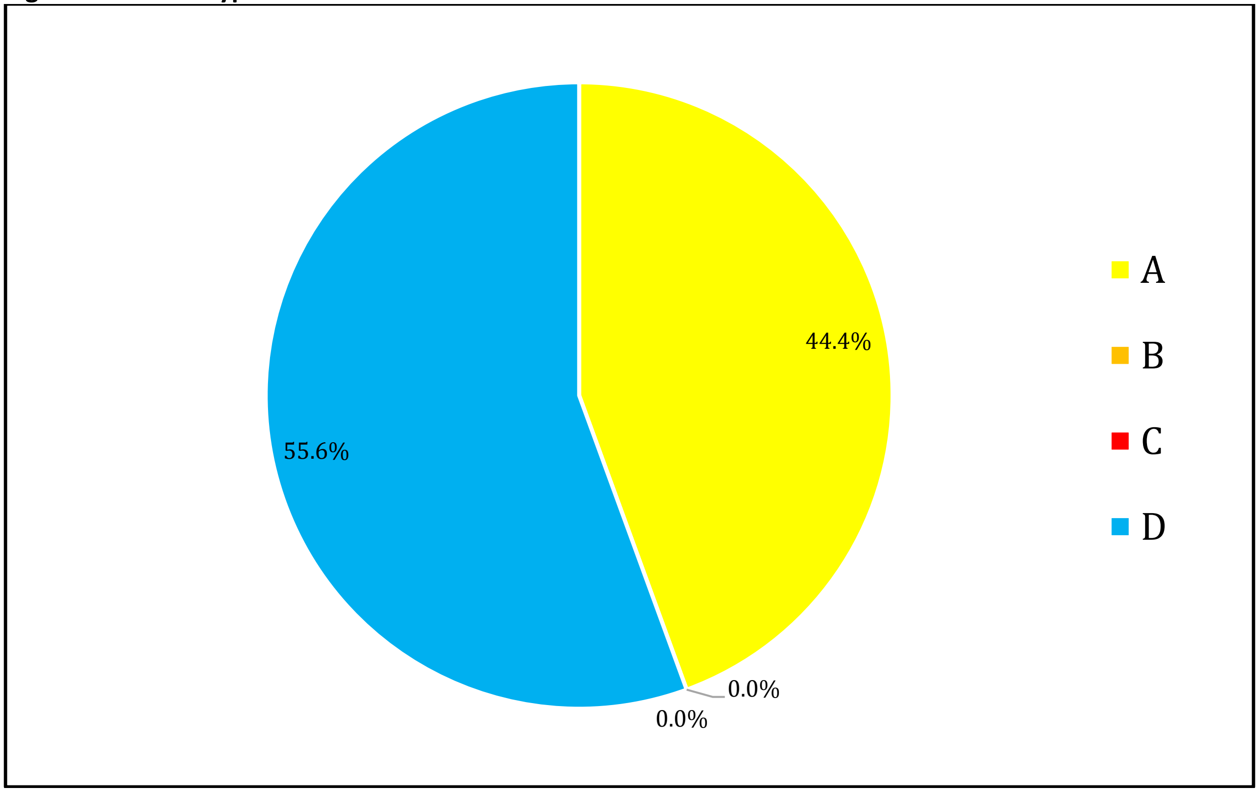
Scale: 1:53,000

City of Hollywood Stormwater Master Plan

Figure 2.2-8

08/10/2022

Figure 2.2-9 HSG Type for the HE Basin



2.2.2 HE Basin Modeling and Analysis Overview

Hydrologic and Hydraulic (H&H) Model Elements

The developed H&H models for the HE Basin stormwater management system were used to evaluate the performance of the City's existing stormwater management system and to analyze future CIP projects. Model analysis evaluated the PSMS for multiple size rainfall events and downstream tidal boundary conditions. The PSMS includes constructed stormwater facilities as well as canals, ditches, and other overland flow paths that drain to the downstream waterbody (i.e., boundary condition). The PSMS generally includes all open channels, swales, and ditches picked up by the LiDAR, and pipes 24 inches in diameter and larger unless an area was isolated with a smaller system and was needed for model continuity.

The HE Basin modeled area is 7,066 acres delineated into 654 sub-basins ranging in size from 0.57 to 797.5 acres with a mean size of 10.8 acres. The larger sub-basins include West Lake and the adjacent wetlands. The largest sub-basin within city limits, excluding the ICW and the connecting Lakes is 64.1 acres in the Hollywood Beach Golf and Country Club. There are 603 sub-basins of the HE Bason delineated within City boundaries, excluding the ICW, lakes and wetlands, covering 3,677 acres with an average size of approximately 6.1 acres. **Table 2.2-2** summarizes the HE Basin model elements.

Table 2.2-2 Summary of the HE Basin Model Elements

Sub-basins		654
Junctions		0
Storages	**Functional**	1,596
	Tabular	677
Outfalls		6
Conduits	**Circular**	1,864
	Custom (Bridge)	0
	Ellipse	47
	Rectangular Closed	4
	Irregular Canal	126
	Irregular Outfall	3
	Irregular Overland	1,752
	Triangular	1
	Arch	4

Appendix A includes the HE Basin model schematic (**Figure HE-EC**) with standard symbology and **Appendix B** includes more detailed tables presenting the HE Basin model element characteristics. These tables include the following:

- **Table HE-1** Hydrologic Parameters per Sub-basin
- **Table HE-2** Hydraulic Nodes Data
- **Table HE-3** Hydraulic Conduit Data
- **Table HE-4** Model Pump Data
- **Table HE-5** Model Weir Data
- **Table HE-6** Model Exfiltration Data

Model Nodes and Outfall Elements

Model nodes representing manholes are modeled as functional storage nodes with a minimal amount of constant storage area (12.56 square feet, which is equivalent to a typical 48-inch diameter manhole). Pump Station wet wells are modeled as functional storage nodes with constant areas equivalent to the wet well area, if the station dimensions were provided, or 100 square feet if the dimensions were not provided.

The six model outfalls represent:

- 1 outfall from the ICW to the cut at Port Everglades, representing the ICW outfall to the Atlantic Ocean. This outfall uses a fixed stage of 2.5 ft-NAVD in the base condition (i.e., prior to the sea level rise analysis). The 2.5 ft-NAVD stage represents the one-year stillwater elevation for the tidal gage in the Port Everglades basin. See the Model Development TM for a more detailed description of the 1-year Stillwater analysis.
- 1 outfall in the ICW south of Hallandale Beach Blvd. this also uses a fixed stage boundary condition at 2.5 ft-NAVD (see the Model Development TM).
- 1 pipe outfall along Sheridan St., west of 22nd Ave. representing the hydraulic grade line (HGL) in the Sheridan FDOT PSMS. This outfall uses a time series of stages in the system, per storm, as developed from the city-wide model. The peak stages at this location may be reduced as CIP elements are introduced to the C-10 Basin; however, because of the slope of the pipe from Dixie Hwy in this HE Basin model to the outfall, reductions in the peak stage of this boundary condition are unlikely to affect HE Basin CIPs.
- 3 overland flow outfalls, which allow floodwater to sheetflow west to the C-10 Basin, and south to Broward County, outside City Limits.

The HE Basin model also has one location where boundary conditions are set with inflow time series per storm (in a storage node, as opposed to an outfall). This inflow location is located at the confluence of the Dania Cutoff Canal and the ICW and represents the flows from the C-10 Basin to the ICW. Though the peak flows can get relatively large (nearly 10,000 cfs in the 100-year storm), the ICW is also wide and deep between this location and the Port Everglades outfall, so increases in ICW stage are minimal. It is not expected that the CIP analysis for either the HC or HE Basin models will significantly alter the stages in the ICW.

In addition to the summary of model elements provided above, 8 sub-basins, 8storage nodes, and 8 outfalls were required to be used to simulate the exfiltration systems in the HE Basin. The aquifer has been divided into 8 contiguous sections in the basin area because the initial level of the base groundwater varies depending on location (see Broward County Future Groundwater Elevation Map, Figure 2-11 in the Model Development TM). Additionally, the aquifer was subdivided geographically for ease of implementation. The virtual systems representing groundwater are not included in the model schematic nor in the tables. The HE exfiltration systems are described in further detail in the section below.

The City's project-specific survey and the GIS coverage of stormwater pipes in the HE Basin identifies:

- 43 stormwater points of discharge (within City limits) that discharge to the ICW
- 13 that discharge to South Lake
- 18 that discharge to North Lake
- 27 that discharge to West Lake, or the ditches that feed into West Lake, including outfalls to the ditches around the Eco Grande Golf Course.

These outfalls will all likely require backflow prevention and raised seawalls; however, for the ditches tributary to West Lake, it may be possible to control many of these with one downstream structure.

There are an additional 89 links (within the City boundary) representing the sheet flow to the ICW, South Lake, North Lake, or West Lake from the sub-basins along the shore. Generally, these overland sheet flow cross-sections represent the seawall surveyed in that area. If a seawall is not present over a portion of the shoreline, the topography behind the shoreline determines the elevation of the overflow. There are many more overland sheetflow locations to the ditches tributary to West Lake; however, as noted above, stages may be controlled by a downstream structure and seawalls may not be necessary at each of these locations.

Pump Stations

In the SWMM, pumps are represented by stage-flow links connected to an inflow storage node that serves as the wet well. The outflow section of the link is connected to a node that serves as a force main to an outfall. The types of pumps represented in this model are in-line pumps where flow increases incrementally with inlet node depth (SWMM Type 2).

There are seven existing SWPSs in the HE Basin, each using a constant flow capacity over the range of wet well depths since the actual pump curves at the SWMP level of analysis for large design storms is unnecessary. Pumps are typically set to turn on at levels above the static water table and cycle off as water levels drop in the wet well.

All pump station information was obtained from City-provided as-builts or other available plan sets and the Stormwater Pump Station Condition Assessment Report, Tetra Tech March 2021.

- SW-01 has a total maximum capacity of 58.5 cfs or 26,200 gpm and is located off Polk St., north of the intersection with N 8th Ave. This pump station discharges water directly into North Lake. For this station, the wet well invert is set at -7.1 ft-NAVD. The SWPS has two pumps:
    - The lead pump is 29.2 cfs and is set to cycle on when the depth in the wet well reaches 6 ft (-1.1 ft-NAVD) and cycles off when the depth falls to 5 ft (-2.1 ft-NAVD).
    - The lag pump is 29.2 cfs and is set to cycle on when the depth in the wet well reaches 6.75 ft (-.35 ft-NAVD) and cycles off when the depth falls to 5 ft (-2.1 ft-NAVD).
- SW-02 has a total maximum capacity of 89 cfs or 40,000 gpm and is located off N. Southlake Dr., south of the intersection with S. 8th Ave. This pump station discharges water directly into South Lake. For this station, the wet well invert is set at -6.8 ft-NAVD. The SWPS has two pumps:
    - The lead pump is 44.6 cfs and is set to cycle on when the depth in the wet well reaches 6.7 ft (-0.1 ft-NAVD) and cycles off when the depth falls to 5.2 ft (-1.6 ft-NAVD).
    - The lag pump is 44.6 cfs and is set to cycle on when the depth in the wet well reaches 7.5 ft (0.7 ft-NAVD) and cycles off when the depth falls to 5.2 ft (-1.6 ft-NAVD).
- SW-06 has a total maximum capacity of 16.6 cfs or 7,500 gpm and is located off N 14th Ave in Hollywood Golf and Country Club, between Fillmore St and Pierce St. This pump station discharges water into North Lake through 950 ft of 18-inch force main. Though the SWPS cycles on at elevation 0.9 ft-NAVD (see below), the initial depths in the model remain at 2.5 ft-NAVD behind the station because there are multiple overland flow paths below 2.5 ft-NAVD that connect the neighborhood being served by the SWPS to an adjacent neighborhood with direct low seawall connections to the ICW. In the proposed condition, seawalls are raised and

the initial depths may be lowered. For this station, the wet well invert is set at -5.7 ft-NAVD. The SWPS has two pumps:

- The lead pump is 8.3 cfs and is set to cycle on when the depth in the wet well reaches 6.6 ft (0.9 ft-NAVD) and cycles off when the depth falls to 6.1 ft (0.4 ft-NAVD).
- The lag pump is 8.3 cfs and is set to cycle on when the depth in the wet well reaches 6.85 ft (1.15 ft-NAVD) and cycles off when the depth falls to 6.1 ft (0.4 ft-NAVD).

- SW-07 has a total maximum capacity of 49.4 cfs or 22,200 gpm and is located off Wiley St, just west of Diplomat Pkwy in the northeast corner of the Diplomat Country Club. This pump station lifts water to the top of the station and discharges water into a closed gravity main to the ICW (west of Harbor Islands). For this station, the wet well invert is set at -7.9 ft-NAVD. The SWMP has two pumps:
  - The lead pump is 24.7 cfs and is set to cycle on when the depth in the wet well reaches 8.3 ft (0.4 ft-NAVD) and cycles off when the depth falls to 6.3 ft (-1.6 ft-NAVD).
  - The lag pump is 24.7 cfs and is set to cycle on when the depth in the wet well reaches 8.6 ft (0.7 ft-NAVD) and cycles off when the depth falls to 6.3 ft (-1.6 ft-NAVD).
- SW-08 has a total maximum capacity of 73 cfs or 32,800 gpm and is located off Moffet St., just east of S. 14th St. on the west side of Diplomat Country Club. This pump station discharges water though a 1920 ft force main to the wet well of SWPS 7. This arrangement limits the capacity of both SW-07 and SW-08. For this station, the wet well invert is set at -11.6 ft-NAVD. The SWPS has two pumps:
  - The lead pump is 36.5 cfs and is set to cycle on when the depth in the wet well reaches 10 ft (-1.6 ft-NAVD), and cycles off when the depth falls to 6 ft (-5.6 ft-NAVD).
  - The lag pump is 36.5 cfs and is set to cycle on when the depth in the wet well reaches 10.5 ft (-1.1 ft-NAVD), and cycles off when the depth falls to 6 ft (-5.6 ft-NAVD).
- SW-09 has a total maximum capacity of only 1.8 cfs or 800 gpm and is located at the corner of S Southlake Dr. and S 12th Ave. This pump station discharges directly to South Lake. For this station, the wet well invert is set at -5.6 ft-NAVD. The SWPS has two pumps:
  - The lead pump is 0.9 cfs and is set to cycle on when the depth in the wet well reaches 4 ft (-1.6 ft-NAVD) and cycles off when the depth falls to 3 ft (-2.6 ft-NAVD).
  - The lag pump is 0.9 cfs and is set to cycle on when the depth in the wet well reaches 4.5 ft (-1.1 ft-NAVD) and cycles off when the depth falls to 3 ft (-2.6 ft-NAVD).

- SW-10 has a total maximum capacity of 29.8 cfs or 13,400 gpm and is located inside the Hollywood Wastewater Treatment Plant Facility (Taft & 14th). This pump station discharges to the Eco Grande Golf Course Ditch system that eventually flows to West Lake. For this station, the wet well invert is set at -10 ft-NAVD. The SWPS has two pumps:
    - The lead pump is 14.9 cfs and is set to cycle on when the depth in the wet well reaches 12.7 ft (2.7 ft-NAVD) and cycles off when the depth falls to 12.3 ft (2.3 ft-NAVD).
    - The lag pump is 14.9 cfs and is set to cycle on when the depth in the wet well reaches 12.8 ft (2.8 ft-NAVD) and cycles off when the depth falls to 12.3 ft (2.3 ft-NAVD).

Exfiltration Systems and Stormwater Wells

The HE Basin uses exfiltration systems as one method to reduce flooding and improve water quality by moving water from the PSMS to the Biscayne Aquifer. These systems include:

1. Exfiltration/French Drains: Perforated pipes situated in a gravel-filled rectangular shaped excavation into the aquifer. There are approximately 10.7 miles of exfiltration/French drains in the HE Basin.
2. Recharge/Drainage Wells: There are two types of recharge wells used in the South Florida area—gravity driven wells and injection (pumped) wells. There are 37 existing gravity drainage/recharge wells in the HE Basin and there are no injection wells in the EC HE Basin. Gravity stormwater wells use the differential driving head of the land surface water surface elevation and the aquifer ground water table elevation to overcome the well casing friction and any salinity interface density to push stormwater runoff out into the porous and highly transmissive limestone layer underground. The use of Biscayne Aquifer drainage wells (Class V wells) is restricted to zones where the TDS exceeds 10,000 mg/L (not directly useable for drinking water) and only if there is there is no Class G-II (potable ground water source) aquifer impact.

As described earlier, in the HE Basin, the regional water table elevation is estimated for 8 separate regions. Each region has a specified initial water table level based on the Broward County future groundwater elevation map (see Model Development TM) and these initial levels will be higher in the sea level rise scenarios. The regional water tables were designed to automatically rise in the model based on precipitation and infiltration using regional land-use estimates, i.e., the 8 model sub-basins ("GW" prefix), 8 storage nodes ("BiscayneAQ" prefix), and 8 outfalls ("AQLossOut" prefix). These are virtual elements designed solely to predict water table elevations and are not hydrologically or hydraulically connected to the model PSMS. The exfiltration rating curves are developed outside the model in a spreadsheet, based on length of system and count of wells per sub-basin, and other sub-basin specific parameters. The curves are head versus flow curves, where the head is internally calculated in the model by subtracting the regional groundwater elevation from the site-specific flood stage. As in actual conditions, in the large design storms, some of the low-lying exfiltration systems cease operations as the water table rises to ground surface. The

Model Development TM provides more details on the exfiltration systems and how rating curves were developed for each type per model sub-basin.

2.2.3 HE Basin Existing Conditions Level of Service

Known Flooding Problem Areas and Causes

Much of the HE Basin is expected to flood in the extreme events simulated with these design storm models. The neighborhoods with the most street flooding in the 5-year and 10-year storms, and structure flooding in the 100-year storm, per square mile include:

- Hollywood Lakes, in low-lying areas near Moffett St. and S 14th Ave. There are multiple issues in this area. First, the road elevations are extremely low, with multiple road crowns dipping below 1.0 ft-NAVD. Second, this neighborhood lies within a relatively large depressional area, incurring possible runoff from as far west as Federal Hwy and portions of Hallandale. Additionally, as noted above, the SW-08 serving this neighborhood is limited by cascade-discharging into the wet well of the smaller SW-07. Operations indicated that due to the topography and the residential land use in this area, significant amounts of trash and debris clog the inlets in the area and reduce the effectiveness of the catch basins ability to direct water into the system.

- Hollywood Lakes, between North Lake and South Lake. This neighborhood also includes extremely low road elevations, some again below 1.0 ft-NAVD. This neighborhood is also susceptible to flooding due to tailwater conditions as not all seawalls are as high as the one-year stillwater boundary condition of 2.5 ft-NAVD. Not only are the two pump stations (SW-01 and SW-02) not able to keep up with seawall overflows in the design storm simulations with the high boundary conditions, but they also do not have enough capacity to meet the City LOS goals even if seawalls were raised.

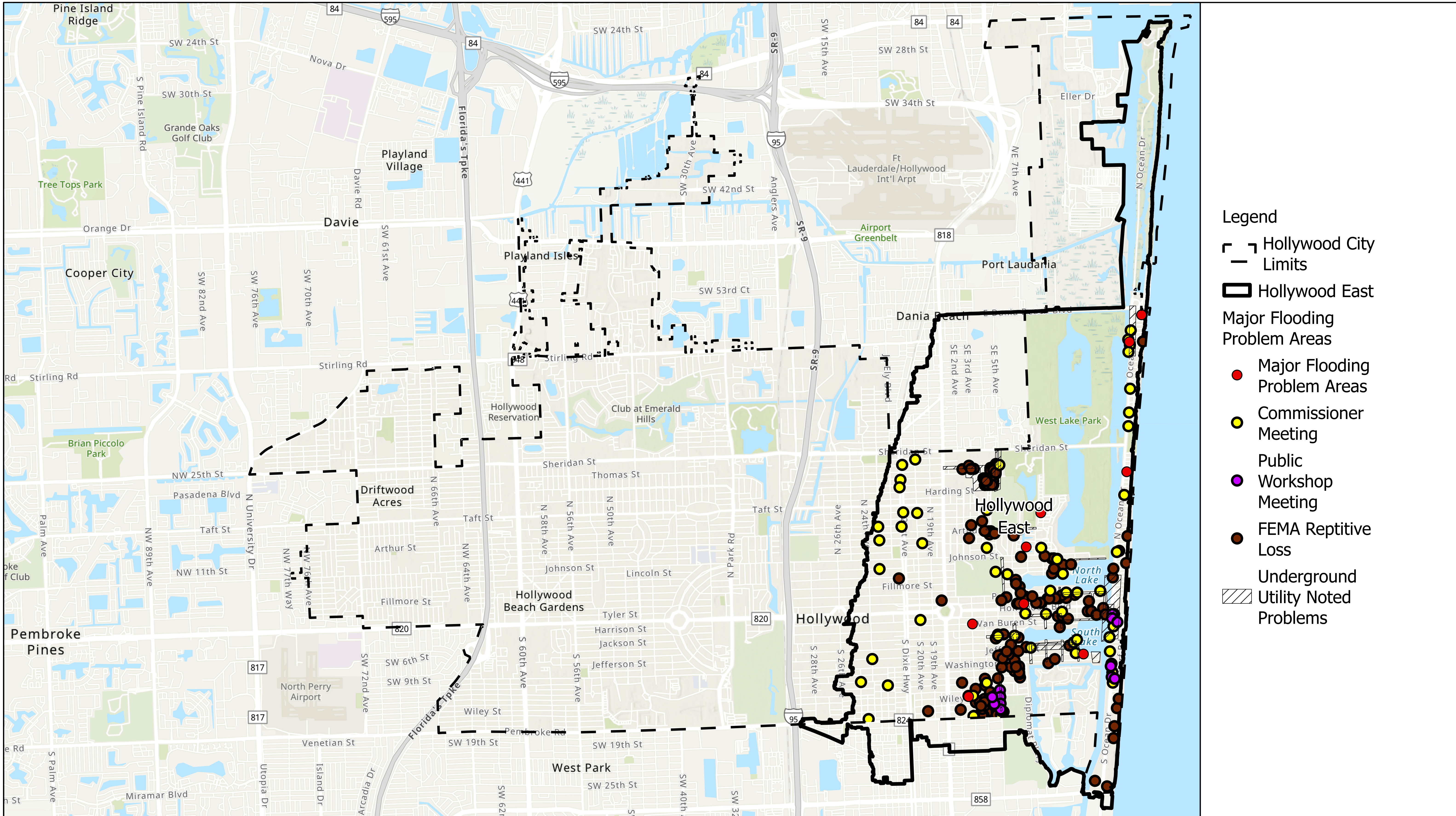
- Hollywood Lakes, between Hollywood Beach Golf and Country Club and North Lake. The primary causes of flooding in this neighborhood are the same as above. Though the roads are slightly higher, nearly all road crowns are below the 2.5 ft-NAVD boundary condition and not all seawalls are high enough to prevent flow into the neighborhood from North Lake. SW-06 cannot keep up with backflows over the seawall, nor has enough capacity to meet LOS Goals if seawalls were raised.

- Hollywood Lakes, N 14th Ave., between Arthur and Sheridan. This is a low depressional area, similar to Moffett and 14th, though not quite as low, no positive system, but also without a pump station.

- Highland Gardens, north of Pembroke Rd., west of Dixie Hwy. This areas is significantly higher than the other problems areas in the HE Basin. The primary causes of flooding in the area is a depressional area and lack of a positive PSMS. The existing exfiltration does not have the capacity to meet the City's LOS Goals.

- South Central Beach including A1A and many low-lying side streets. The side streets tend to be lower than the roadway at A1A, with many well below the 1-year stillwater boundary condition of 2.5 ft-NAVD. This causes flooding to be trapped and accumulate to at least this level in the gravity systems.
- North Beach. Similar situation to South Central Beach.
- For the South and Central Beach flooding, FDOT is planning to eventually improve the stormwater systems along their roadway (A1A), adding backflow prevention at their outfalls, and raise their intermittent seawalls in many small phases of pump stations in the future as funding allows. There are depressional areas noted in the analysis by FDOT and seen in the model on the City's side streets that may be better resolved by raising the roads to alleviate the accumulation of flooding in the low spots, rather than providing a physical connection to the FDOT system and cost sharing additional capacity when/if it is constructed and available in the future. This will require coordination with FDOT and the Hollywood Beach CRA, as the new street grade may require private driveways to be re-graded to match.

Figure 2.2-10 provides a more comprehensive HE Basin map of complaints related to storms and/or flooding, locations where moderate to severe flooding was noted in community workshops, and streets where City staff, including Underground Utilities staff have noted problems.



City of Hollywood Stormwater Master Plan

Figure 2.2-10

08/10/2022

CDM Smith

City of Hollywood Florida

Major Flooding Areas within the Hollywood East Basin

0 2,000 4,000 8,000 Feet

1:53,000

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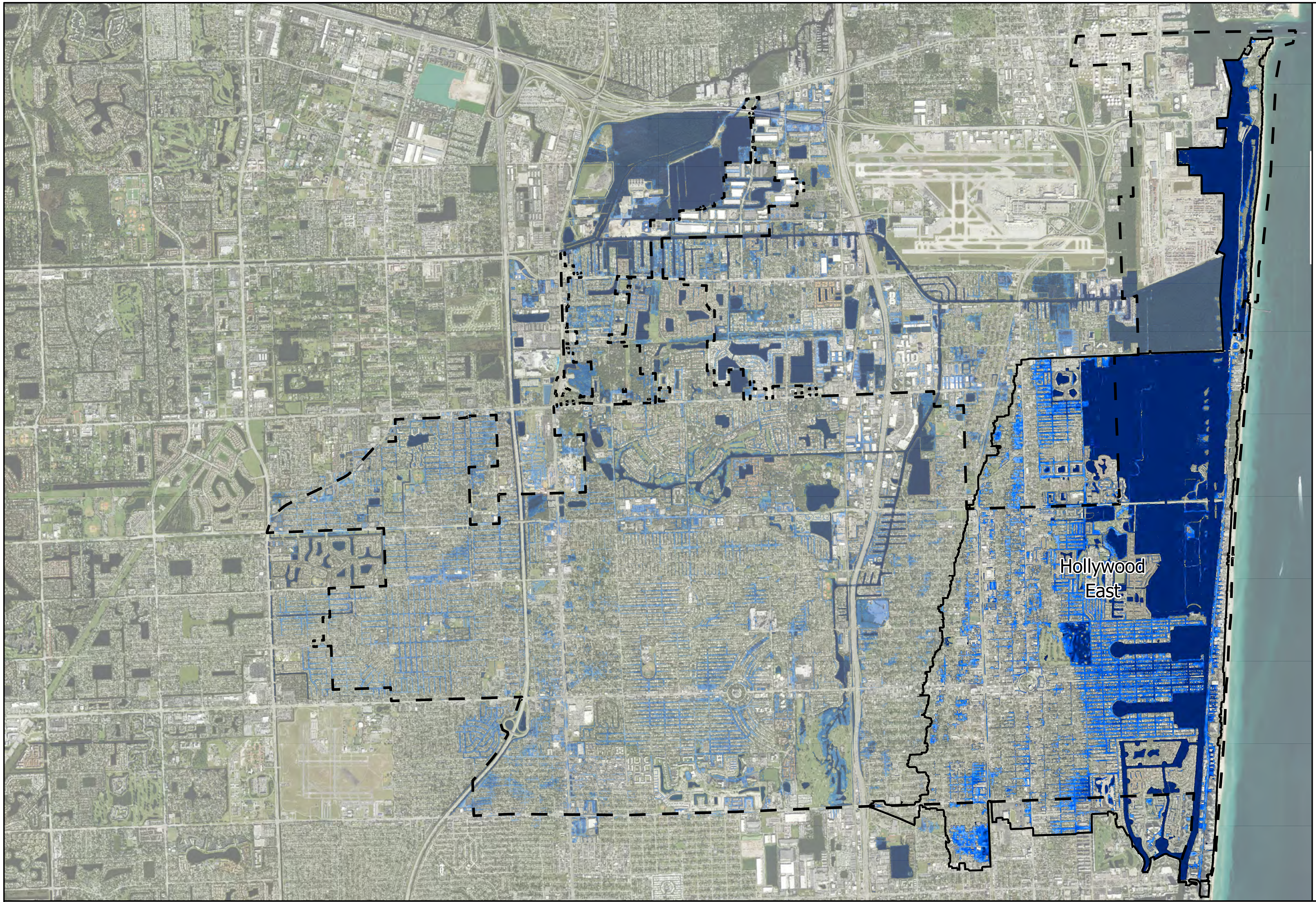
Existing Conditions (EC) Model Results and Design Storm Inundation Mapping for HE Basin

The verified HE Basin EC model was run for the base simulation for each design storm considering a well maintained, clean pipe condition. A summary of peak flood stages for the simulated EC model is presented in **Appendix B Table HE-7.** Flood mapping of the base simulations of existing conditions for the 5-year and 10-year, 24-hour design storm; and the 25-year and 100-year, 72-hour design storms are presented on **Figures 2.2-11 through 2.2-14**.



Legend

Hollywood City Limits

Hollywood East

5-Year Storm Flood Depth Feet

<= 0ft

0 - 0.5ft

0.5 - 1ft

1 - 1.5ft

> 1.5ft

N

CDM Smith

City of Hollywood Florida

5-Year, 24-Hour Design Storm for the Hollywood East Basin

0 2,000 4,000 8,000 Feet

Scale: 1:53,000

City of Hollywood Stormwater Master Plan

Figure 2.2-11

08/10/2022

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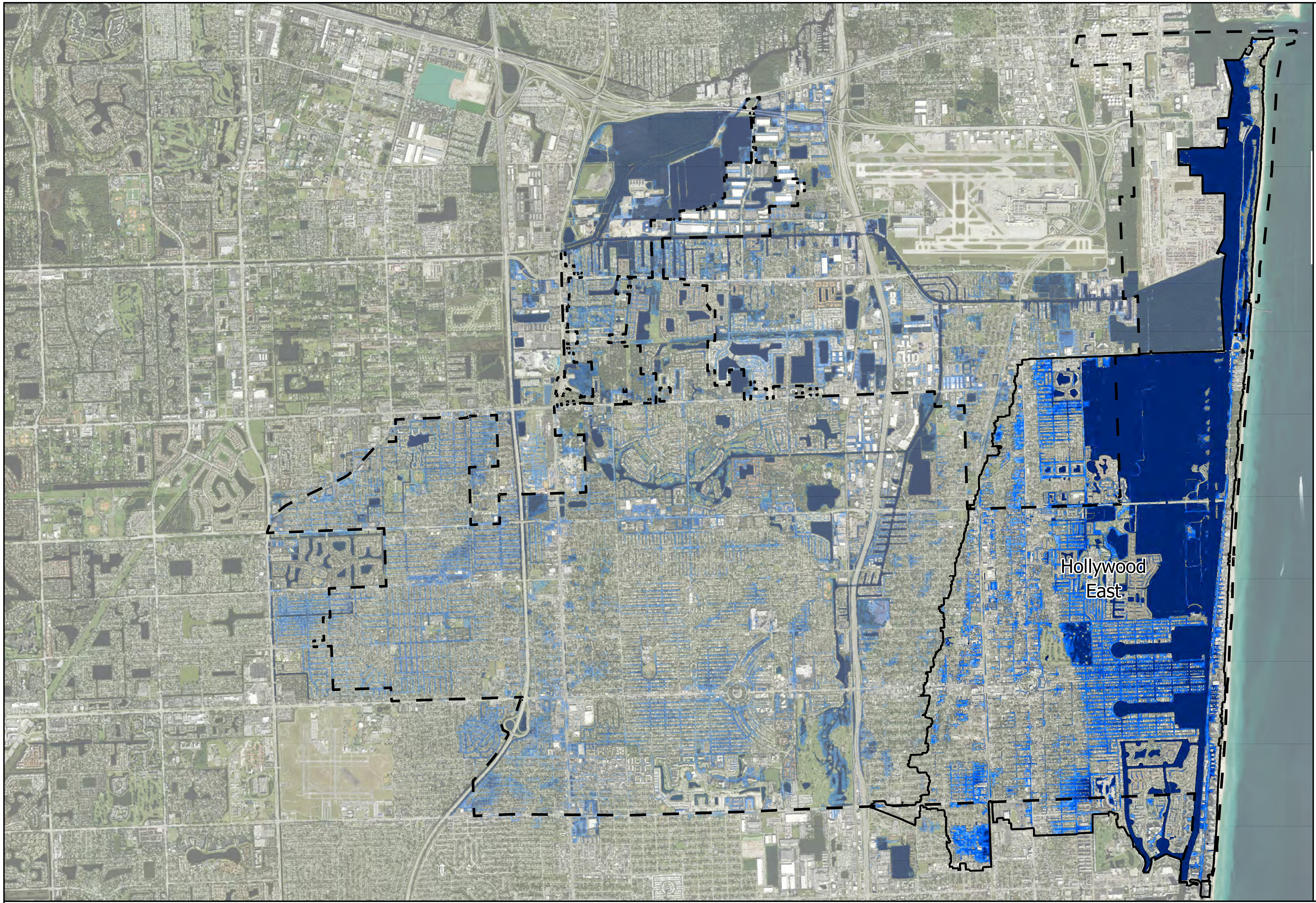


Legend

Hollywood City Limits

Hollywood East

10-Year Storm Flood Depth Feet

- <= 0ft
- 0 - 0.5ft
- 0.5 - 1ft
- 1 - 1.5ft
- > 1.5ft

N

CDM Smith

City of Hollywood Florida

10-Year, 24-Hour Design Storm for the Hollywood East Basin

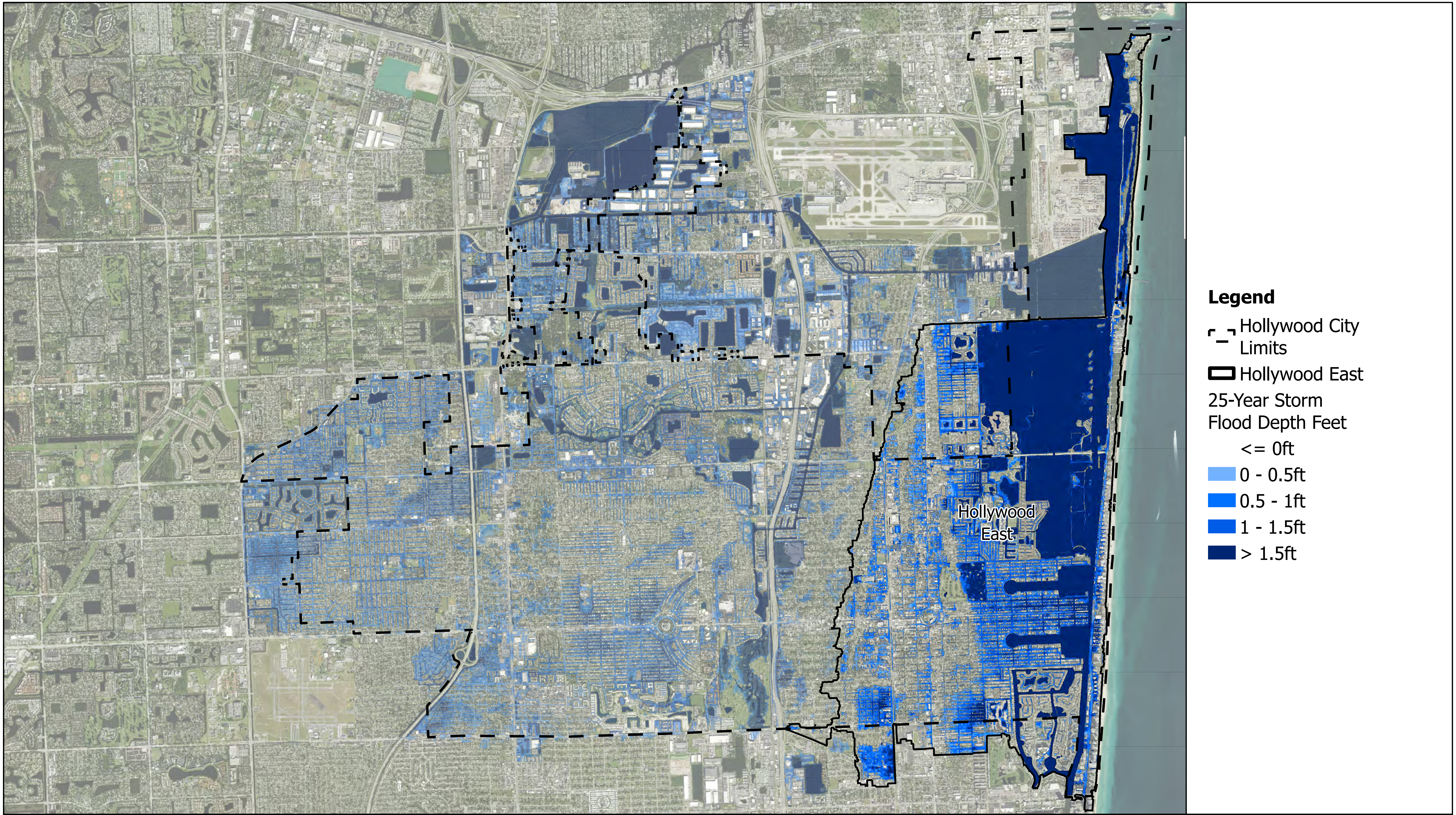
0 2,000 4,000 8,000 Feet

Scale: 1:53,000

City of Hollywood Stormwater Master Plan

Figure 2.2-12

08/10/2022



N

CDM Smith

City of Hollywood Florida

25-Year, 72-Hour Design Storm for the Hollywood East Basin

0 2,000 4,000 8,000 Feet

Scale: 1:53,000

City of Hollywood Stormwater Master Plan

Figure 2.2-13

08/10/2022

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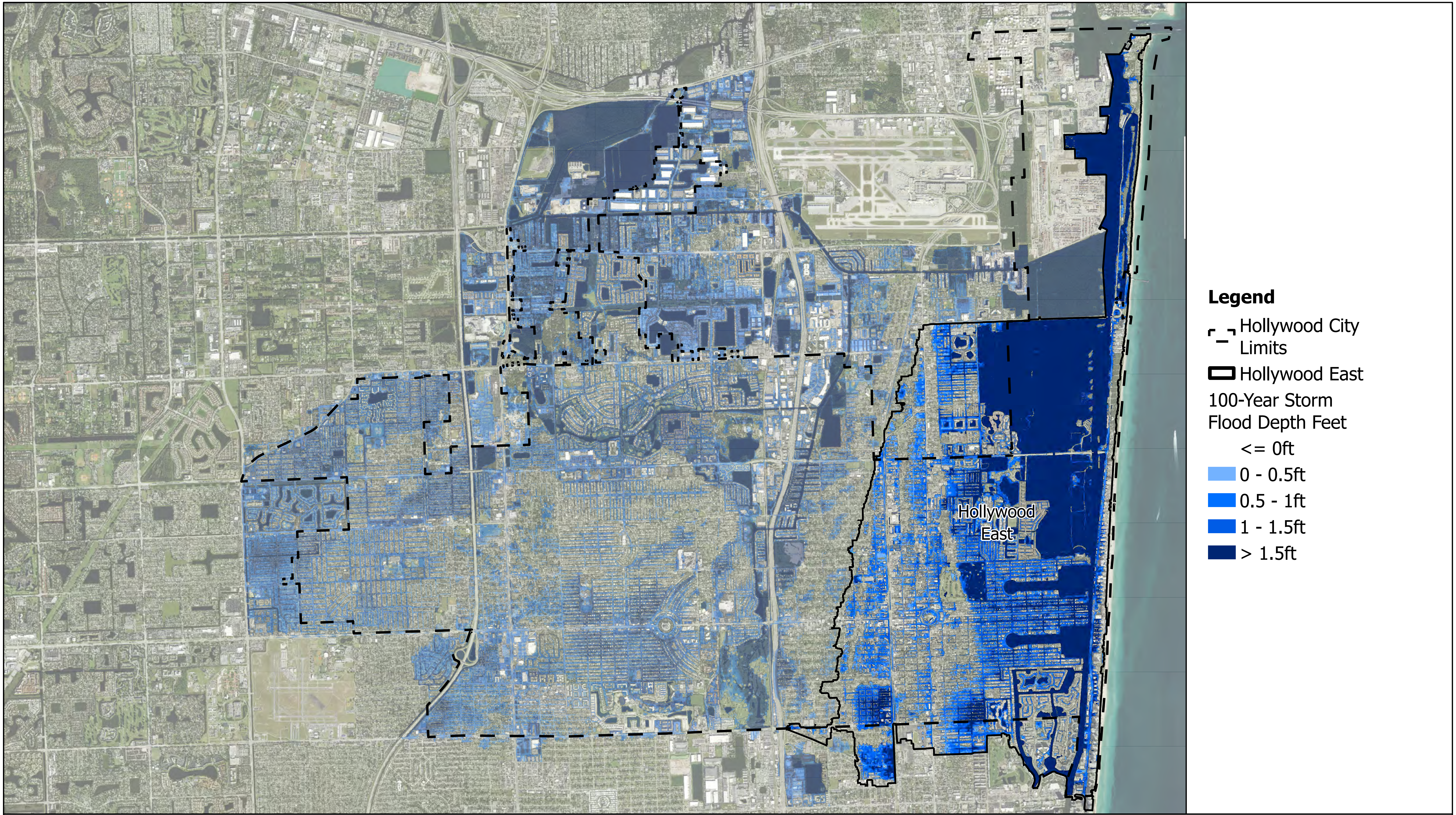

N

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CITY OF Hollywood FLORIDA

100-Year, 72-Hour Design Storm for the Hollywood East Basin

0 2,000 4,000 8,000 Feet

Scale: 1:53,000

City of Hollywood Stormwater Master Plan

Figure 2.2-14

08/10/2022

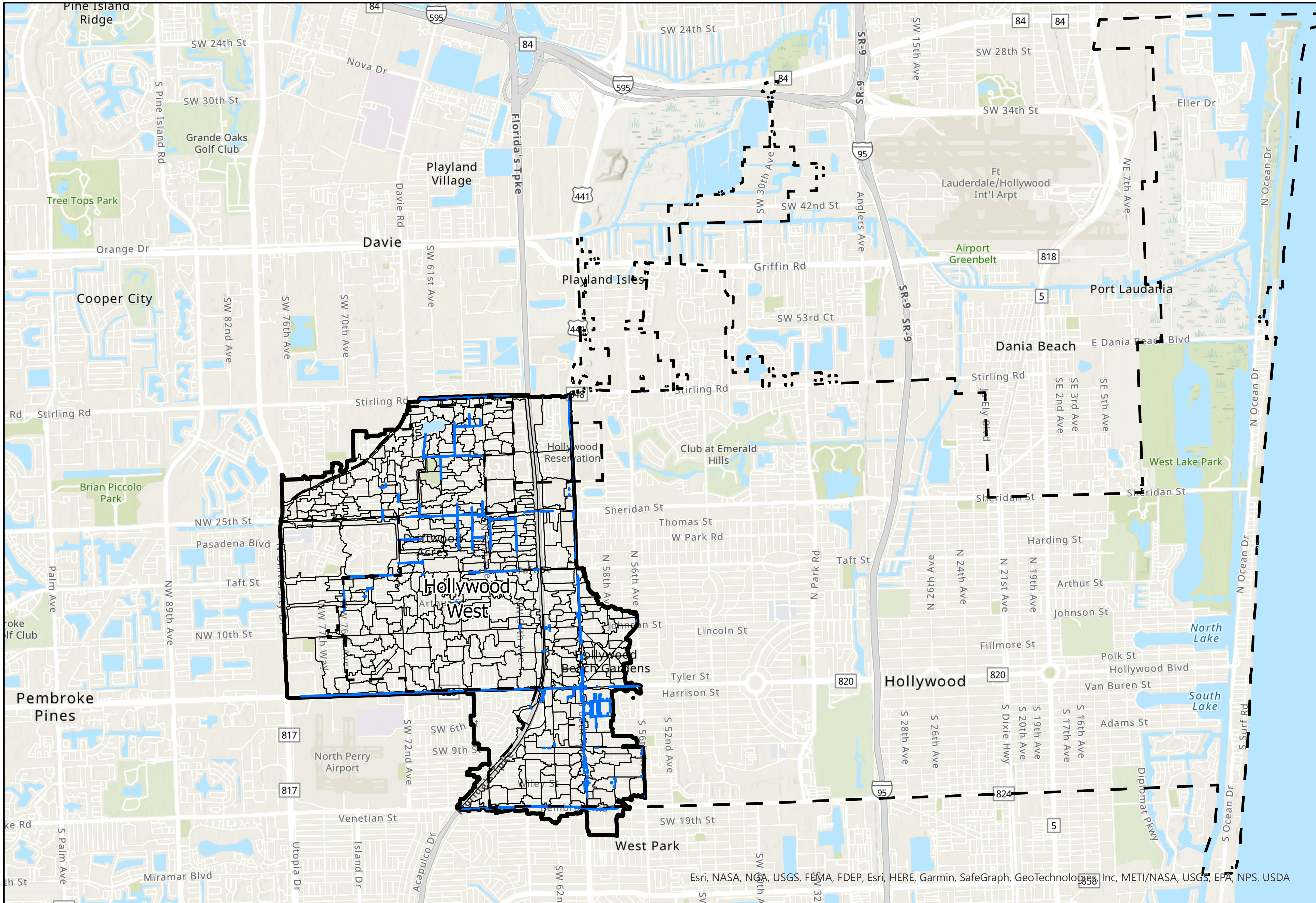
2.3 Hollywood West Basin Model (HW)

2.3.1 Hollywood West Basin Description

The Hollywood West Basin (HW) consists of 8,036 acres of low-lying land that primarily discharges to the Central Broward Water Control District (CBWCD) and the South Broward Drainage District (SBDD). The primary PSMS discharges from the HW Basin are through dual 72-inch culverts under N. University Dr. at the intersection of University Dr. and Sheridan St., and through dual 42-inch culverts under NW 76th Ave, near the intersection of NW 76th Ave and Arthur St. The CBWCD ditch runs north, parallel to University Drive to a structure near the CBWCD office south of Stirling Rd. Though this structure included a pump station in the past, it has long since been removed and large flows bypass this structure. The CBWCD system has multiple ditches between Stirling Rd and the C-11 Canal, upstream of the SFWMD C-13 Structure. The latest CBWCD model was provided and run (see Model Development TM) to develop time series boundary conditions per storm for this discharge location.

The culverts to the SBDD system discharge into a spur canal that eventually flows to the SBDD S-1 Canal along University Dr . This canal flows approximate 3 miles south to the SBDD S-1 SWPS, which in turn discharges to the C-9 Canal and out to the ocean. This pump station includes a gated structure for normal flows; however, when the tailwater condition is high at high tides, the gates are closed and the structure must use the pumps for discharge. Since the design storm modeling uses a 2.5 ft-NAVD boundary condition in the eastern part of the City at the ICW, it follows that the C-9 Canal would be as high, if not higher. Therefore, the boundary condition at this location is determined by the SBDD's SWPS capacity.

Figure 2.3-1 includes a delineation of the HW Basin and a schematic representation of the PSMS within the basin. Eight sub-basins covering 3,200 acres have been added to the HW Basin model, representing tributary areas to the SBDD S-1 Canal, well outside the City of Hollywood. Note the model includes sub-basins outside, but generally close to, the City Boundary that topography indicates may contribute to City flooding in all three basin models as noted previously. In addition, these very large SBDD basins have been added to the HW Basin model to provide contributing areas to the SBDD S-1 SWPS flows. The northern boundary is delineated by Stirling Rd. East of University Dr, the southern boundary is delineated by Pembroke Rd, while west of University the southern boundary extends to the Florida Turnpike Extension. The west boundary is delineated S. Douglass Rd south of Taft St and University Dr. north of Taft St. The east boundary is determined by topography and PSMS, and roughly follows State Rd. 7 (US-441). The HW Basin Model boundaries are adjacent to the C-10 Basin on the east side. This model includes 3,424 acres within the City limits and necessarily includes tributary areas beyond the City boundaries of 4,611 acres as shown on the figure.



Legend
- Hollywood City Limits
- Subbasins
- PSMS >= 24in

0 2,000 4,000 8,000 Feet
1:53,000

CDM Smith
City of Hollywood Florida

Hollywood West Basin and PSMS

City of Hollywood Stormwater Master Plan
Figure 2.3-1
11/28/2022

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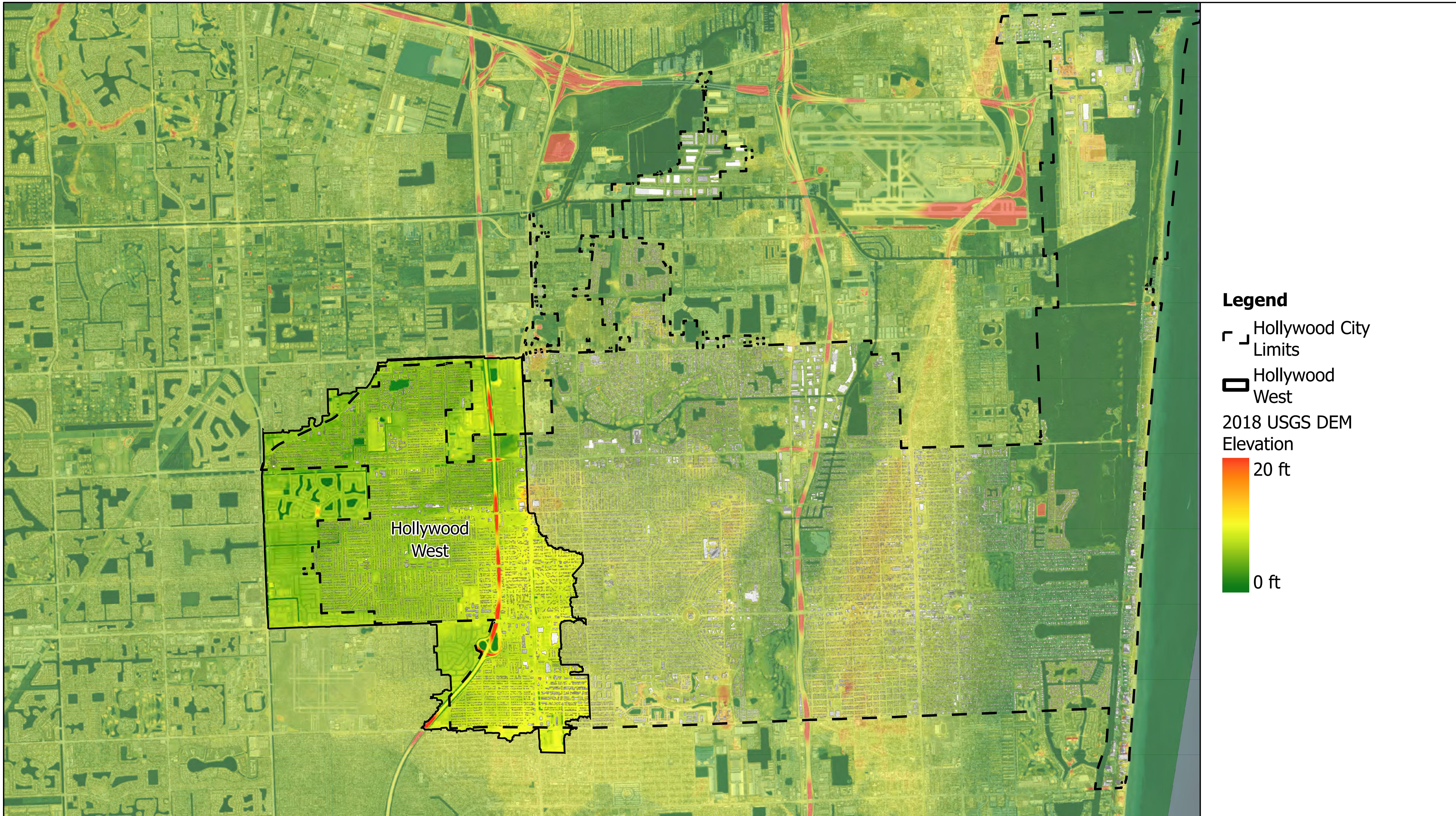
Figure 2.3-2 shows the Digital Elevation Model (DEM) for the HW Basin in North American Vertical Datum (NAVD 88). Natural topographic elevations range from approximately 2 ft-NAVD in John Williams Park to approximately 17 ft-NAVD near U.S. 441 and Taft St.. Approximately 99% of the HW Basin's stormwater inlets are between 2.5 ft-NAVD and 17 ft-NAVD; however, 5 inlets (1%) on the PSMS are located where the LiDAR elevations are below 2.5 ft-NAVD. These lower elevations preclude the use of exfiltration systems, since the driving heads are not sufficient for effective or efficient gravity discharge. Existing exfiltration systems currently installed in these areas and low-lying areas just above 2.5 ft-NAVD are not expected to work well, either as simulated in the model or in actual operation.

Figure 2.3-3 presents a map of the impervious cover for the HW Basin based on the USGS NLCD coverage, and **Figure 2.3-4** presents a map of the SFWMD land-use for the HW Basin. As described in detail in the Model Development TM, impervious coverages were intersected with the sub-basin delineations to develop average impervious percentages for each sub-basin. The model also distinguishes between DCIA areas, which are routed to the PSMS, and non-DCIA areas, which are routed to pervious areas within the sub-basin (such as a roof drain directed to a yard, rather than a driveway). In general, sub-basins with low total impervious area have large percentages of non-DCIA routed to pervious, while sub-basins with high imperviousness have low route-to-pervious percentages. The routing of runoff to pervious surfaces does not affect the volume infiltrated to soils but does change the timing of the runoff hydrograph. Other hydrologic parameters, such as pervious area roughness, were based on land-use type.

Figure 2.3-5 presents the total impervious percentage in the HW Basin, delineated by sub-basin. **Figure 2.3-6** presents a breakdown of the land use by 10 standard consolidated categories, for use in the model. **Figure 2.3-7** presents a breakdown of the impervious cover in the model. The area-weighted total impervious percent of the HW Basin is estimated to be 47.6 %; therefore, approximately 3,916 acres of the 8,036 acres are expected to be impervious surface. Of this, approximately 1,136 acres are expected to be routed to pervious surfaces prior to entry into the HW Basin PSMS.

For design storm simulations, the SFWMD 24-hour and 72-hour unit hyetographs were used to simulate the rainfall distributions per storm. **Table 2.3-1** presents the volumes for the HW Basin for the 5-year, and 10-year 24-hour; and 25-year, and 100-year 72-hour design storms obtained from the NOAA Atlas 14. Design Storm rainfall volume development is discussed in the Model Development TM, Section 2.5.2. Generally, the largest volume within the HW basin was used in the model.



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City of Hollywood Florida

Digital Elevation Model (DEM)
for the Hollywood West Basin

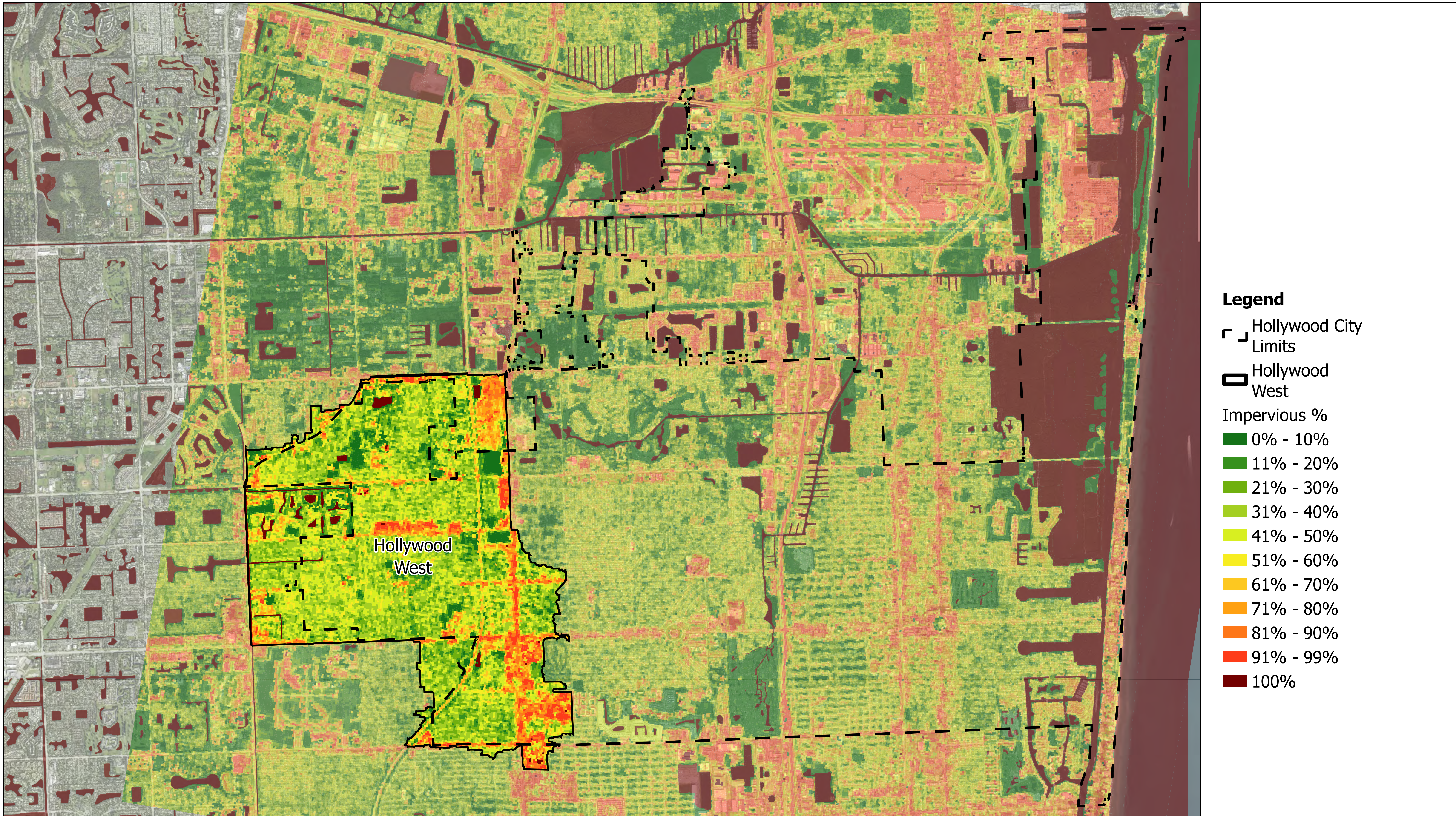
0 2,000 4,000 8,000 Feet

Scale: 1:53,000

City of Hollywood Stormwater Master Plan

Figure 2.3-2

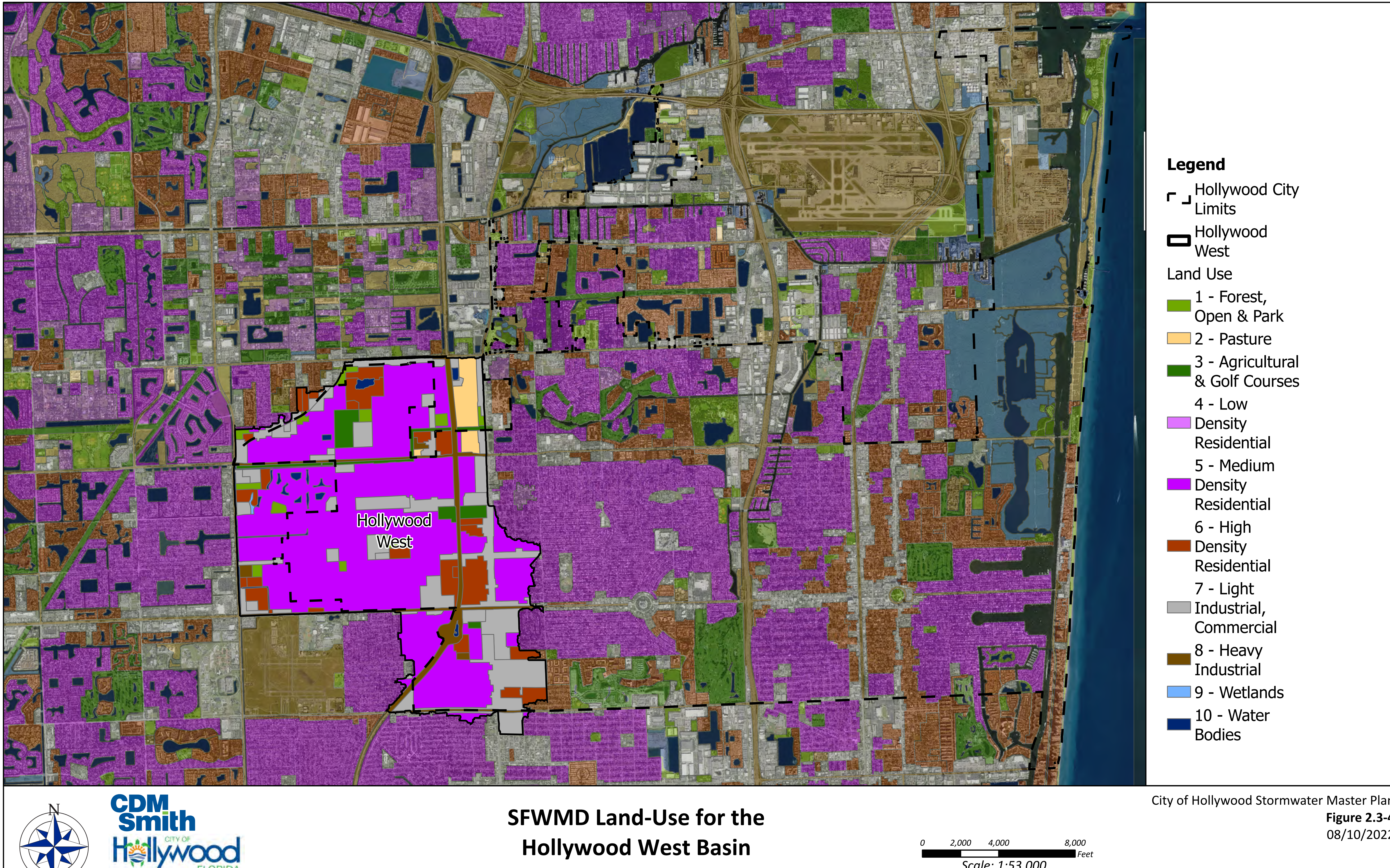
08/10/2022



Impervious Cover for the Hollywood West Basin

City of Hollywood Stormwater Master Plan
Figure 2.3-3
08/10/2022

0 2,000 4,000 8,000 Feet
Scale: 1:53,000



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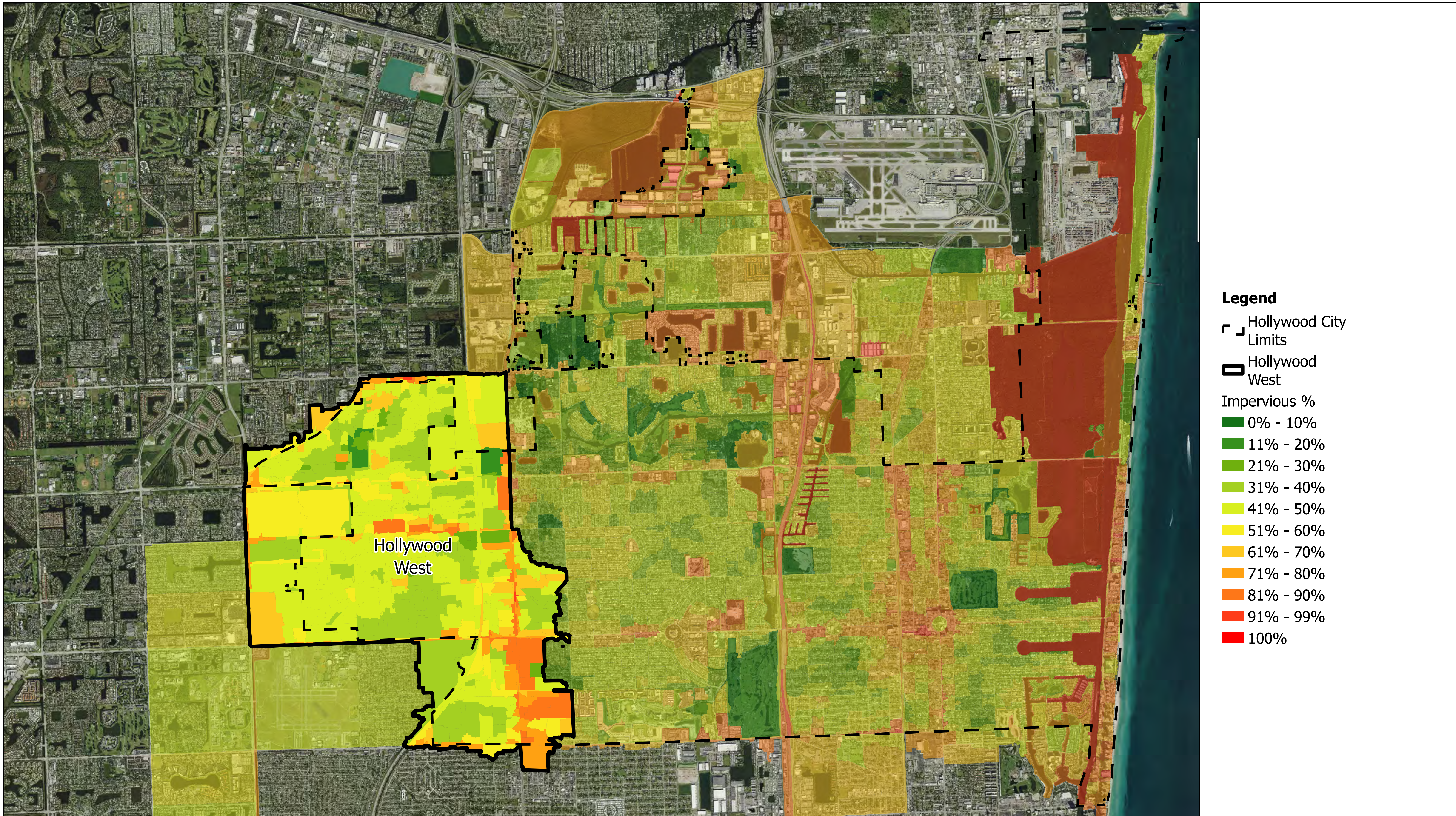
SFWMD Land-Use for the Hollywood West Basin

City of Hollywood Stormwater Master Plan

Figure 2.3-4

08/10/2022



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City of Hollywood Florida

Total Impervious Percentage for the Hollywood West Basin

City of Hollywood Stormwater Master Plan

Figure 2.3-5

08/10/2022

Figure 2.3-6 Landuse Category Breakdown for the HW Basin

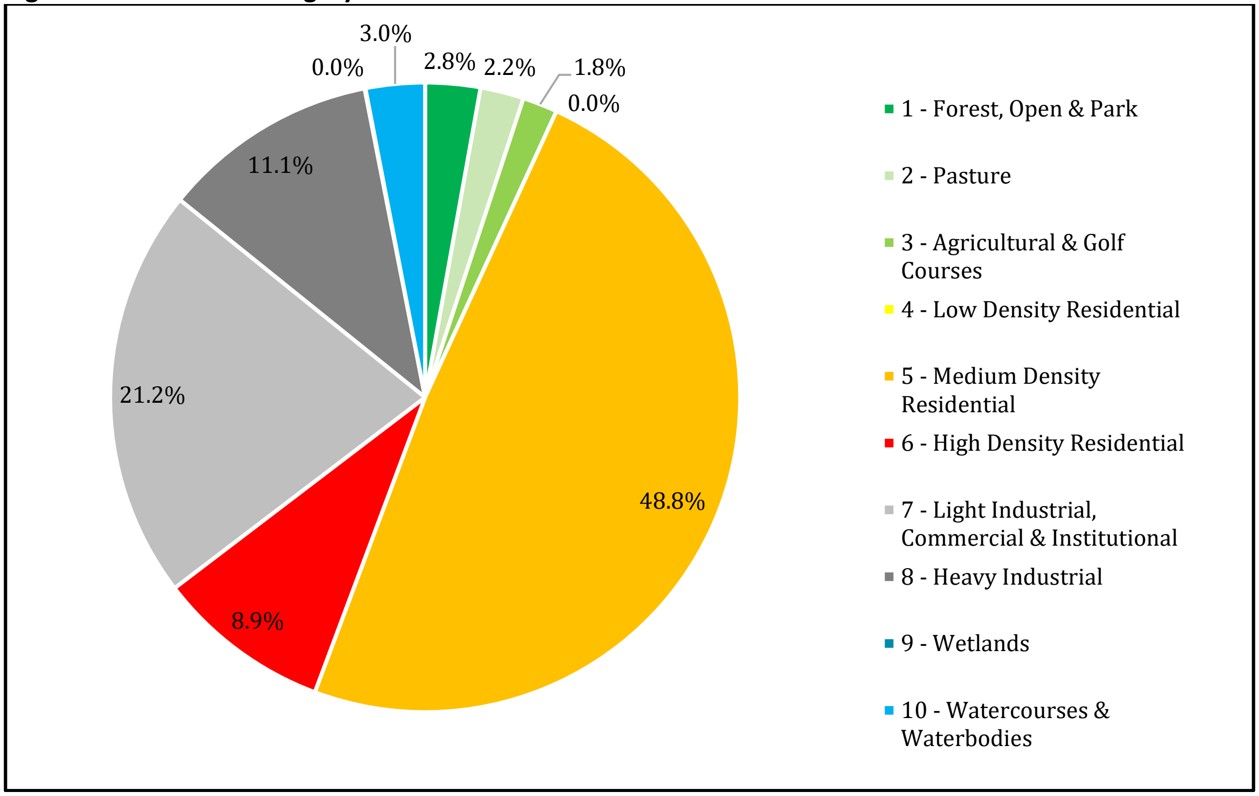


Figure 2.3-7 Breakdown of Impervious Cover for the HW Basin

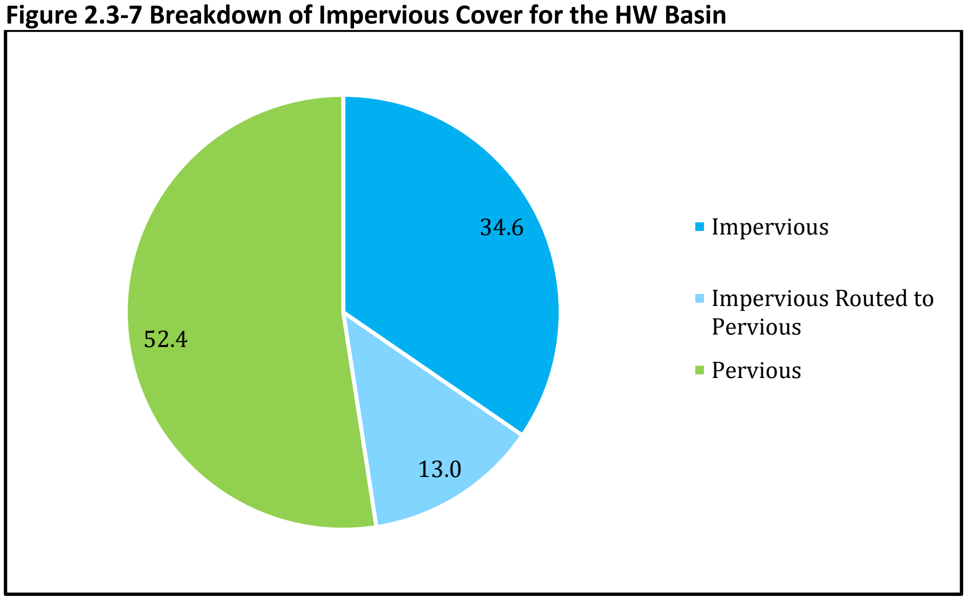
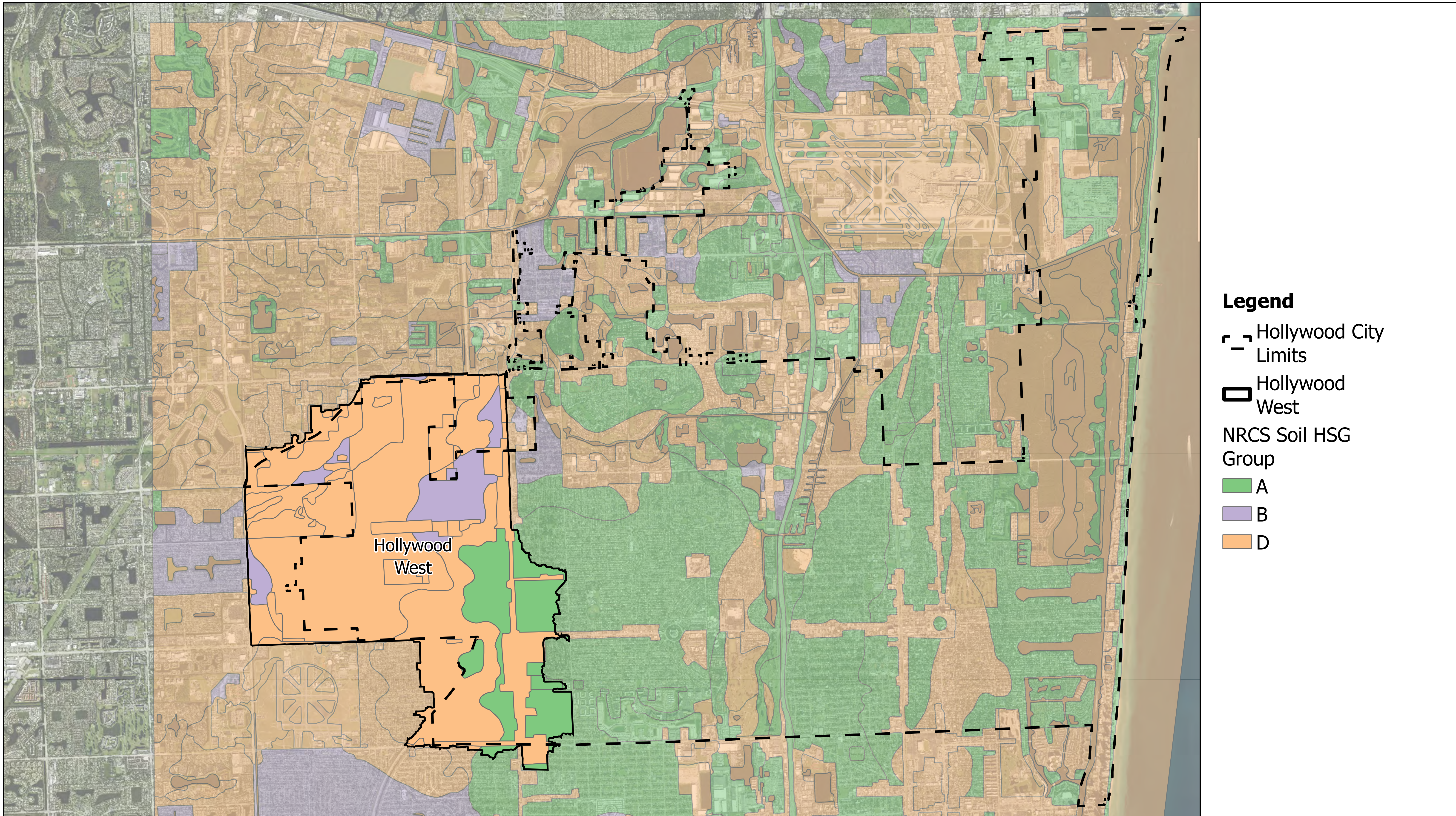


Table 2.3-1 HW Basin Design Storm Volumes and Intensities

Storm	Rainfall Depth (inches)	Peak Hour (inches)
5-year, 24-hour	7.2	3.0
10-year, 24-hour	8.8	3.6
25-year, 72-hour	15.4	4.7
100-year, 72-hour	21.3	6.5

Surface soils in the HW Basin are primarily composed of HSG Type A, Type B, or Dual Class (A/D, or B/D) soils in the NRCS soils map included as shown on **Figure 2.3-8**. One of the soil types found in the HW Basin is classified as Urban Land, which again is classified as Type D for this project. Dual class soils were also provided the lower infiltration capacity Type D classification in the HW Basin. **Figure 2.3-9** displays the HSG classifications deployed in the HW Basin model. The Model Development TM describes how the different soils types are converted to Green-Ampt model parameters.



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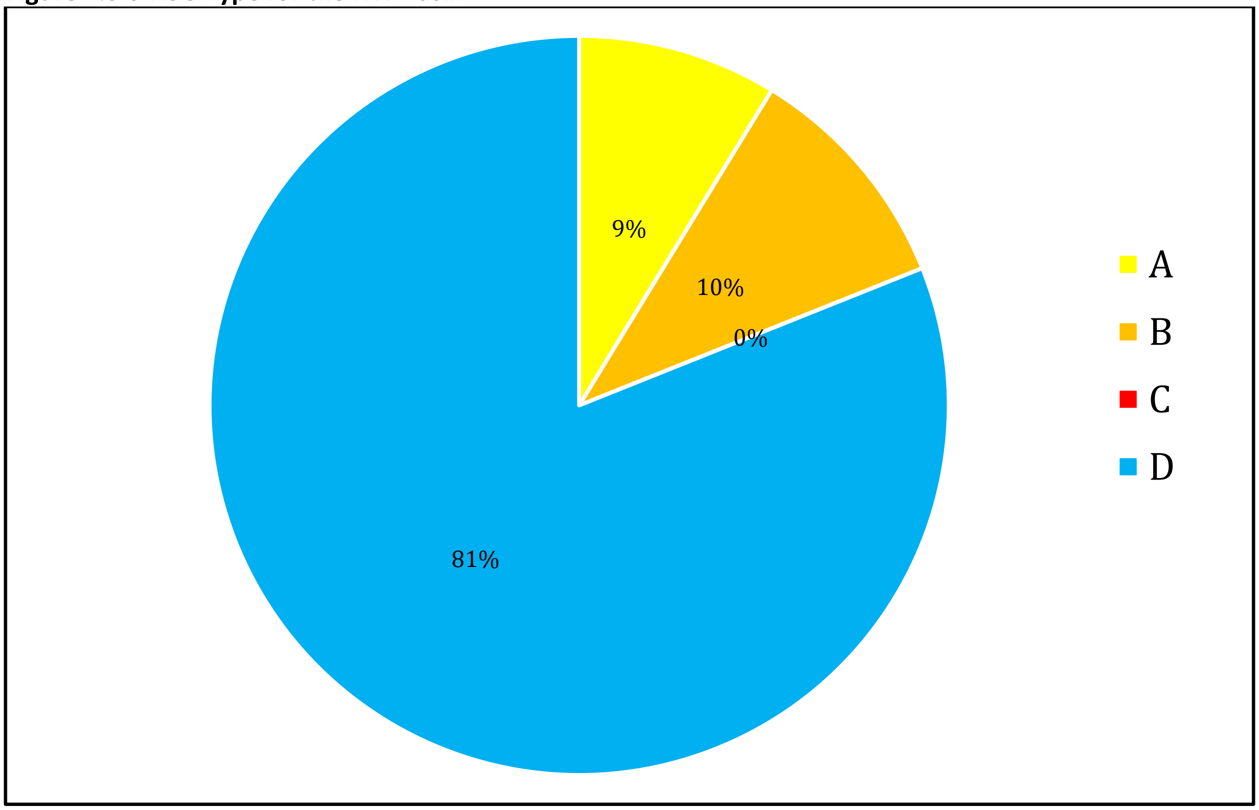
NRCS Soils Map for the Hollywood West Basin

City of Hollywood Stormwater Master Plan

Figure 2.3-8

08/10/2022

Figure 2.3-9 HSG Type for the HW Basin



2.3.2 HW Basin Modeling and Analysis Overview

Hydrologic and Hydraulic (H&H) Model Elements

The developed H&H models for the HW Basin stormwater management system were used to evaluate the performance of the City's existing stormwater management system and to analyze future CIP projects. Model analysis evaluated the PSMS for multiple size rainfall events and downstream tidal boundary conditions. The PSMS includes constructed stormwater facilities as well as canals, ditches, and other overland flow paths that drain to the downstream waterbody (i.e., boundary condition). The PSMS generally includes all open channels, swales, and ditches picked up by the LiDAR, and pipes 24 inches in diameter and larger, except where required to be smaller for model continuity.

The HW Basin modeled area is 8,036 acres delineated into 500 sub-basins ranging in size from 0.85 to 967.8 acres with a mean size of 16.1 acres. Excluding the eight SBDD sub-basins that were added to find contributing flows to the SBDD S-1 SWPS, the HW Basin Model is 4,831 acres delineated into 492 sub-basins ranging in size from 0.85 to 139.2 acres, with a mean size of 9.8 acres. Within the City boundary, there are approximately 423 sub-basins covering 3,424 acres, ranging in size from 0.85 to 41.2 acres, with a mean size of 8.1 acres. The largest sub-basin within the City represents a commercial area in the Lawn Acres neighborhood. **Table 2.3-2** summarizes the HW model elements.

Table 2.3-2 Summary of the HW Basin Model Elements

Sub-basins		500
Junctions		0
Storages	**Functional**	796
	Tabular	502
Outfalls		18
Conduits	**Circular**	893
	Custom (Bridge)	0
	Ellipse	19
	Rectangular Closed	7
	Irregular Canal	69
	Irregular Outfall	11
	Irregular Overland	1,197
	Trapezoidal	1
	Arch	5

Appendix A includes the HW Basin model schematic (**Figure HW-EC**) with standard symbology and **Appendix B** includes more detailed tables presenting the HW model element characteristics. These tables include the following:

- **Table HW-1** Hydrologic Parameters per Sub-basin
- **Table HW-2** Hydraulic Nodes Data
- **Table HW-3** Hydraulic Conduit Data
- **Table HW-4** Model Pump Data
- **Table HW-5** Model Weir Data
- **Table HW-6** Model Exfiltration Data

Model Node and Outfall Elements

Model nodes representing manholes are modeled as functional storage nodes with a minimal amount of constant storage area (12.56 square feet, which is equivalent to a typical 48-inch diameter manhole). Pump Station wet wells are modeled as functional storage nodes with constant areas equivalent to the wet well area, if the station dimensions were provided, or 100 square feet if the dimensions were not provided.

The 18 model outfalls represent:

- One pipe outfall at the intersection of University Dr. and Sheridan St. representing the major northern outfall from the HW Basin model, with a stage time series boundary condition developed from the CBWCD models (see Model Development TM).
- One SWPS outfall near the intersection of University Dr and the Florida Turnpike Extension (SR 821), downstream of the SBDD S-1 SWPS, representing the major southern outfall from the HW Basin Model, with a fixed stage boundary condition for all storms set at 2.5 ft-NAVD.
- One pipe outfall to the Florida Turnpike Ditch, north of Stirling Rd. This 24-inch pipe under Stirling Road was not in the City GIS layer, but was present in the CBWCD model, and was added to this model for that reason. The time series boundary condition per storm was condition developed from the CBWCD models (see Model Development TM).
- Two outfalls north of Stirling Road, from the FDOT Stirling Rd PSMS to the CBWCD ditches, with stage time series boundary conditions per storm developed from the CBWCD models (see Model Development TM).
- Two outfalls on either side of the Florida Turnpike at Pembroke Rd, representing stages in the ditches adjacent to the Turnpike. These outfalls have been set to fixed stage elevations of 1.5 ft-NAVD, for all storms based on future groundwater levels. The City PSMS near the

intersection of Pembroke Rd and the Turnpike is significantly higher; therefore, rising stages in the Turnpike ditch are not expected to have major impacts on the City LOS.

- Eleven overland flow outfalls, which allow floodwater to sheetflow to the northwest off Stirling Rd and the Dania Rd Extension and south off Pembroke Rd to Broward County, outside City Limits.

In addition to the summary of model elements provided above, 4 sub-basins, 4 storage nodes, and 4 outfalls were required to be used to simulate the exfiltration systems in the HW Basin. The aquifer has been divided into 4 contiguous sections in the basin area because the initial level of the base groundwater varies depending on location (see Broward County Future Groundwater Elevation Map, Figure 2-11 in the Model Development TM). Additionally, the aquifer was subdivided geographically for ease of implementation. The virtual systems representing groundwater are not included in the model schematic nor in the tables. The HW exfiltration systems are described in further detail in the section below.

The City's project-specific survey and the GIS coverage of stormwater pipes in the C-10 Basin identifies:

- 11 stormwater points of discharge (within City limits) that discharge to the Turnpike Ditch
- 4 that discharge to the SBDD S-1 Spur Canal
- 16 that discharge to the CBWCD Canal system

If the CBWCD and the SBDD are able to maintain stages below the City's LOS Goals for each storm, these outfalls may not require backflow prevention; although it is anticipated that some backflow prevention will be necessary (to be determined in the CIP analysis).

Similarly, there are multiple neighborhoods adjacent to the SBDD and CBWCD canal system that may require raised seawalls in order to meet the City's LOS Goals. Additionally, neighborhoods outside the City Limits may also require backflow prevention and raised seawall, else backflow that floods adjacent neighborhoods may flow into the City though low-lying streets. If the CIP analysis shows this happening, the City may need to work with adjacent municipalities or Broward County to have the HW Basin neighborhoods meet LOS Goals.

Pump Stations

In the SWMM, pumps are represented by stage-flow links connected to an inflow storage node that serves as the wet well. The outflow section of the link is connected to a node that serves as a force main to an outfall. The types of pumps represented in this model are in-line pumps where flow increases incrementally with inlet node depth (SWMM Type 2).

There is one existing SWPS in the HW Basin, which uses a constant flow capacity over the range of wet well depths. The constant capacity is applied since using actual pump curves at the SWMP level of analysis for large design storms is unnecessary. Pumps are typically set to turn on at levels above the static water table and cycle off as water levels drop in the wet well.

This SWPS information was provided by the SBDD.

1. SBDD SWPS S1 has a total maximum capacity of 425 cfs or 1,900,000 gpm and is located on the SBDD S-1 Canal, immediately east of S University Dr, between Riviera Blvd and the Florida Turnpike Extension (SR 821) approximately 3 miles south of the City of Hollywood. This pump station discharges water to the C-9 (Snake Creek) Canal through an additional 4,000 ft of canal adjacent to University Dr. For this station, the wet well is set at -10 ft-NAVD. The SWPS has three pumps as provided by SBDD:

    - The bleed down pump is 87 cfs and is set to cycle on when the depth in the wet well reaches 11.45 ft (1.45 ft-NAVD) and cycles off when the depth falls to 10.95 ft (0.95 ft-NAVD).

    - The primary pump is 169 cfs and is set to cycle on when the depth in the wet well reaches 11.65 ft (1.65 ft-NAVD), and cycles off when the depth falls to 10.95 ft (0.95 ft-NAVD).

    - The secondary pump is 169 cfs and is set to cycle on when the depth in the wet well reaches 11.75 ft (1.75 ft-NAVD) and cycles off when the depth falls to 10.95 ft (0.95 ft-NAVD).

Exfiltration Systems

The HW Basin uses exfiltration systems as one of its methods to reduce flooding and improve water quality by moving water from the PSMS to the Biscayne Aquifer. These systems include:

1. Exfiltration/French Drains: Perforated pipe situated in a gravel-filled rectangular shaped excavation into the aquifer. There are approximately 7.6 miles of exfiltration/French drains in the HW Basin.

As described earlier, in the HW Basin, the regional water table elevation is estimated for 4 separate regions. Each region has a specified initial water table level based on the Broward County future groundwater elevation map (se Model Development TM) and these initial levels will be higher in the sea level rise scenarios. The regional water tables were designed to automatically rise in the model based on precipitation and infiltration using regional land-use estimates, i.e., the 4 model sub-basins ("GW" prefix), 4 storage nodes ("BiscayneAQ" prefix), and 4 outfalls ("AQLossOut" prefix). These are virtual elements designed solely to predict water table elevations and are not hydrologically or hydraulically connected to the model PSMS. The exfiltration rating curves are developed outside the model in a spreadsheet, based on length of system and count of wells per sub-basin, and other sub-basin specific parameters. The curves are head versus flow curves, where the head is internally calculated in the model by subtracting the regional groundwater elevation from the site-specific flood stage. As in actual conditions, in the large design storms, some of the low-lying exfiltration systems cease operations as the water table rises to ground surface. The Model Development TM provides more details on the exfiltration systems and how rating curves were developed for each type per model sub-basin.

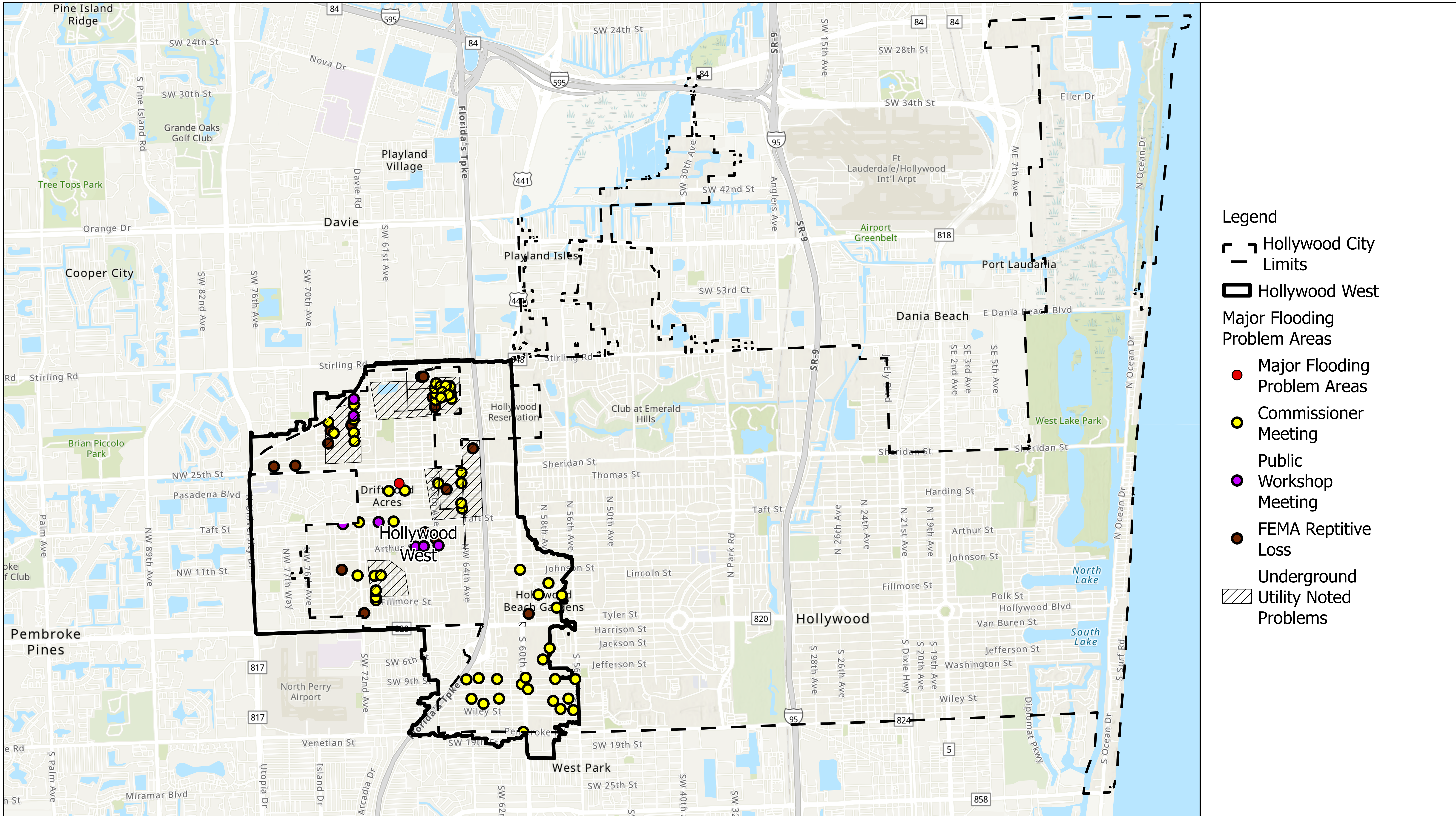
2.3.3 HW Basin Existing Conditions Level of Service (LOS)

Known Flooding Problem Areas and Causes

Known problem areas in HW Basin include the neighborhoods of:

- Driftwood, from Charleston St to Sheridan Rd and from NW 64th Ave to NW 68th Ave. The primary causes of flooding are that this is a depressional area including a wall to the neighboring entity on the east; though there is a positive system to the CBWCD Canal, the pipe capacity is not large enough to meet the City's LOS Goals; and the tailwater in the CBWCD PSMS is too high to meet the City's LOS Goals.
- Driftwood and Carriage Hills, west of 68th Ave. The primary causes of flooding in these neighborhoods are the limited pipe capacity to the CBWCD Canals, and the relatively high tailwater conditions in the CBWCD PSMS.
- Boulevard Heights in multiple locations but particularly adjacent to the SBDD S-1 Spur Canal. For many streets in Boulevard Heights, the primary causes of flooding are localized depressions with a lack of a positive PSMS. From Arthur to Taft, between NW 73rd and NW 76th Aves, causes of flooding include relatively low-lying topography, low or missing seawalls on the SBDD Canal, and relatively high tailwater conditions in the SBDD Canal.
- Beverly Park. Though street elevations are relatively high compared to the other problem areas, this neighborhood as localized depressions adjacent to the Florida Turnpike and no positive PSMS to a significant water body (i.e., other than the local Turnpike ditch).

Figure 2.3-10 provides a more comprehensive HW Basin map of complaints related to storms and/or flooding, locations where moderate to severe flooding was noted in community workshops, and streets where City staff, including Underground Utilities staff have noted problems.



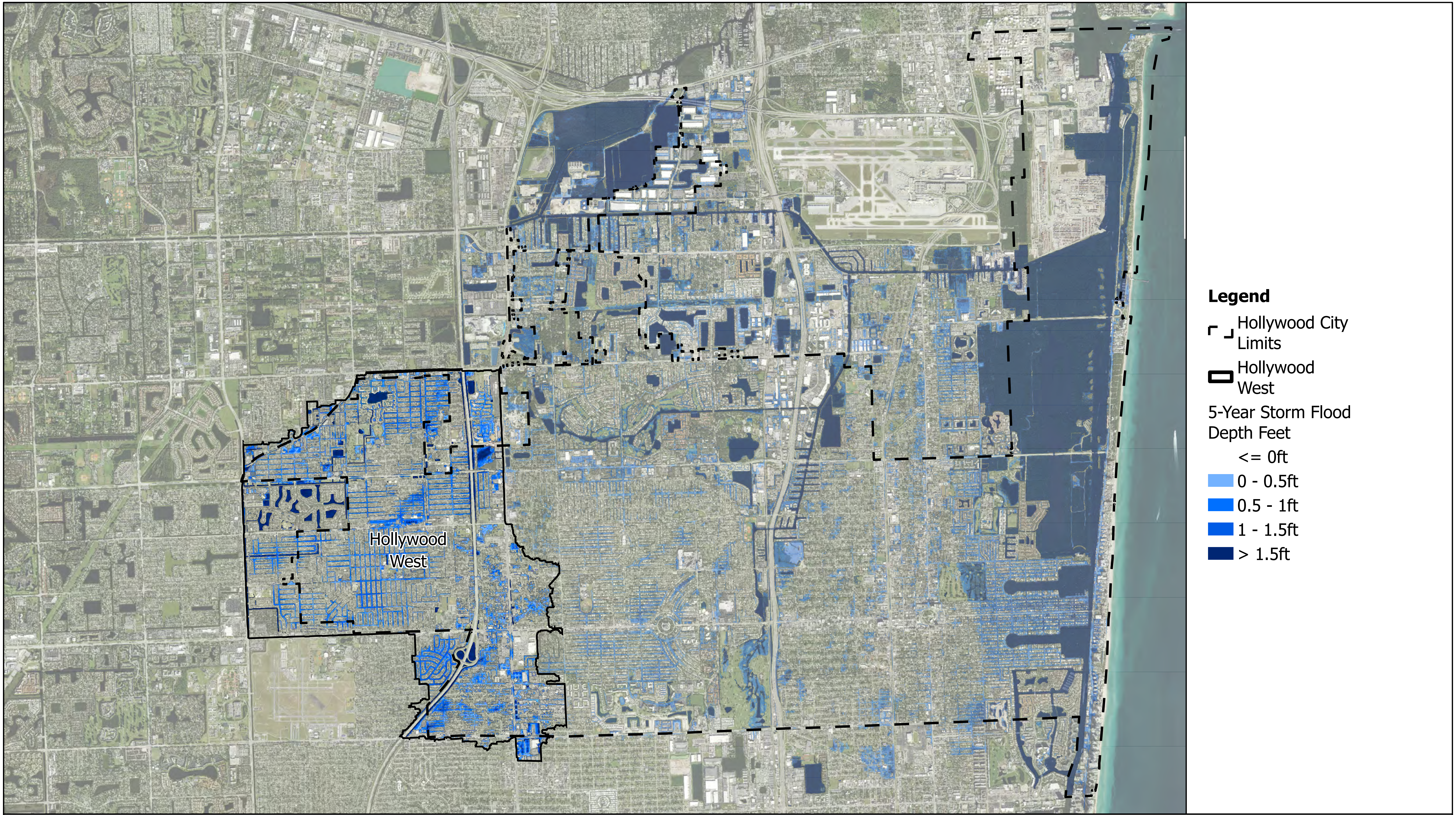
Major Flooding Areas within the Hollywood West Basin

0 2,000 4,000 8,000 Feet
1:53,000

City of Hollywood Stormwater Master Plan
Figure 2.3-10
08/10/2022

Existing Conditions (EC) Model Results and Design Storm Inundation Mapping for HW Basin

The verified HW Basin EC model was run for the base simulation for each design storm considering a well maintained, clean pipe condition. A summary of peak flood stages for the simulated EC model is presented in **Appendix B Table HW-7.** Flood mapping of the base simulations of existing conditions for the 5-year and 10-year, 24-hour design storm; and the 25-year and 100-year, 72-hour design storms are presented on **Figures 2.3-11 through 2.3-14**.



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City of Hollywood Florida

5-Year, 24-Hour Design Storm for the Hollywood West Basin

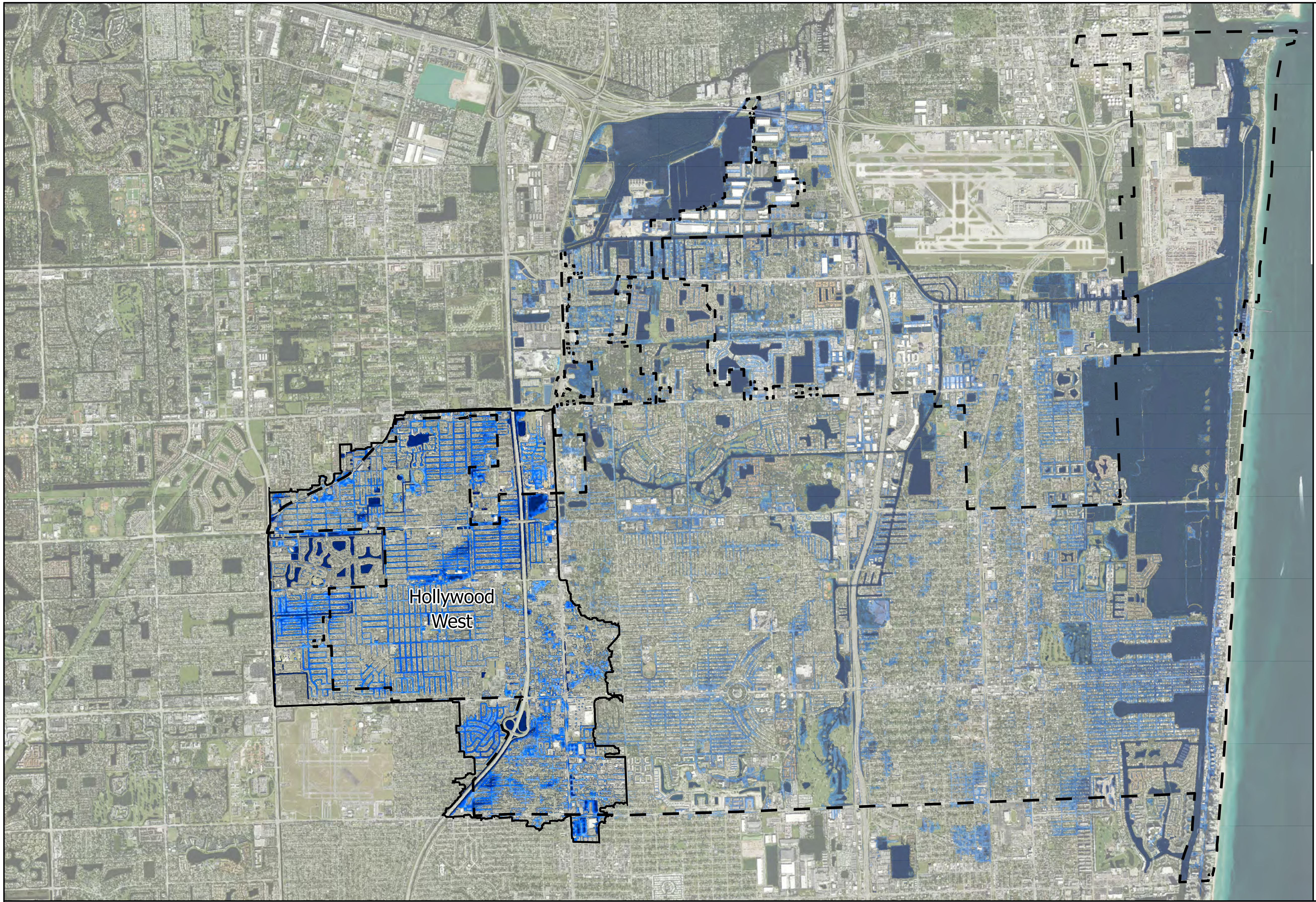
0 2,000 4,000 8,000 Feet

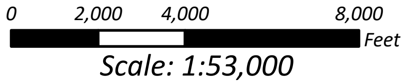
Scale: 1:53,000

City of Hollywood Stormwater Master Plan

Figure 2.3-11

08/10/2022





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City of Hollywood Florida

10-Year, 24-Hour Design Storm for the Hollywood West Basin

City of Hollywood Stormwater Master Plan
Figure 2.3-12
08/10/2022

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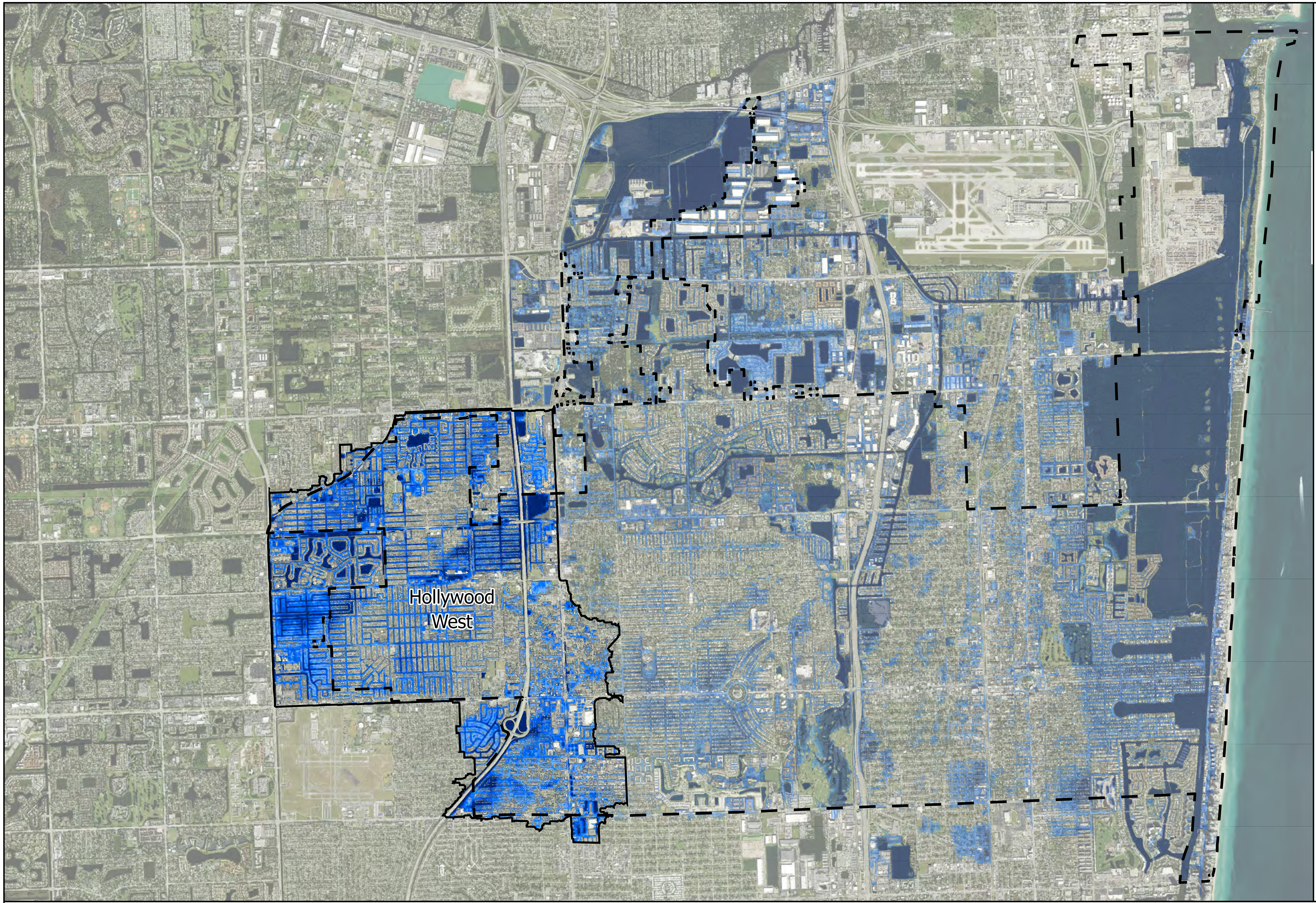

Legend

Hollywood City Limits

Hollywood West

25-Year Storm Flood Depth Feet

<= 0ft

0 - 0.5ft

0.5 - 1ft

1 - 1.5ft

> 1.5ft

N

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CITY OF Hollywood FLORIDA

25-Year, 72-Hour Design Storm for the Hollywood West Basin

0 2,000 4,000 8,000 Feet

Scale: 1:53,000

City of Hollywood Stormwater Master Plan

Figure 2.3-13

08/10/2022

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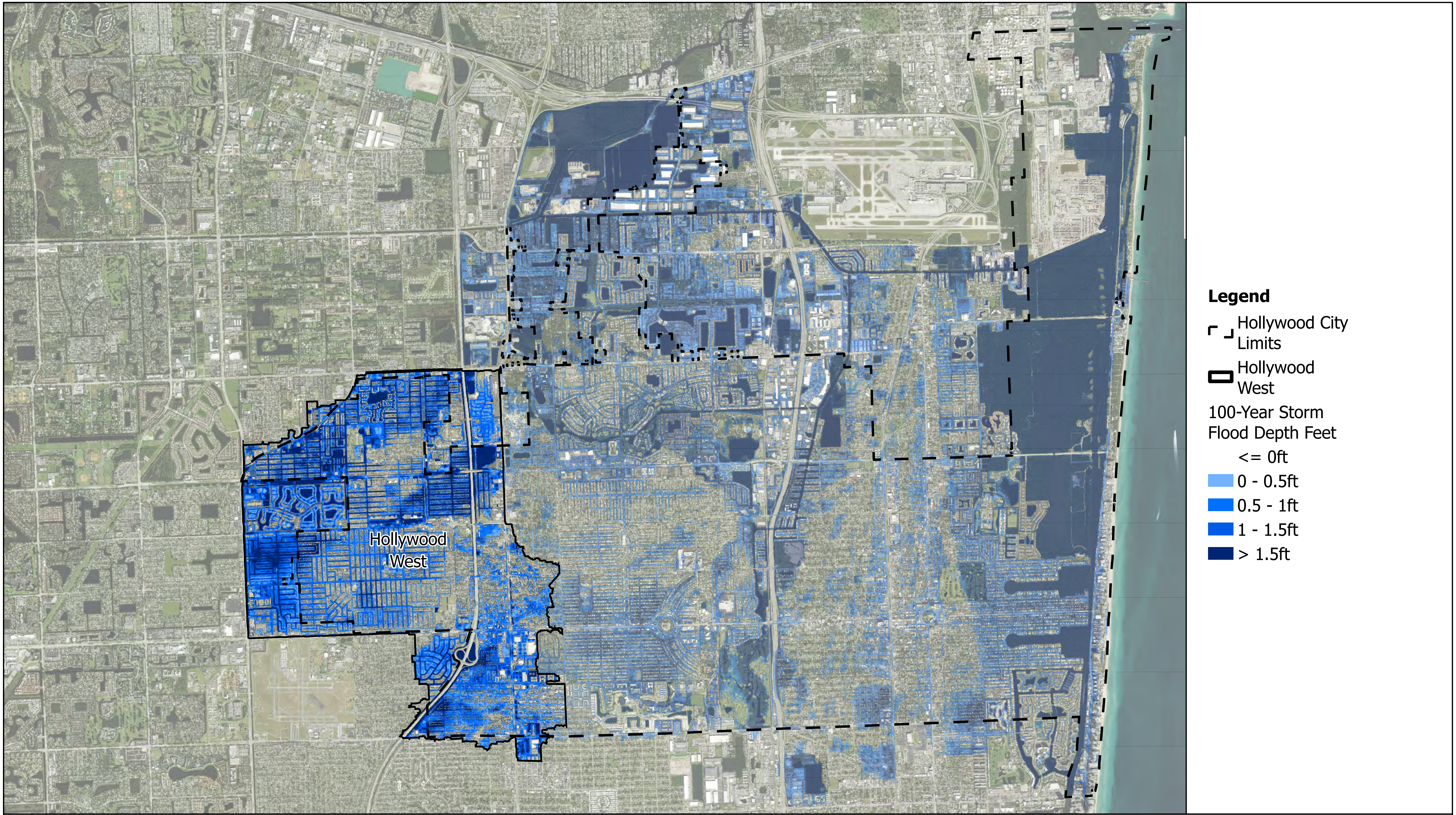

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City of Hollywood Florida

100-Year, 72-Hour Design Storm for the Hollywood West Basin

City of Hollywood Stormwater Master Plan

Figure 2.3-14

08/10/2022

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2.4 Citywide Swale Simulation

One of the common stormwater management components found citywide are swales. A swale is an unpaved, depressional area, shallow channel with gently sloping sides designed to capture and manage stormwater water runoff, filter pollutants, and increase rainwater infiltration. Swales collect stormwater from roads, driveways, parking lots, and other hard surfaces. Swales can connect to convey water through culvert piping or be standalone and add needed green (pervious) areas to otherwise highly developed, impervious (paved) areas of the City. Two basic types of swales exist in the City:

- Retention swales – which are narrow and shallow and typically found in the yards of properties along the roadways, and are designed to capture (or "retain") runoff from the property and a portion of the street in front of the property; and

- Conveyance/Detention swales – which are typically wider and deeper and design to both capture, detain, and convey runoff through a series of connecting culverts to equalize and maximize the available storage and/or channel the water toward an outfall pipe or system.

Another variation of swale that may be of either type above is the Bioswale, which is specifically designed with specially selected plant life, water levels, and engineered media to increase the uptake of specific pollutants under a given water quality.

Swale Functionality

The cumulative effect of many smaller swales spread throughout developed neighborhoods is both the addition of needed stormwater management storage to capture the typical afternoon thunderstorm and dissipate the associated street ponding rapidly after the rainfall to areas where there would otherwise be none, and enhanced water quality treatment of the surface pollutants that wash off the roadways and hard surfaces at the beginning of the storm. Capturing this "first flush" can significantly reduce the pollutant load on the receiving canals and as an added benefit, lower the temperature of the hot runoff from the paved streets and land surface as it is released into the temperature-sensitive marine environment.

Swale Maintenance

Over time, a swale's effectiveness will decrease because of the accumulation of sediment and debris, as well as compaction from vehicular activity and parking. To maintain a swale in proper functioning condition, periodically, collected sediment, trash, and debris must be removed from in and around the swale as well as removing weeds and plants that do not belong and checking for any obstruction or blockage of flow along inflow areas or pipes. The grass also should be mowed regularly no shorter than 3 inches. As the swales are only effective synergistically, (i.e., several small swales compound to a larger effect), education of the public on the importance of maintaining the swales is a critical component of the program, as property owners are sometimes inclined to fill in the City's swales for their own land uses in front of their property.

Citywide Recapture the Swale Program

At the time of this TM, the City is embarking on a “Recapture the Swale” Program that is focused on restoring the usefulness of swales as a green stormwater infrastructure solution across the City as part of the overall stormwater management system. Restored swales will collect, store, treat infiltrate, and convey stormwater in the public right-of-way, and will help to provide flood mitigation, enhance aquifer recharging, and improved water quality. The program will also seek to educate residents and businesses on the important role they play in stormwater management. A grant funded pilot area is currently in progress to show the effectiveness of the swale in the overall stormwater management system.

Model Simulation of Swales

There are two ways the model simulates swales: initial abstraction and explicit modeling as a shallow channel, depending on the type of swale. Initial abstraction is a parameter that accounts for other losses of stormwater prior to runoff and consists mainly of interception, infiltration, evaporation, and surface depression storage. The swale storage is simulated as enhanced initial abstraction via depressional storage or using the SWMM low impact development [LID] control module and determined from identification of swale coverages using GIS manipulations. The swale storage is recorded in a separate layer that can be “switched” on and off to perform a pre- post condition analysis for existing and restored swales to determine their effectiveness in their design storms citywide.

Larger swales, like the existing swales adjacent to Sheridan St, between Federal and N 14th Ave, have been modeled explicitly as channels, with connecting culverts under side streets and driveways. This allows for both the swale storage and the potential conveyance to be captured by the model. For the large number of potential swales in the recapture the swales program, and the unknowns involved—connectivity issues, size of private driveway culverts, other potential blockage—it is not feasible to attempt to model conveyance; therefore, these swales are captured in the model as an initial abstraction from the runoff hydrograph (storage only). A volume of each potential swale is calculated based on available length and width and then summed over each model sub-basin. The summed volume of the swales are divided by the sub-basin areas to determine equivalent depths per sub-basin, in inches, which is then added to the base initial abstraction parameters (see Model Development TM).

Model runs were performed to test the effectiveness of the swales with a 2.5-inch, 3-hour storm with a similar distribution shape as the 5-year, 24-hour storm (i.e., the peak intensity of the storm is centered at 1.5 hours and the central hour is significantly more intense than the 1st and 3rd hours). The existing condition models with the swales added are then compared to the existing condition without swales and the results recorded.

3.0 Design Storm Simulations

A range of simulations are being performed for the three basin models covering multiple design storm intensities and an array of varying boundary conditions. Model simulations are performed for the 5-year and 10-year, 24-hour design storm; and 25-year, and 100-year, 72-hour design storms. Additionally, simulations will be performed with an increased rainfall over the 100-year storm, or with the 500-year rainfall volume, (the results of this analysis will be presented in the SWMP report and are not included in this TM).

Table 3-1 presents the EC (hydraulically prior to the CIP analysis) simulation scenarios being run for the SWMP. The Base Condition simulation has been performed for this TM. The SLR scenario results will be presented in the final SWMP Report. The CIP Analysis for both Alternatives 1 and 2, the Primary and Secondary LOS Goals will be performed for the base tailwater condition, as well as for the Sea Level Rise scenarios.

The projected Sea Level Rise Scenarios were developed with the Florida Department of Environmental Protection (FDEP) requirements in mind as under recent Florida Statute 380.093, scenarios required for State Grant Funding include the NOAA 2017 Intermediate Low (IL) and Intermediate High (IH) for the years 2040 and 2070. The Virginia Key Gage is used as it is the closest NOAA Gage to the City of Hollywood. The next closest NOAA gage is Daytona Beach, and distance weighting the sea level rise values from Virginia Key and Daytona Beach provides nearly the same estimates as just using the Virginia Key gage, to within a hundredth of a foot.

Table 3-1 Design Storm Simulations

Tailwater Condition	Tailwater Stage in ICW (ft-NAVD 88)				
	5-yr, 24-hr	10-yr, 24-hr	25-yr,72-hr	100-yr, 72-hr	Excess Rainfall**
Base Condition*	2.5	2.5	2.5	2.5	2.5
Base Plus 0.36 feet SLR (2040 IL)	2.86	2.86	2.86	2.86	2.86
Base Plus 0.78 feet SLR (2040 IH)	3.28	3.28	3.28	3.28	3.28
Base Plus 0.92 feet SLR (2070 IL)	3.42	3.42	3.42	3.42	3.42
Base Plus 2.65 feet SLR (2070 IH)	5.15	5.15	5.15	5.15	5.15

*Base condition represents the one-year stillwater tide elevation – see Model Development TM.

**The Excess Rainfall simulation has a volume and intensity to be determined

Both Alternatives 1 and 2 (the Primary and Secondary LOS Goal simulations) will include backflow preventors and raised seawalls to provide effective flood mitigation in the low-lying areas adjacent to the Intracoastal and the C-10 Canals. One additional simulation of the 5-year, 24-hour design storm will be performed for the Primary LOS Goal (Alternative 1) with backflow preventors and all the internal CIP projects, but with existing conditions seawalls to show the limitations of adding new infrastructure without raising seawalls concurrently.

4.0 Citywide Level of Service Rankings

4.1 Model Result Summary and EC Level of Service Scoring

EC peak flood stages were compared to indicator elevations throughout the three basins, comparing the 10-year storm to major roads and evacuation routes (see Figure 1-3), comparing the 5-year storm to the remaining roads in the City, and comparing the 100-year storm to estimated First Floor Elevations (FFEs) for all structures larger than 500 square feet in the City (thus eliminating storage sheds, bus stops, etc.).

The City was analyzed and grouped logically into 40 improvement regions (CIP Areas) considering both neighborhoods and Commission District Boundaries, in-common topography, contiguous flooding extents, and the PSMS elements of adjoining neighborhoods, and assigned a unique numerical name for this analysis. **Figure 4-1** presents the CIP Area map and assigned CIP area names. A CIP Area thus represents the minimum boundary that improvements will extend into to address a "connected" area of flooding. The CIP areas can be further sub phased into smaller projects during CIP execution, however, to meet the LOS goal fully, all of the improvements in a CIP Area must eventually be constructed.

Table 4-1 presents the length of major roads and evacuation routes flooded 3 inches above crown in each region for the 10-year storm, the length of the remaining roads flooded 3 inches above crown for the 5-year storm, and the number of buildings expected to flood for the 100-year storm, under existing conditions. Because the verification of each individual First Floor Elevation (FFE) for every building and residence property in Hollywood is not within of the scope of this project, a standard 1 foot above existing grade has been added to the LiDAR DEM around the periphery of each structure as a reasonable estimate of the minimum building FFEs. It is noted that Current Florida Building Code requires 1 foot or more above the base flood elevation (BFE) depending on the FIRM flood hazard zone within that the property is located. Future minimum FFEs may be required to include additional height provisions for sea level rise.

Additionally, 71 critical structures were identified in the study area (emergency operations, police, fire, hospital, evacuation shelter, government, etc.) and added to the surveyed FFEs. The Critical Structures **Figure C-1** and table of corresponding FFEs using the perimeter averaged LiDAR plus 1 foot vs the 100-year storm elevation for all basins citywide are provided in **Appendix C**. Three critical structures are expected to flood above the estimated FFE in the 100-year storm, in CIP areas District 1_2, District 4_7, and in District 6_6.

It is noted that the City has recently completed a *City of Hollywood Citywide Vulnerability Assessment and Adaptation Plan*, (Hazen 2020) that addresses the hardening of the majority of its utility-related critical facilities through measures such as waterproofing, raising local structure entrance drives, elevating or relocating sensitive electrical equipment, strengthening structures to withstand water inundation, adding or adjusting finished-floor access to the structures above the flood zone.

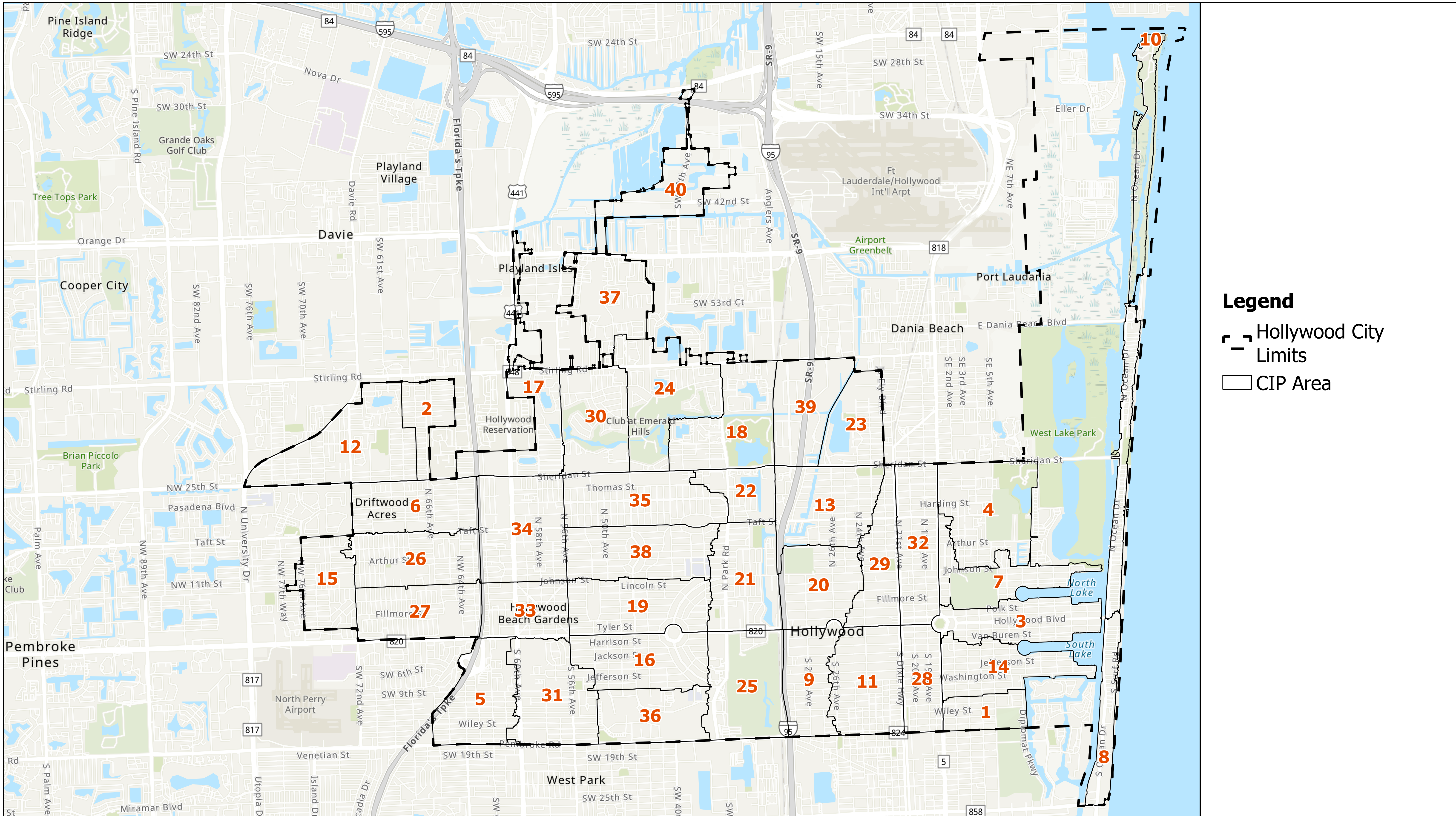

Figure 4-1

CIP Area

City of Hollywood Stormwater Master Plan

Figure 4-1

08/12/2022

0 2,000 4,000 8,000 Feet

Scale: 1:53,000

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Table 4-1. Model Result Summary per CIP Area

DISTRICT	Total Area (Ac)	CIP Name	Effective Area* (Ac)	100-year Storm**			10-year Storm		5-year Storm	
				Structure Count	Structures per square mile	Critical Structure Count	Length of Major Roads Flooded > 3 inches (miles)	Length of Major Roads Flooded per square mile (miles)	Length of Residential Steets Flooded > 3 inches (miles)	Length of Streets Flooded per square mile
1	2,140	District 1_1	217	31	91.2	0	1.19	3.49	1.45	4.27
		District 1_2	224	38	108.7	1	0.79	2.27	1.38	3.95
		District 1_3	184	104	362.5	0	0.32	1.11	2.20	7.67
		District 1_4	414	14	21.7	0	1.11	1.71	5.31	8.22
		District 1_5	419	112	171.2	0	0.25	0.38	8.73	13.35
		District 1_6	245	26	67.8	0	1.09	2.83	5.62	14.66
		District 1_7	438	97	141.8	0	0.46	0.67	5.45	7.96
2	2,280	District 2_1	250	18	46.0	0	0.01	0.03	0.89	2.27
		District 2_2	352	7	12.7	0	0.37	0.66	1.24	2.26
		District 2_3	464	6	8.3	0	0.62	0.86	1.72	2.37
		District 2_4	536	187	223.4	0	0.07	0.08	2.23	2.66
		District 2_5	298	1	2.1	0	0.38	0.81	1.20	2.57
		District 2_6	379	123	207.8	0	0.32	0.55	0.65	1.10
3	3,245	District 3_1	520	131	161.4	0	0.15	0.19	2.25	2.77
		District 3_2	380	28	47.1	0	0.06	0.10	0.85	1.43
		District 3_3	206	3	9.3	0	0.10	0.32	1.06	3.31
		District 3_4	457	27	37.8	0	0.72	1.01	1.13	1.58
		District 3_5	584	3	3.3	0	0.82	0.90	3.28	3.59
		District 3_6	557	1	1.1	0	0.03	0.03	3.65	4.19
		District 3_7	541	77	91.1	0	0.01	0.01	5.67	6.71
4	3,474	District 4_1	417	10	15.3	0	0.07	0.11	1.11	1.70
		District 4_2	381	62	104.2	0	0.03	0.05	2.55	4.29
		District 4_3	439	17	24.8	0	0.23	0.34	4.01	5.84
		District 4_4	296	7	15.1	0	0.00	0.00	0.23	0.49
		District 4_5	291	3	6.6	0	0.00	0.00	3.29	7.23
		District 4_6	424	9	13.6	0	0.02	0.03	2.74	4.14
		District 4_7	378	69	116.8	1	0.17	0.28	2.21	3.74
		District 4_8	624	28	28.7	0	0.31	0.31	1.58	1.62
		District 4_9	224	70	200.3	0	0.00	0.00	5.65	16.18
5	2,349	District 5_1	622	157	161.5	0	0.00	0.00	9.78	10.06
		District 5_2	451	153	217.0	0	0.14	0.20	7.53	10.68
		District 5_3	354	84	151.9	0	0.16	0.28	5.03	9.10
		District 5_4	453	0	0.0	0	0.95	1.34	7.28	10.28
		District 5_5	469	2	2.7	0	0.06	0.09	5.01	6.84
6	2,319	District 6_1	244	25	65.6	0	0.22	0.57	0.58	1.53
		District 6_2	511	99	124.0	0	0.53	0.67	6.89	8.62
		District 6_3	174	4	14.7	0	0.00	0.00	0.92	3.40
		District 6_4	565	15	17.0	0	0.18	0.20	1.96	2.22
		District 6_5	474	248	335.0	0	0.22	0.30	3.00	4.05
		District 6_6	352	12	21.8	1	0.01	0.02	0.46	0.84

* excludes water, wetland, park & open, and golf course areas

** compares 100-year storm peak stage to LiDAR DEM + 1 ft to estimate FFE

Thus it is not necessary for the City to rely solely on more costly, citywide stormwater infrastructure CIP to address individual, on-site flooding problems at all of its critical facilities, and concentrate the Stormwater CIP on the citywide initiative of reducing the depth and duration of inundation of the public roadways, rights of way, and in the neighborhoods to the LOS goal with the limited available funding over time.

LOS Scoring of CIP Areas For Existing Conditions

To set a baseline condition for comparative purposes, the delineated CIP Areas were analyzed for their depth and extents, and potential damage of flooding inundation. An effective area was calculated for each CIP Area, which was then adjusted to exclude lakes, wetlands, golf courses and the larger parks, as intermittent flooding in these locations is expected and acceptable as compared to the residential/commercial "habitable" portions of the City. The length of street flooding and the building counts (density) were then normalized per square mile by the effective area to compare the severity of flooding in residential, commercial, and industrial areas. For reference, the flood maps for each Basin model may be found in Section 2.

CDM Smith and the City conducted multiple workshops where citizens and elected officials noted flooding problem areas on maps. Additionally, City staff have located problem areas for flooding, locations where road closures have been necessary, and have provided a complaint database. This data has been intersected with the CIP Areas to determine the lengths of streets expected to flood and a count of complaints and road closures by area. **Table 4-2** presents this data by CIP Area.

An LOS score for each region was determined by the following basic equation:

$$S_{LOS} = C_1 * Bldg_{100} + C_2 * Str_{Crit} + C_3 * Len_{10} + C_4 * Len_5 + C_5 * Len_{UU} + C_6 * RdCl + C_7 * CMP_H + C_8 * CMP_{WS} + C_9 * CMP_C$$

Where:

- S_{LOS} is the LOS score,
- Len_{10} is the length of major roads flooded 3 inches above crown for the 10-year storm normalized by area,
- Len_5 is the length of roads flooded 3 inches above crown for the 5-year storm normalized by area,
- $Bldg_{100}$ is the number of buildings flooded above the estimated FFE for the 100-year storm, normalized by area,
- Str_{Crit} is the number of critical structures identified in the region with a flooding issue,
- Len_{UU} is the length of problem area streets as indicated by Underground Utilities Staff, normalized by area,

- RdCl is the number of road closures,
- CMP_H is the number of historic complaints, normalized by area,
- CMP_{WS} is the number of citizen workshop complaints, multiplied by severity (by 1 for moderate, by 2 for medium, and by 3 for severe),
- CMP_C is the number of major problem areas identified by City Staff in the Kickoff Meeting, and
- C_1 through C_9 are coefficients that may be adjusted as necessary to account for weighting one parameter vs another, initially set at 1.0.

Table 4-2. Known Problem Areas and Complaints per CIP Area

DISTRICT	Total Area (Ac)	CIP Name	Effective Area* (Ac)	DPU Mapped Street Length**		City Road	Historic Complaint Database		Complaint Workshop		City Problem Areas
				Roads Flooded (miles)	Roads Flooded (mi. per sq. mi.)	Number of Roads Closed	Number of Complaints	Complaints per square mile	Number of Complaints	Complaints per square mile	Number of Major Areas
1	2,140	District 1_1	217	0.02	0.05	0	12	35.31	20	58.86	1
		District 1_2	224	0.08	0.22	0	21	60.07	20	57.21	1
		District 1_3	184	1.19	4.14	1	21	73.20	12	41.83	2
		District 1_4	414	1.75	2.71	3	24	37.14	19	29.40	2
		District 1_5	419	1.90	2.90	5	59	90.19	21	32.10	0
		District 1_6	245	0.71	1.84	1	34	88.64	12	31.28	0
		District 1_7	438	2.30	3.36	7	46	67.23	11	16.08	3
2	2,280	District 2_1	250	0.08	0.21	0	1	2.56	15	38.33	0
		District 2_2	352	0.00	0.00	0	8	14.55	14	25.46	0
		District 2_3	464	0.00	0.00	0	12	16.54	12	16.54	0
		District 2_4	536	0.00	0.00	0	11	13.14	14	16.72	0
		District 2_5	298	0.05	0.11	0	22	47.21	2	4.29	0
		District 2_6	379	0.07	0.12	0	23	38.85	9	15.20	0
3	3,245	District 3_1	520	0.00	0.00	0	20	24.64	22	27.10	1
		District 3_2	380	0.28	0.47	0	10	16.83	18	30.30	2
		District 3_3	206	0.19	0.59	0	6	18.67	17	52.91	0
		District 3_4	457	0.00	0.00	0	13	18.19	34	47.59	0
		District 3_5	584	0.00	0.00	0	8	8.76	8	8.76	0
		District 3_6	557	0.00	0.00	0	4	4.59	13	14.93	0
		District 3_7	541	0.00	0.00	0	9	10.65	10	11.83	0
4	3,474	District 4_1	417	0.01	0.01	0	1	1.53	0	0.00	0
		District 4_2	381	0.33	0.55	0	27	45.37	3	5.04	0
		District 4_3	439	0.00	0.00	0	20	29.14	9	13.11	0
		District 4_4	296	0.00	0.00	0	0	0.00	0	0.00	0
		District 4_5	291	0.00	0.00	0	1	2.20	0	0.00	0
		District 4_6	424	0.00	0.00	0	9	13.60	3	4.53	1
		District 4_7	378	0.01	0.02	0	7	11.85	9	15.23	1
		District 4_8	624	0.00	0.00	0	8	8.20	0	0.00	0
		District 4_9	224	2.77	7.93	0	12	34.34	36	103.03	1
5	2,349	District 5_1	622	0.60	0.61	0	17	17.49	15	15.43	1
		District 5_2	451	1.09	1.54	0	15	21.27	19	26.94	1
		District 5_3	354	0.00	0.00	0	5	9.04	2	3.62	0
		District 5_4	453	0.34	0.48	0	8	11.30	6	8.48	0
		District 5_5	469	0.00	0.00	0	12	16.39	13	17.75	1
6	2,319	District 6_1	244	0.00	0.00	0	5	13.12	0	0.00	0
		District 6_2	511	0.00	0.00	0	2	2.50	9	11.27	0
		District 6_3	174	0.00	0.00	0	4	14.69	0	0.00	0
		District 6_4	565	0.00	0.00	0	10	11.34	23	26.08	0
		District 6_5	474	0.07	0.10	0	3	4.05	10	13.51	0
		District 6_6	352	0.00	0.00	0	2	3.64	5	9.10	1

* excludes water, wetland, park & open, and golf course areas

** also includes streets called out by other City Staff, in conversation and/or emails.

Relative Rankings of CIP Areas For Existing Conditions

A map of the ranked CIP areas by raw score was developed in conjunction with City Staff and is presented in **Figure 4-2**. The top 25 areas were vetted by the City for validity and concurrence in a workshop. The highest ranked areas (1-5) were Moffett Street (and vicinity), Driftwood, Hollywood Lakes South, West Lake, and Beverly Park. Areas 6-10 were Boulevard Heights, areas surrounding the Hollywood Beach Golf Club, Hollywood South Central Beach, Hollywood Beach, and Highland Gardens. It is important to note that the ranking does not in any way lessen the severity of lower-ranked areas for flooding, and only provides the relative severity of the depth and extent of flooding in populated areas and is not necessarily "priority." These rankings are presented for initial evaluation purposes only, as the two proposed LOS alternatives will attempt to mitigate all problem areas to the chosen LOS, and not just those in the highest-ranked areas. It is further noted that the calculated score is relative only to other areas of the City so "Lower" ranked areas may still have many flooding issues to be resolved, but were not as widespread, affecting primary evacuation routes, or potentially affecting as many population or critical structures as in other areas of the City, but are just as important.

4.2 CIP Recommendation Guidelines

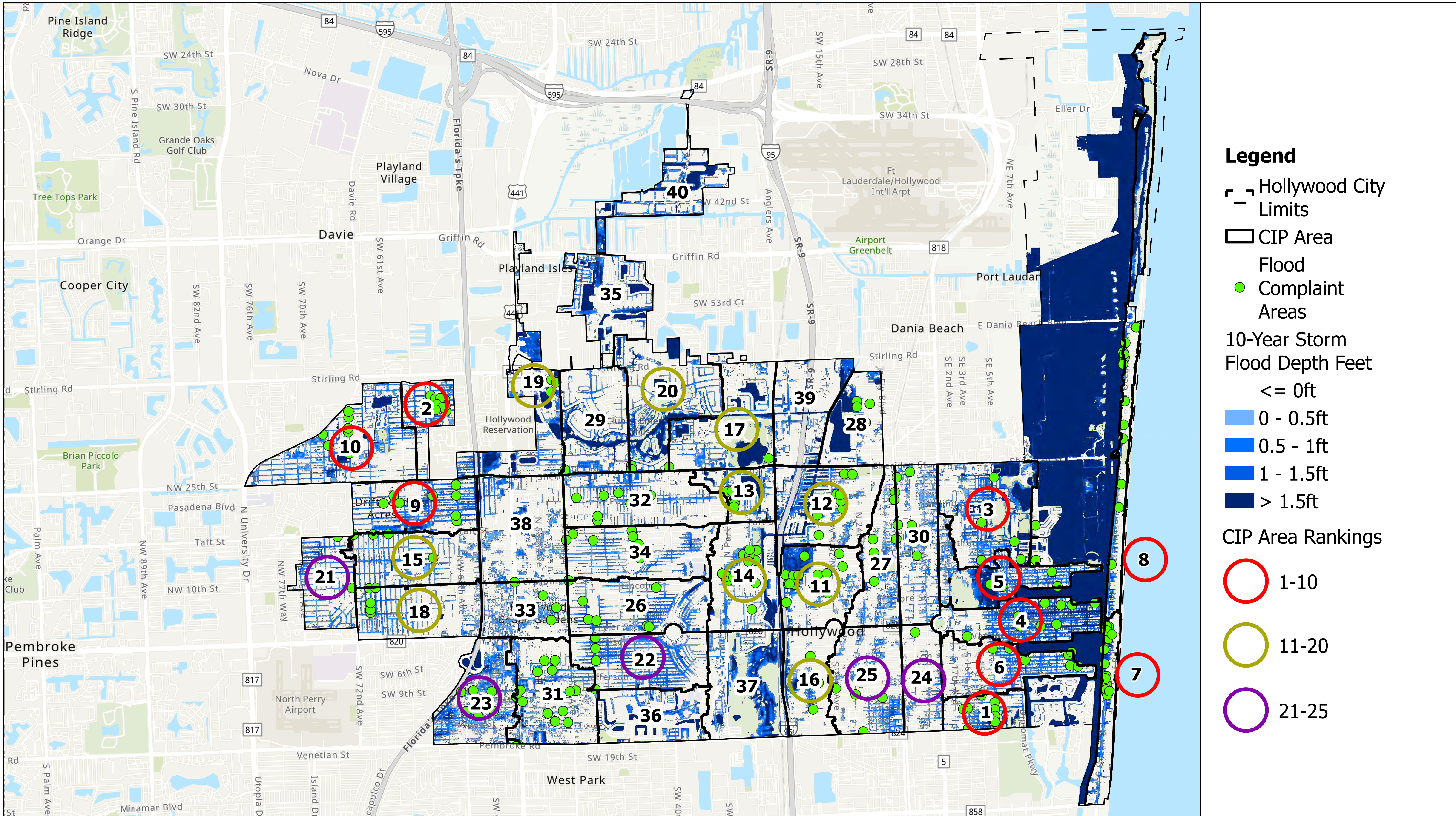
For each of the LOS analyses, the following practical general guidelines were followed:

- Dips in Roads – If a roadway section dipped too low to react to additional CIP improvements in the analysis, the recommendation is to fill the dip in the road by adding a few inches to the crown with compensating storage for the floodplain loss where necessary, and additional, larger stormwater infrastructure was not recommended.

- LiDAR Variances – Citywide LiDAR was used for the digital elevations for practicality due to the scale of the masterplan analysis. While highly accurate in most areas, random, small areas of obvious imperfection/anomalies exist in the data points that were identified. Future survey may be used to fill-in holes in the LiDAR data if additional accuracy is needed during final design and additional stormwater infrastructure was not recommended for these areas.

- Low-Elevation Dead-End Streets and at Waters' Edge – Low lying, dead-end street sections terminating at the waterways or Bay with no ingress or egress allowed to pond during storms and do not warrant additional, dedicated CIPs to correct these small sections of mostly unused roadway. Most of these areas should be converted to pervious linear parks with stormwater storage as neighborhood improvements.

- Atypical Low-Elevation Structures – Existing structures that were built at an elevation significantly lower than the majority of the surrounding structures in the same area, and that are not able to be remedied with additional CIPs, will continue to have flooding and are candidates for notification of flood insurance requirements, buyouts, or re-construction at the recommended higher elevation.



Ranked CIP Areas By Score

City of Hollywood Stormwater Master Plan
Figure 4-2
10/10/2022

0 2,000 4,000 8,000 Feet
Scale: 1:53,000

CDM Smith
City of Hollywood Florida