RESOLUTION No. 21-123

A RESOLUTION OF THE MAYOR AND THE CITY COUNCIL OF THE CITY OF DORAL, FLORIDA, ADOPTING THE CITY OF DORAL 2021 STORMWATER MASTER PLAN (SMP) UPDATE AND THE INCLUDED 5-YEAR CAPITAL IMPROVEMENT PLAN (CIP) AND AUTHORIZING THE CITY MANAGER TO PROCEED WITH THE UPDATED CIP; PROVIDING FOR IMPLEMENTATION; AND PROVIDING FOR AN EFFECTIVE DATE

WHEREAS, on March 12, 2014, the 2013 Stormwater Master Plan (SMP) and the proposed 5-Year Capital Improvement Plan (CIP) was adopted by the Mayor and City Council-Members by Resolution No. 14-52 (approved 5-0); and

WHEREAS, the results of the Stormwater Master Plan analysis allowed the City to identify and prioritize general areas where major drainage systems are deficient and define the extent of the deficiencies; and

WHEREAS, the City of Doral Public Works Department (PWD) has completed the design and construction for all projects identified in the 5-Year CIP in the 2013 SMP; and

WHEREAS, On November 19, 2019, the Mayor and City Council-Members approved Work Order No. 13 to BCC Engineering by Resolution No. 19-297, (approved 5-0) to provide professional engineering services and update the 2013 SMP and 5-Year CIP; and

WHEREAS, the 2021 SMP and CIP provides a measure to fund different improvement projects within the Stormwater infrastructure and address sites that have been identified to be in need of improvement; and

WHEREAS, a copy of the 2021 SMP and 5-Year CIP update is attached as Exhibit “A”; and

WHEREAS, staff recommends that the Mayor and City Council-Members adopt the City of Doral 2021 Stormwater Master Plan (SMP) and Capital Improvement Plan (CIP) and authorize the City Manager to proceed with the updated CIP included in this update.

NOW THEREFORE, BE IT RESOLVED BY THE MAYOR AND THE CITY COUNCIL OF THE CITY OF DORAL AS FOLLOWS:

Section 1. **Recitals.** The above recitals are true and correct and incorporated herein.

Section 2. **Adopt.** The 2021 Stormwater Master Plan and the 5-year Capital Improvement Plan included in the update, a copy which is attached as Exhibit "A", is hereby adopted.

Section 3. **Authorization.** The City Manager is authorized to proceed with the updated 5-Year Capital Improvement Plan on behalf of the City in furtherance hereof.

Section 4. **Implementation.** The City Manager and the City Attorney are hereby authorized to take such further action as may be necessary to implement the purpose and the provisions of this Resolution.

Section 5. **Effective Date.** This Resolution shall take effect immediately upon adoption.

The foregoing Resolution was offered by Councilmember Mariaca who moved its adoption. The motion was seconded by Councilmember Cabral and upon being put to a vote, the vote was as follows:

Mayor Juan Carlos Bermudez	Yes
Vice Mayor Pete Cabrera	Yes
Councilwoman Digna Cabral	Yes
Councilwoman Claudia Mariaca	Yes
Councilman Oscar Puig-Corve	Yes

PASSED AND ADOPTED this 12 day of May, 2021.

JUAN CARLOS BERMUDEZ, MAYOR

ATTEST:

CONNIE DIAZ, MMC
CITY CLERK

APPROVED AS TO FORM AND LEGAL SUFFICIENCY
FOR THE USE AND RELIANCE OF THE CITY OF DORAL ONLY:

LUIS FIGUEREDO, ESQ.
CITY ATTORNEY

EXHIBIT “A”

City of Doral

STORMWATER MASTER PLAN 2021 UPDATE

Final Report

Prepared by:

bc engineering

6401 SW 87th Avenue, Suite 200
Miami, Florida 33173

March 2021

CITY OF DORAL

STORMWATER MASTER PLAN REPORT
2021 UPDATE

Professional Engineering Certificate

I hereby certify that I am a registered professional engineer in the State of Florida practicing with BCC Engineering LLC., a corporation, authorized to operate as an engineering business with Certificate of Authorization No. 7184, by the State of Florida, and that I have reviewed or approved the evaluation, findings, opinions, conclusions, or technical advice of this Stormwater Master Plan Report.

Project: CITY OF DORAL STORMWATER MASTER PLAN REPORT 2021 UPDATE

Prepared for: City of Doral

I acknowledge that the procedures and references used to develop the results contained in this Stormwater Master Plan Report are standard to the professional practice of engineering and planning as applied through professional judgment and experience.

This document has been digitally signed by
Alex Vazquez, State of Florida, PE No. 42108

BCC Engineering, LLC.
Certificate of Authorization No. 7184

Name: Alex Vazquez, PE

Digital Signature: ____________________

The Official record of this document has been electronically signed and sealed by Alex Vazquez, PE, on 03/19/2021 using a digital signature as required by Rule 61G 15-23.004, F.A.C. Printed copies of this document are not considered signed and sealed. The signature must be verified on the electronic documents.

City of Doral
Stormwater Management Master Plan 2021 Update

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1.0 EXECUTIVE SUMMARY

1.1 Background & Scope

The City of Doral (City) was incorporated in 2003 and is located geographically in the west-central portion of Miami-Dade County. The City is roughly bounded by NW 90th Street to the north, the Florida Turnpike to the west, State Road 836 (Dolphin Expressway) to the south, and State Road 826 (Palmetto Expressway) to the east – see **Figure 1-1.** In its entirety, the City encompasses a total area of approximately 15.1 square miles. The City falls within the boundaries of the South Florida Water Management District (SFWMD) C-4 and C-6 Basins**.** These basins are drained by the C-4 and C-6 canals, which are both classified as primary canal systems by the SFWMD.

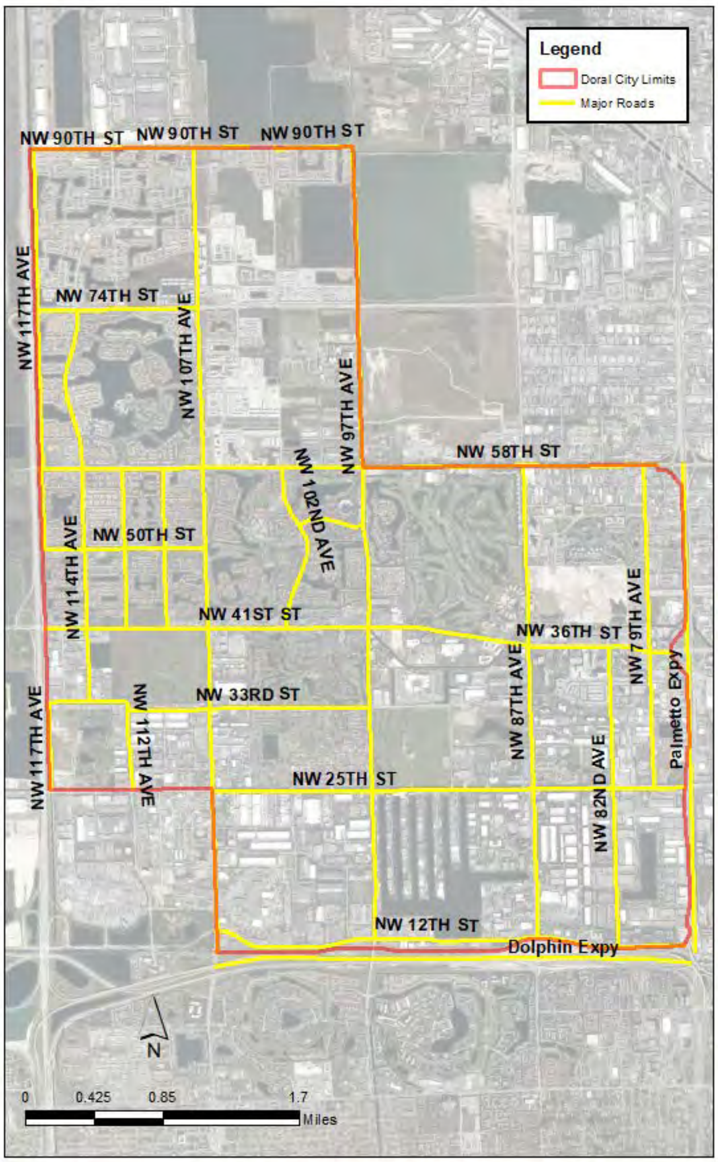


Figure 1-1 – City of Doral Limits and Major Roads

The City's Stormwater Master Plan (SWMP) was last updated in 2014. The last SWMP evaluated known flood problem areas throughout the City and provided recommendations for improvements needed in the City's drainage system. The 2014 SWMP developed a 5-year Capital Improvement Plan (CIP) to address high-priority flooding issues throughout the City. All of the recommendations included in the 2014 SWMP have been implemented to date.

The City retained BCC Engineering to update the 2014 SWMP. The primary objective of this SWMP update is to develop a new 5-year CIP. As part of the 5-year CIP, stormwater improvement projects were identified and ranked based on cost-effectiveness to address the current high priority water resource issues, flooding, and mitigate the sea-level and groundwater rise to the maximum extent possible for the climate change projected for the Year 2050 planning horizon. The current SWMP update Scope of Services was divided into the following key technical tasks:

Task 1 – Data Collection and Evaluation
Task 2 – Existing Conditions Hydrologic/Hydraulic Model Update
Task 3 – Identification and Ranking of Sub-basins
Task 4 – Sea Level and Groundwater Rise Assessment
Task 5 – Stormwater Improvement Project Formulation, Conceptual Design, and Ranking
Task 6 – Capital Improvement Plan Development

These tasks are further explained in the sub-sections below.

1.2 Data Collection and Evaluation

Data was collected from a wide range of sources to support the development of the SWMP. The main sources of information were from the following agencies and entities:

- City of Doral
- Miami-Dade County Regulatory and Economic Resources (RER)
- Other Sources:
    - South Florida Water Management District (SFWMD)
    - A&P Consulting Engineers (APCTE)
    - National Oceanic and Atmospheric Administration (NOAA)
    - National Resources Conservation Service (NRCS)
    - U.S. Army Corps of Engineers (USACE)
    - Federal Emergency Management Agency (FEMA) – National Flood Insurance Program
    - United States Geological Survey (USGS)
    - Southeast Florida Regional Climate Change Compact

The collected data was cataloged, evaluated, and utilized as needed to support the analyses and update the SWMP. The cataloged data is included in **Appendix A** for the City of Doral, **Appendix B** for Miami-Dade County, and **Appendix C** for other sources. The provided data, along with computational hydraulic modeling, provided sufficient information to update the City's SWMP and develop a new 5-year CIP.

1.3 Existing Conditions Hydrologic / Hydraulic Model Update

The 2014 SWMP update used a one-dimensional (1D) XP-SWMM H&H model to assess the flood protection level of service (FPLOS) within the City and to develop a 5-year CIP. The XP-SWMM model did not model the canals within and adjacent to the City with canal cross-sections. Instead, the model used time-stage boundary conditions from the Miami-Dade County regional modeling. This limits the ability to assess any canal deficiencies or impacts to the canal from proposed stormwater improvement projects. Also, modeling of the secondary positive drainage systems within the City was not included in the XP-SWMM model. As with the canal modeling approach, the deficiencies of the secondary system could not be assessed. Furthermore, being that the XP-SWMM model was a 1D model, to develop flood maps, a single elevation was used for each sub-basin. This approach tends to potentially under or overestimate the flooding in a given sub-basin.

For this SWMP update, a fully integrated one-dimensional (1D) and two-dimensional (2D) hydrologic/hydraulic model was developed for the entire City using the ICPRv4 model to better assess localized flooding conditions in areas having flat terrains. In addition, canals were modeled with available cross-sections, and secondary positive drainage systems (i.e., drainage inlets and storm pipes) were included in the model. Projects implemented as part of the 2014 SWMP 5-year CIP were also included in the model. The model boundary conditions were obtained from Miami-Dade County as part of their ongoing efforts in developing the Stormwater Master Plans for the C-4 and C-6 Canal basins.

Once the existing conditions ICPRv4 model was developed, the model was validated with the May 26, 2020 rainfall event which created significant flooding throughout the City. Flood maps were generated for this observed rainfall event. The validation flooding maps were presented to the City Public Works staff, and they concurred that flooding simulated with the model was in agreement with the City observations and documented flooding.

After validating the 1D/2D ICPRv4 model, the model was used to simulate existing flooding during the following design storm events:

- 5-year, 24-hour
- 10-year, 24-hour
- 25-year, 72-hour
- 100-year, 72-hour
- 250-year, 72-hour
- 500-year, 72-hour
- 1000-year, 72-hour

Flood and inundation maps were developed for each of these design storm event to represent the current flooding throughout the City based on current conditions. These maps are included in **Appendix I**.

1.4 Identification and Ranking of Sub-basins

After the 1D/2D ICPRv4 model was completed and the resulting data was compiled, the City's problem areas were ranked using a refined version of the scoring methodology used as part of the 2014 SWMP update. The refined scoring methodology includes ranking sub-basins by establishing a Flood Protection Severity Score (FPSS). The FPSS is derived by scoring the results of four (4) Flooding Severity Indicators, weighting factor (WF) for applicable flooding severity indicators, and an exceedance factor (E) for each indicator. The flooding indicator and weighting factors were derived in coordination with City's Public Work staff.

The Flooding Severity Indicators are summarized as follows:

1. **NS:** Number of structures flooded by the 100-year flood, which can include commercial, residential, and public buildings. All structures and/or buildings were considered equivalent, regardless of their size or value. **(WF = 6)**

2. **MER:** Miles of principal arterial roads, including major evacuation routes, which were impassable during the 100-year flood. A principal arterial road is considered impassable if the depth of flooding exceeds 8 inches above the crown of the road during the 100-year design event. **(WF = 5)**

3. **MER10:** Miles of principal arterial roads, including major evacuation routes, with roadway flooding during the 10-year event. **(WF = 4)**

4. **MCLRS:** Miles of collector and local residential streets impassable during a 5-year flood. collector and local residential streets are considered impassable if the depth of flooding exceeds the crown of the road during the 5-year design storm event. **(WF = 3)**

The severity indicators are rated by an exceedance (E) value pursuant to the following score listed in the table below for all values.

Depth of Flooding Above the FPLOS	E
Less than or equal to 6 inches	1
Greater than 6 inches and less than or equal to 12 inches	2
Greater than 12 inches	3

Given the definitions for the flooding severity indicators (NS, DEM, MER, MER10, and MCLRS), WF, and E, the FPSS for each sub-basin were calculated using the following formula, where $E_{(i)}$ through $E_{(v)}$ relates to the degree of exceedance for each of the applicable severity indicators.

$$\mathbf{FPSS} = [4 \times E_{(i)} \times NS] + [4 \times E_{(iii)} \times MER] + [4 \times E_{(iv)} \times MER10] + [2 \times E_{(v)} \times MCLRS]$$

The FPSS value was then divided by the area of the sub-basin to normalize the score for all sub-basins. The sub-basin delineation was further refined to include permitted name changes (from H5 to H8 and from H8 to H-8-1) and boundary delineations as described in **Section 5.4**. **Table 1-1** lists the results of the ranking for the top 20 City sub-basins based on the value of the existing condition weighted FPSS Score, and **Figure 1-2** shows the location of these top 20 City sub-basins.

Table 1-1 – FPSS Baseline Model Scenario Ranking

Sub-Basin	Sub-Basin Area (Acres)	FPSS	RANK	WEIGHTED FPSS	RANK
H-7	172.13	11205.34	1	65.10	1
F-1	78.08	3533.54	2	45.25	2
NW 102AVE	34.18	1336.13	6	39.09	3
NW 33 St	8.36	265.84	48	31.80	4
D-3-1	54.96	394.38	24	31.10	5
D-4-2	79.99	1061.32	12	28.14	6
D-1-1	17.97	463.83	20	25.81	7
H-8	67.88	1599.57	4	23.56	8
NW 52 ST W	16.69	285.20	28	17.09	9
F-5	76.91	1203.25	7	15.64	10
NW-114AVE	37.79	441.48	22	11.68	11
H-8-1	116.44	1157.82	9	9.94	12
G-4	121.64	1085.08	11	8.92	13
G-1	199.44	1543.48	5	7.74	14
D-5	167.89	1203.10	8	7.17	15
E-1	76.37	466.89	19	6.11	16
D-2-1	14.07	85.32	34	6.06	17
E-7	16.00	91.02	33	5.69	18
C-5	159.98	869.90	14	5.44	19
O-1	347.34	2647.38	3	5.10	20

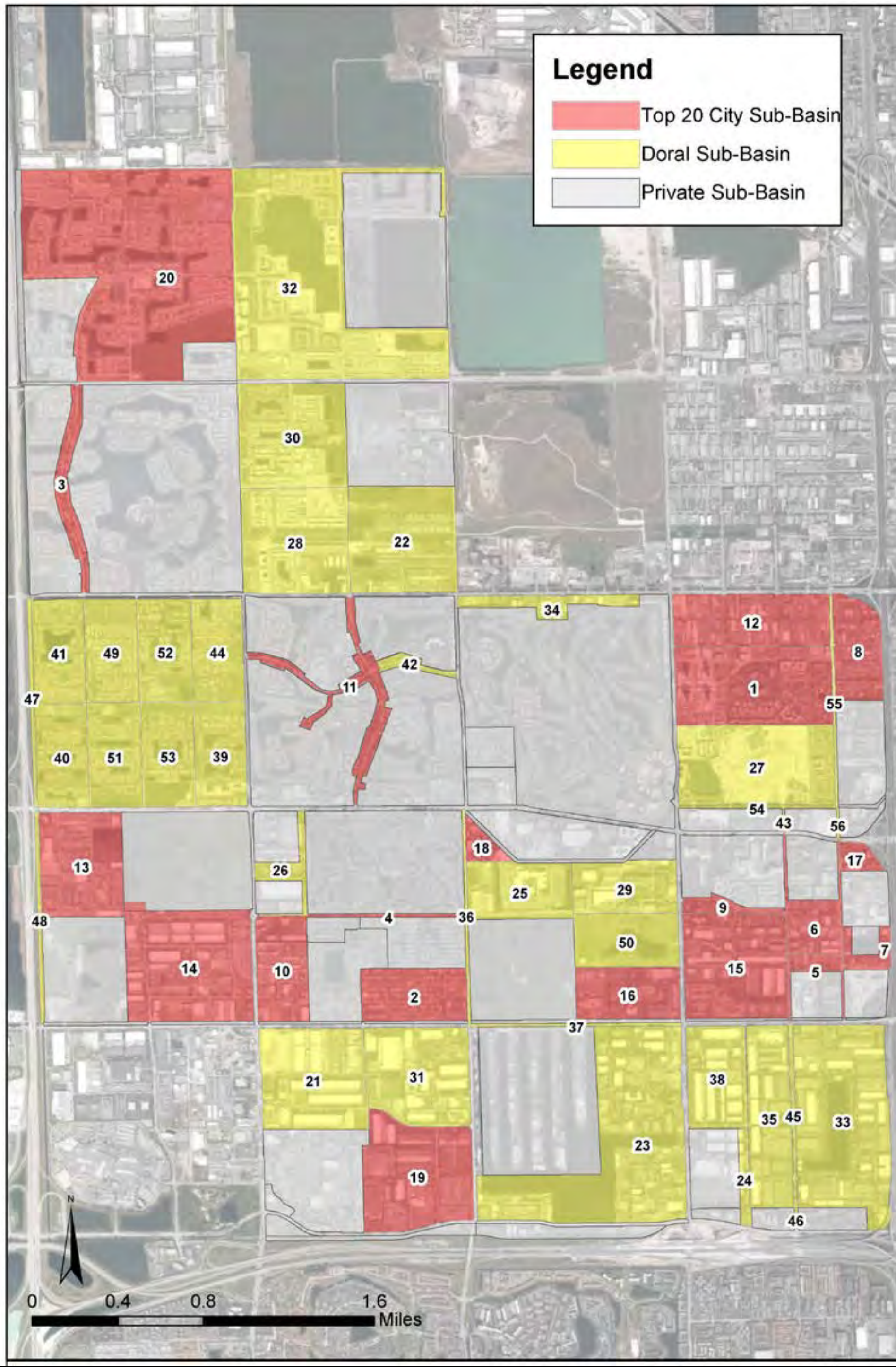


Figure 1-2 – Location of Ranking Top 20 City Sub-Basins

1.5 Sea Level and Groundwater Rise Assessment

The purpose of this task was to evaluate the potential impacts of sea-level rise (SLR), groundwater rise, and rainfall amount increase to the flood protection level of service of the City. The Southeast Florida Regional Climate Change Compact (the Compact) published in 2019 the latest Unified Sea Level Rise Projections for Southeast Florida for various planning horizons. The Unified Sea Level Rise Projections contains three global curves adapted for regional application – See **Figure 1-3**.

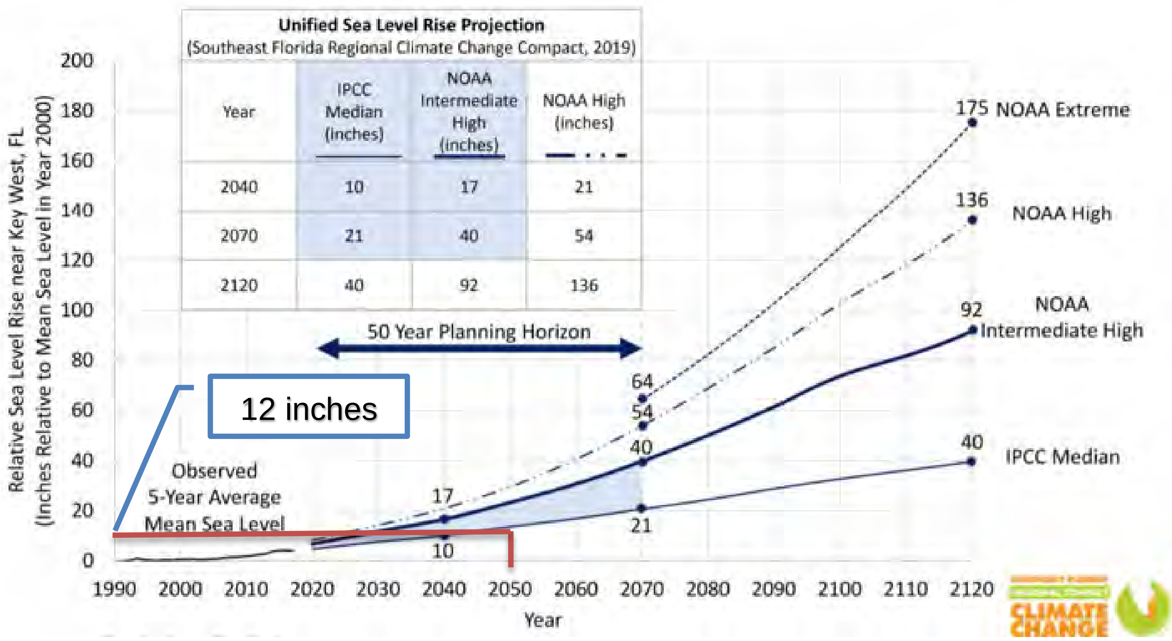


Figure 1-3 – Unified Sea Level Rise Projections for Southeast Florida (2019)

In coordination with the City, it was agreed that the planning horizon for this study should be the Year 2050. It was also agreed that the low-end value (12 inches) of the NOAA curve should be used to account for future sea-level rise impacts, as depicted in **Figure 1-3**. A seasonal high groundwater table (SHGWT) elevation of 2.75 feet relative to the North America Vertical Datum of 1988 (ft-NAVD88) was implemented for the entire City for the 2050 planning horizon. According to the information presented and in coordination with the City, it was determined that a groundwater elevation of 2.75 ft-NAVD88 should be implemented for the entire City for the 2050 planning horizon. This increase of 0.25 ft correlates with the lower end of the 2019 projections for the low range and groundwater increase projections summarized in the *City of Doral Stormwater Vulnerability Assessment Study, 2020*. Finally, it was also agreed that a rainfall increase of 5 percent should be used for the entire City due to uncertainty in data indicating that rainfall intensities are increasing.

The existing conditions model developed as described in **Section 1.3** was revised to reflect the changes associated with the projected higher sea-level rise, groundwater rise, and rainfall increase. The revised model was run the following design storm events:

- 5-year, 24-hour
- 10-year, 24-hour
- 25-year, 72-hour
- 100-year, 72-hour
- 250-year, 72-hour

- 500-year, 72-hour
- 1000-year, 72-hour

Flood inundation maps were developed for each of these design storm events to represent the flooding throughout the City at the year 2050 conditions. These maps are included in **Appendix R**. The FPSS score was also computed for all sub-basins for the Year 2050 projections. **Table 1-2** shows the existing condition FPSS score, the Year 2050 FPSS score, and the difference.

The sub-basins were re-ranking based on the Year 2050 FPSS. A new ranking map was developed, which is shown in **Figure 1-4**. The City requested a combined map, which was revised and re-ranked by the City, according to their knowledge of the City and areas of high priority. This revised re-ranking map is shown in **Figure 1-5**. The combined map was used to propose the stormwater improvement projects for the top 20 ranked City sub-basins.

Table 1-2 – FPSS Combined Ranking

SUB-BASIN	SUB-BASIN AREA (AC)	RANK CITY MODIFIED	EXISTING WEIGHTED FPSS	WEIGHTED FPSS SLR	DIFFERENCE FROM EXISTING
H-8	67.88	1	23.56	25.17	1.61
F-1	78.08	2	45.25	51.95	6.7
H-7	172.13	3	65.10	194.96	129.86
H-8-1	116.44	4	9.94	14.39	4.45
D-3-1	18.22	5	31.10	21.97	-9.13
D-4-2	47.81	6	28.14	38.19	10.05
NW 33 St	8.36	7	31.80	1.92	-29.88
D-1-1	17.97	8	25.81	29.84	4.03
33rd St	16.48	9	24.33	20.50	-3.83
F-5	76.91	10	15.64	28.46	12.82
NW 52 ST W	50.81	11	17.09	56.83	39.74
NW-114AVE	37.79	12	11.68	26.76	15.08
G-4	121.64	13	8.92	10.56	1.64
G-1	199.44	14	7.74	11.38	3.64
H-79AVE-N	8.59	15	0.57	0.64	0.07
H-79AVE-S	1.30	16	0.40	0.38	-0.02
D-2-1	14.07	17	6.06	6.61	0.55
E-7	16.00	18	5.69	9.81	4.12
C-5	159.98	19	5.44	9.08	3.64
O-1	518.79	20	5.10	15.11	10.01

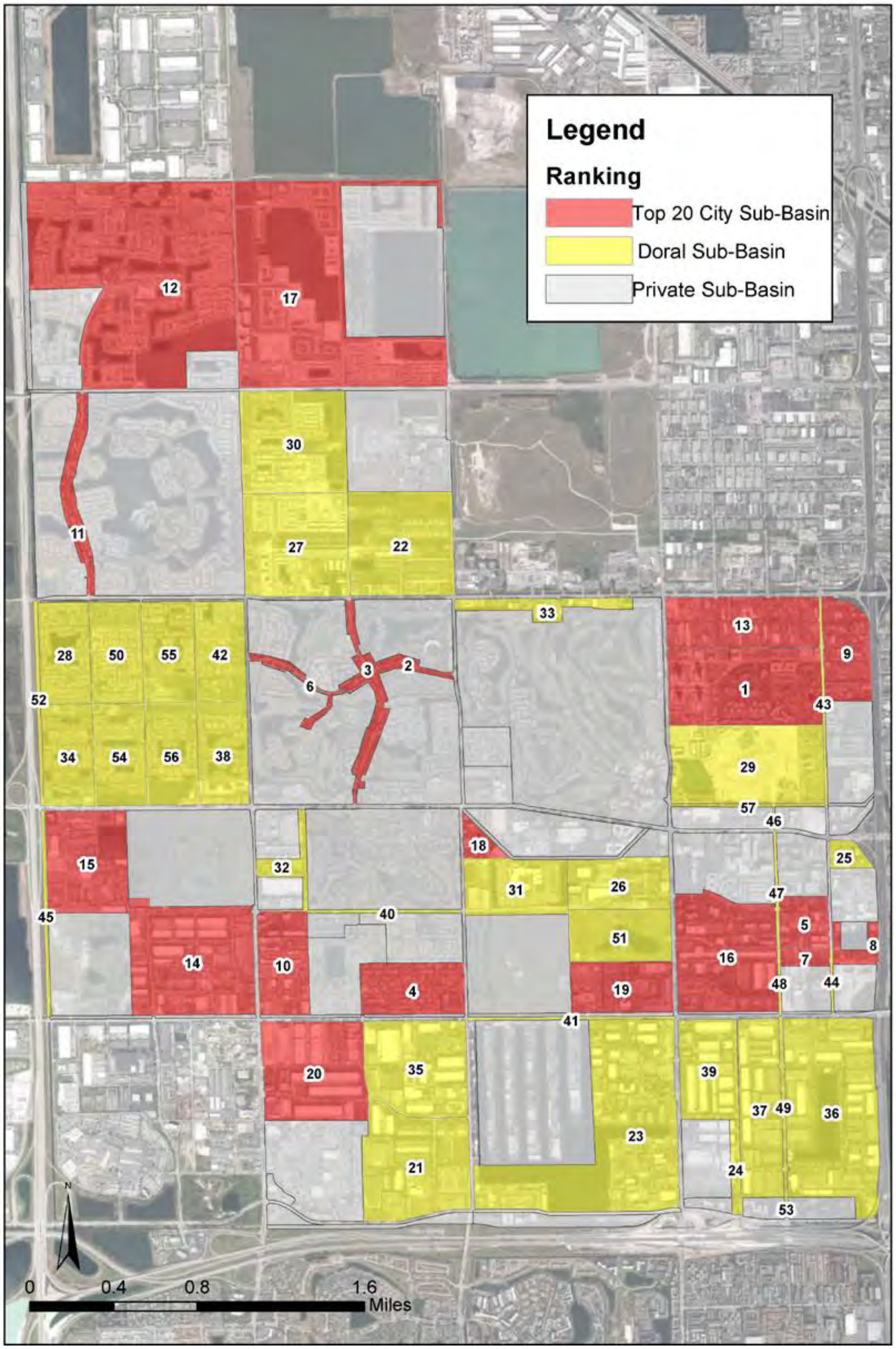


Figure 1-4 – Location of Top 20 City Sub-Basin Ranking with the Year 2050 Projections

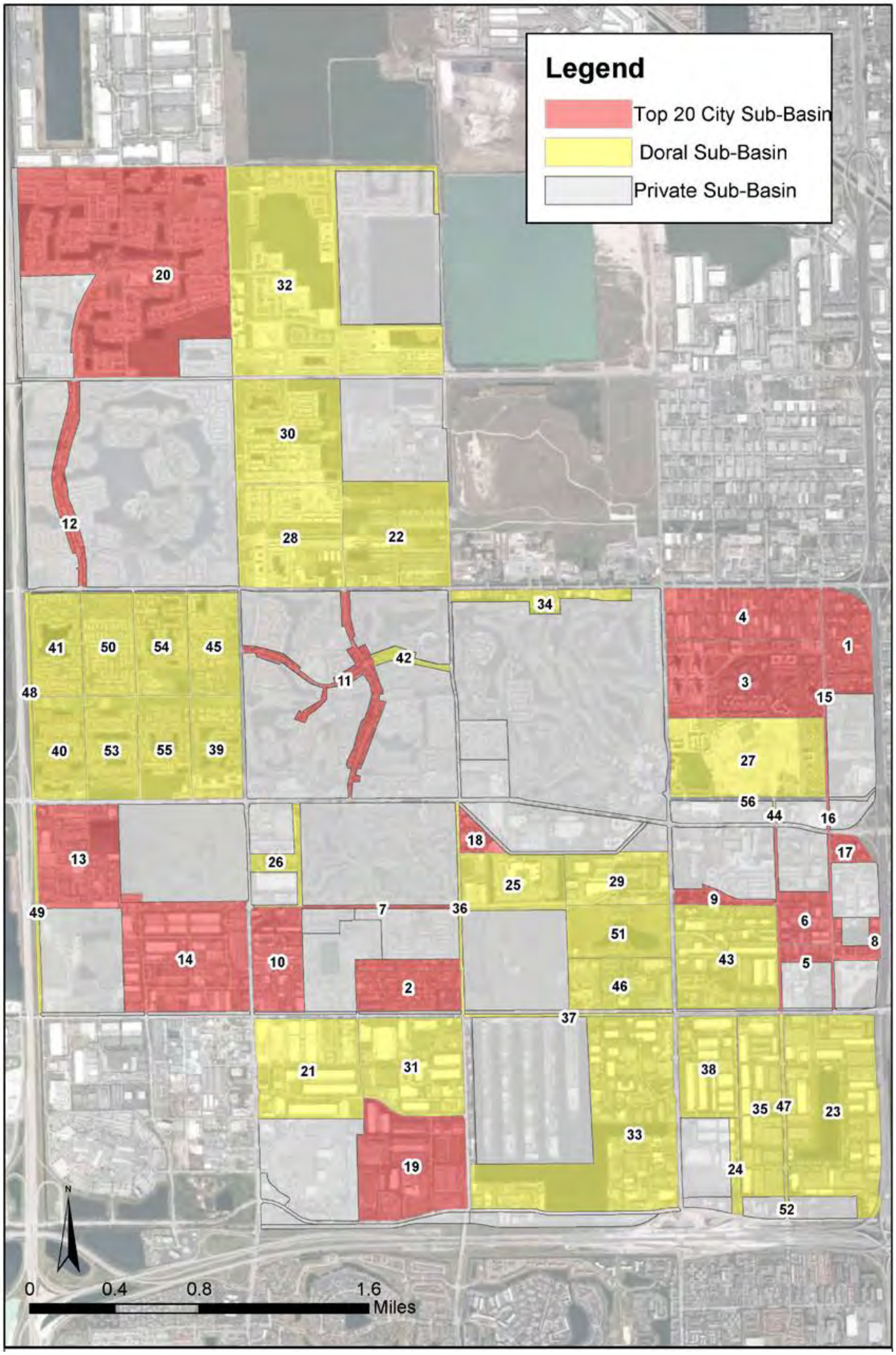


Figure 1-5 – Location of Top 20 Ranked City Sub-Basin Combined

1.6 Stormwater Improvement Project Formulation, Conceptual Design, and Ranking

The purpose of this task was to formulate and evaluate up to 20 stormwater management improvement projects and prepare conceptual designs to address the top-ranked sub-basins identified in **Table 1-2**. The following stormwater best management practices were considered in formulating the stormwater improvement projects:

- Positive drainage with outfalls
- Exfiltration trenches with interconnections with existing drainage systems
- Stormwater pump stations
- Dry retention ponds and off-line storage areas
- Low Impact Development (LID) best management practices (BMPs)
- Raising roads
- Wet and dry floodproofing

Based on discussion with Miami-Dade County, they are not allowing new outfalls or pump stations discharges to the canals within and in the vicinity of the City because these canals are at capacity. One exception is the outfall currently being design and permitted by the City to address flooding issues at the northeast end of the City, along NW 79th Avenue. This outfall was incorporated in the Year 2050 model as part of other proposed projects in this portion of the City. The County stated that they might allow a pump station to address the flooding in the Vanderbilt Area (Sub-basin F1). However, the County would need to evaluate if the Northline Canal will be able to handle that additional flow. The County stated that it would take several years before they would complete the evaluation. A stormwater pump station was added and evaluated in the Vanderbilt Area, but it did not provide major flood protection improvements because this area is mostly treated with exfiltration trenches which limits the pump on elevation to the SHGWT elevation of 2.75 ft-NAVD88.

Several areas and open parcels were identified throughout the City to potentially be used for dry retention ponds and off-line storage areas. Given the limited availability and cost of land within the City's flood-prone areas, these types of stormwater management systems would be costly and determined not to be viable compared to exfiltration trench systems. In addition, these tracks of lands will also be taken off the City's tax rolls, reducing tax revenue to the City. However, these areas could be evaluated in the future, if and when it becomes cost-effective to purchase these land parcels for flood mitigation.

LID BMPs mainly mitigate low rainfall events and improve the quality of stormwater discharges. In addition, locating and sizing these types of BMPs will require extensive project-specific information. Therefore, these BMPs were not evaluated as part of the regional hydrologic/hydraulic assessment performed as part of this SWMP. During the design phase of the conceptual design projects, opportunities should be evaluated to implement as many of the LID BMPs outlined in the City's Low Impact Development Stormwater Master Plan.

When roadway flooding cannot be mitigated via the stormwater management systems outlined above, one alternative is to raise the roads. However, this alternative sometimes becomes costly and requires in-depth harmonization assessment to ensure access to residents or business are not impacted. Therefore, raising roads should be considered and evaluated for roadway widening projects or for new road construction. For new roadway projects, the flood elevations outlined in this SWMP for the 2050 sea level and groundwater rise conditions should be used in establishing the minimum roadway elevation.

For older buildings constructed below the latest FEMA flood elevations, it is not feasible to raise buildings' finish floor elevations to the FEMA flood elevations. For these buildings, floodproofing techniques can be applied. Floodproofing applications follow all the latest flood codes and regulations enforced by the NFIP, FEMA, and local ordinances. Viable floodproofing techniques include wet floodproofing and dry floodproofing with passive and active components. The City should consider these types of BMPs when retrofitting City facilities that are below the FEMA flood elevations.

With the limitation of the stormwater management BMPs outlined above, this left implementing exfiltration trench systems for the stormwater improvement projects. When possible, the proposed exfiltration trench systems were interconnected with existing drainage systems to provide redundancy. In some cases, order exfiltration drainage systems were replaced with new exfiltration trench systems at the interconnection points. Conceptual designs were developed for the top 20 City high-priority Sub-Basin included in **Table 1-2**. The conceptual designs for each sub-basin are included in **Appendix T**.

The Year 2050 model developed as described in **Section 1.5** was revised to incorporate the top 20 high-priority City Sub-Basin stormwater improvement projects. The revised model was run the following design storm events:

- 5-year, 24-hour
- 10-year, 24-hour
- 25-year, 72-hour
- 100-year, 72-hour
- 250-year, 72-hour
- 500-year, 72-hour
- 1000-year, 72-hour

Flood inundation maps were developed for each of these design storm events to represent the flooding improvement at the Year 2050 conditions. These maps are included in **Appendix P**. The FPSS score was also computed for all sub-basins for the Year 2050 projections with projects. **Table 1-3** shows the existing condition FPSS score, the Year 2050 FPSS score, and the Year 2050 conditions with projects. Based on the reduction in FPSS, the proposed stormwater improvement projects will not be able to mitigate the entire flooding conditions because the City, throughout the years, has maximized the implementation of exfiltration trenches. In addition, the projected 2050 higher SHGWT elevation limits the capacity of the existing and any future exfiltration trench systems. However, the projects warrant implementation due to the net flood protection and water quality benefits they will provide.

Planning-level cost estimates were then developed for each project based on the Florida Department of Transportation (FDOT) cost databases, costs from recent projects constructed within the City, and BCC's construction cost databases. The project costs are included in **Table 1-3**. These costs should be further refined during the final design and permitting phases of the capital improvement plan implementation process.

To prioritize projects, the capital improvements for each sub-basin were ranked based on the cost per FPSS area-weighted reduction, as depicted in **Table 1-3** and **Figure 1-6**. In other words, the Problem Areas are ranked in order from the least expensive to improve FPSS by one point to the most expensive to improve FPSS by one point.

Table 1-3 – Capital Improvement Project Planning-Level Cost Estimate

BASIN RANKING - CITY MODIFIED	COST EFFECTIVENESS RANKING	APPROX. TOTAL COST PROJECT	EXISTING WEIGHTED FPSS	WEIGHTED FPSS SLR	NEW WEIGHTED FPSS WITH IMPROVEMENT PROJECTS	COST PER % REDUCTION FPSS
F-1 with PS	NA	$ 8,225,582.00	NA	NA		
NW 33 ST W	1	$ 301,645.14	24.33	20.50	20.50	$ 20
D-1-1	2	$ 165,360.97	25.81	29.84	29.83	$ 43
E-7	3	$ 515,181.63	5.69	9.81	9.81	$ 56
D-2-1	4	$ 204,138.38	6.06	6.61	6.61	$ 77
D-4-2	5	$ 937,994.33	28.14	38.19	38.18	$ 248
D-3-1	6	$ 421,231.74	31.10	21.97	21.96	$ 375
H-8	7	$ 645,402.70	23.56	25.17	25.12	$ 1,346
H-79AVE-S	8	$ 253,849.67	0.40	0.38	0.37	$ 3,099
NW 33 ST	9	$ 823,837.44	31.80	1.92	1.91	$ 4,093
C-5	10	$ 1,570,433.93	5.44	9.08	9.04	$ 7,340
F-1 No PS	11	$ 2,345,582.00	45.25	51.95	51.79	$ 7,451
F-5	12	$ 826,550.60	15.64	28.46	28.14	$ 9,316
NW 52 ST W	13	$ 1,488,362.73	17.09	56.83	55.41	$ 37,115
NW 114 AVE	14	$ 1,107,908.26	11.68	26.76	25.65	$ 46,015
G-4	15	$ 2,095,009.55	8.92	10.56	10.20	$ 73,135
H-8-1	16	$ 2,347,477.31	9.94	14.39	13.80	$ 97,117
H-79AVE-N	17	$ 417,610.88	0.57	0.64	0.48	$ 106,432
H-7	18	$ 2,781,300.98	65.10	194.96	161.11	$ 482,976
G-1	19	$ 3,692,714.23	7.74	11.38	9.73	$ 533,885
O-1	20	$ 12,011,203.06	5.10	15.11	14.38	$ 580,612
TOTAL no Pump Station (PS)		$ 34,952,795.52				

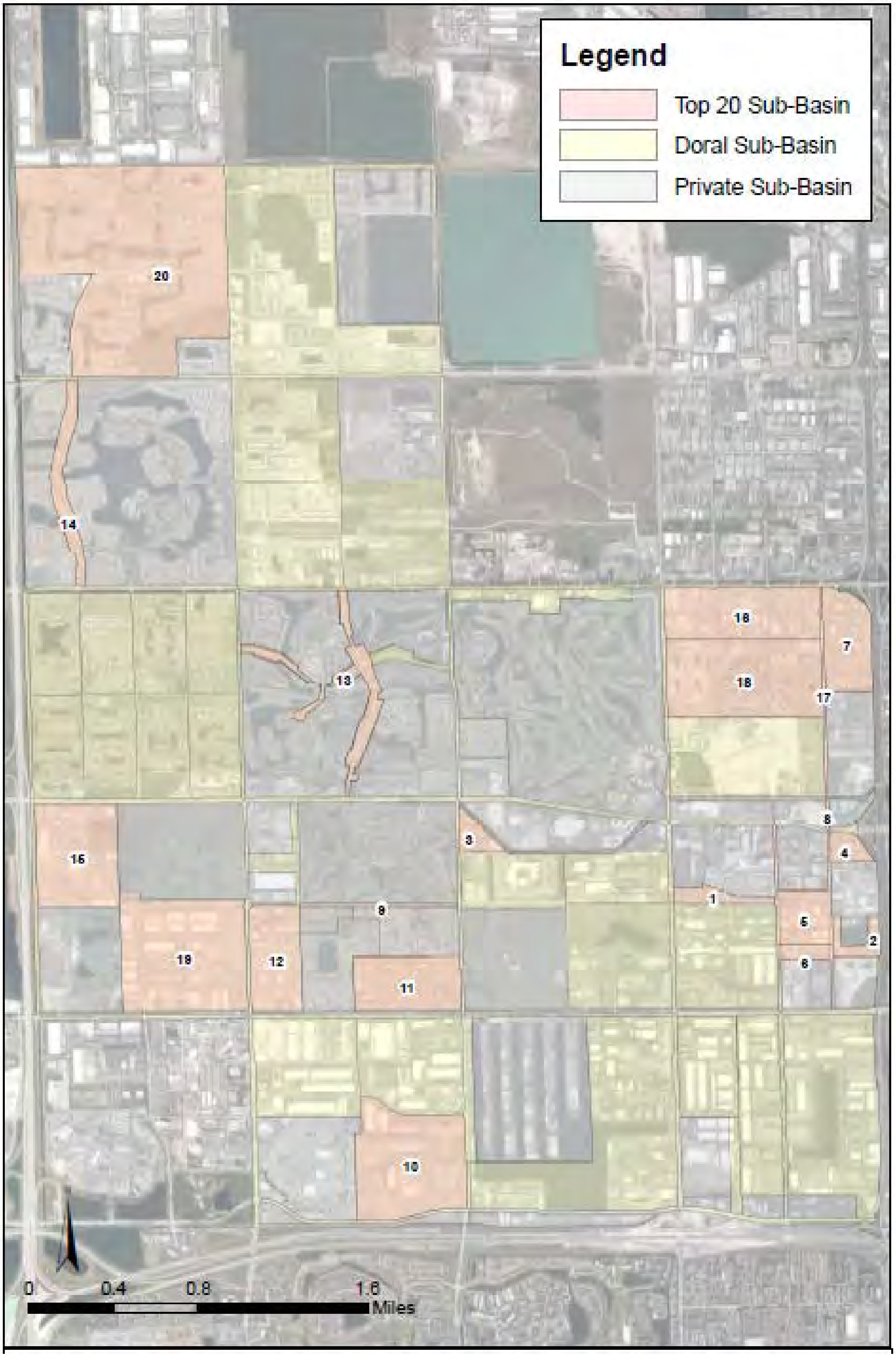


Figure 1-6 – Cost Effectiveness Rank

1.7 Capital Improvement Plan Development

Considering the top 20 City Sub-Basin prioritized and ranked by cost-effectiveness as shown in **Table 1-3,** and the proposed stormwater improvement projects, BCC and the City further refined the implementation plan into the 5-year Capital Improvement Plan (CIP). The CIP takes into consideration the estimated yearly budgetary allocations for stormwater improvement projects for the City. The City's annual budget is approximately $2 Million for stormwater improvement projects, and to maximize available funds, the City has started implementing an alternating CIP that includes one-year designing and the following year constructing the projects. In order to have some options for the CIP implementation, BCC, in coordination with the City, identified three (3) alternatives for implementing stormwater improvement projects:

- **Alternative 1**: the proposed annual projects for the next 5 years will be implemented based on the Cost-Effectiveness and the Maximum Annual Benefit as shown in **Table 1-4**
- **Alternative 2**: the proposed annual projects for the next 5 years will be implemented based on the Basin Severity Score and the Maximum Annual Budget as shown in **Table 1-5**
- **Alternative 3**: this is a hybrid option where the proposed annual projects for the next 5 years will be implemented based on a combination of cost-effectiveness, basin severity score, available funding, and coordination with other CIP roadway and/or utility projects, as shown in **Table 1-6**

Table 1-4 – Alternative 1 CIP Proposed Project Order (Cost-Effectiveness)

COST-EFFECTIVENESS	COST EFFECTIVENESS RANK	SLR BASIN RANK	SUB-BASIN NAME	ESTIMATED PROJECT COST
Year 1	1	9	NW 33 ST W	$301,645.14
	2	8	D-1-1	$165,360.97
	3	18	E-7	$515,181.63
	4	17	D-2-1	$204,138.38
	5	6	D-4-2	$937,994.33
SUBTOTAL YEAR 1				***$2,124,320.45***
Year 2	6	5	D-3-1	$421,231.74
	7	1	H-8	$645,402.70
	8	16	H-79AVE-S	$253,849.67
	9	7	NW 33 St	$823,837.44
SUBTOTAL YEAR 2				***$2,144,321.54***
Year 3	10	19	C-5	$1,570,433.93
	17	15	H-79AVE-N	$417,610.88
SUBTOTAL YEAR 3				***$1,988,044.81***

COST-EFFECTIVENESS	COST EFFECTIVENESS RANK	SLR BASIN RANK	SUB-BASIN NAME	ESTIMATED PROJECT COST
Year 4	11	2	F-1 No PS	$2,345,582.00
SUBTOTAL YEAR 4				***$2,345,582.00***
Year 5	12	10	F-5	$826,550.60
	14	12	NW 114 AVE	$1,107,908.26
SUBTOTAL YEAR 5				***$1,934,458.86***
TOTAL				**$10,536,727.66**

Table 1-5 – Alternative 2 CIP Proposed Project Order (Basin Ranking)

FISCAL YEAR	SLR BASIN RANK	COST RANK	SUB-BASIN NAME	ESTIMATED PROJECT COST
Year 1	1	7	H-8	$645,402.70
	5	6	D-3-1	$421,231.74
	6	5	D-4-2	$937,994.33
SUBTOTAL YEAR 1				***$2,004,628.76***
Year 2	2	11	F-1 No PS	$2,345,582.00
SUBTOTAL YEAR 2				***$2,345,582.00***
Year 3	4	16	H-8-1	$2,347,477.31
SUBTOTAL YEAR 3				***$2,347,477.31***
Year 4	7	9	NW 33 St	$823,837.44
	8	2	D-1-1	$165,360.97
	9	1	NW 33 ST W	$301,645.14
	10	12	F-5	$826,550.60
SUBTOTAL YEAR 4				***$2,117,394.15***
Year 5	12	14	NW 114 AVE	$1,107,908.26
	15	17	H-79AVE-N	$417,610.88
	16	8	H-79AVE-S	$253,849.67
	17	4	D-2-1	$204,138.38
SUBTOTAL YEAR 5				***$1,983,507.19***
TOTAL				**$10,798,589.42**

Table 1-6 – Alternative 3 CIP Proposed Project Order (Hybrid)

FISCAL YEAR	HYBRID RANK	COST RANK	SUB-BASIN NAME	ESTIMATED PROJECT COST
Year 1	1	7	H-8	$645,402.70
	5	6	D-3-1	$421,231.74
	9	1	NW 33 ST W	$301,645.14
	8	2	D-1-1	$165,360.97
	15	17	H-79AVE-N	$417,610.88
SUBTOTAL YEAR 1				***$1,951,251.42***
Year 2	6	5	D-4-2	$937,994.33
	7	9	NW 33 St	$823,837.44
	16	8	H-79AVE-S	$253,849.67
SUBTOTAL YEAR 2				***$2,015,681.44***
Year 3	2	11	F-1 No PS	$2,345,582.00
SUBTOTAL YEAR 3				***$2,345,582.00***
Year 4	10	12	F-5	$826,550.60
	12	14	NW 114 AVE	$1,107,908.26
	17	4	D-2-1	$204,138.38
SUBTOTAL YEAR 4				***$2,138,597.24***
Year 5	4	16	H-8-1	$2,347,477.31
SUBTOTAL YEAR 5				***$2,347,477.31***
TOTAL				**$10,798,589.42**

These lists do not commit the City to allocate or expend the estimated amounts within the 5-year period. The SWMP serves to guide the City in locating potential projects and correlating potential projects which simulated real-world events. A further detailed analysis will be required to refine the information presented in this SWMP. Additionally, more projects may be added to the 5-year CIP plan if more funding is allocated to these types of projects or if these projects can be combined with other types of Capital Improvement projects.

2.0 INTRODUCTION

2.1 Background

The City of Doral (City) was incorporated in 2003 and is located geographically in the west-central portion of Miami-Dade County. The City is roughly bounded by NW 90th Street to the north, the Florida Turnpike to the west, State Road 836 (Dolphin Expressway) to the south, and State Road 826 (Palmetto Expressway) to the east – see **Figure 2-1.** In its entirety, the City encompasses a total area of approximately 15.1 square miles.

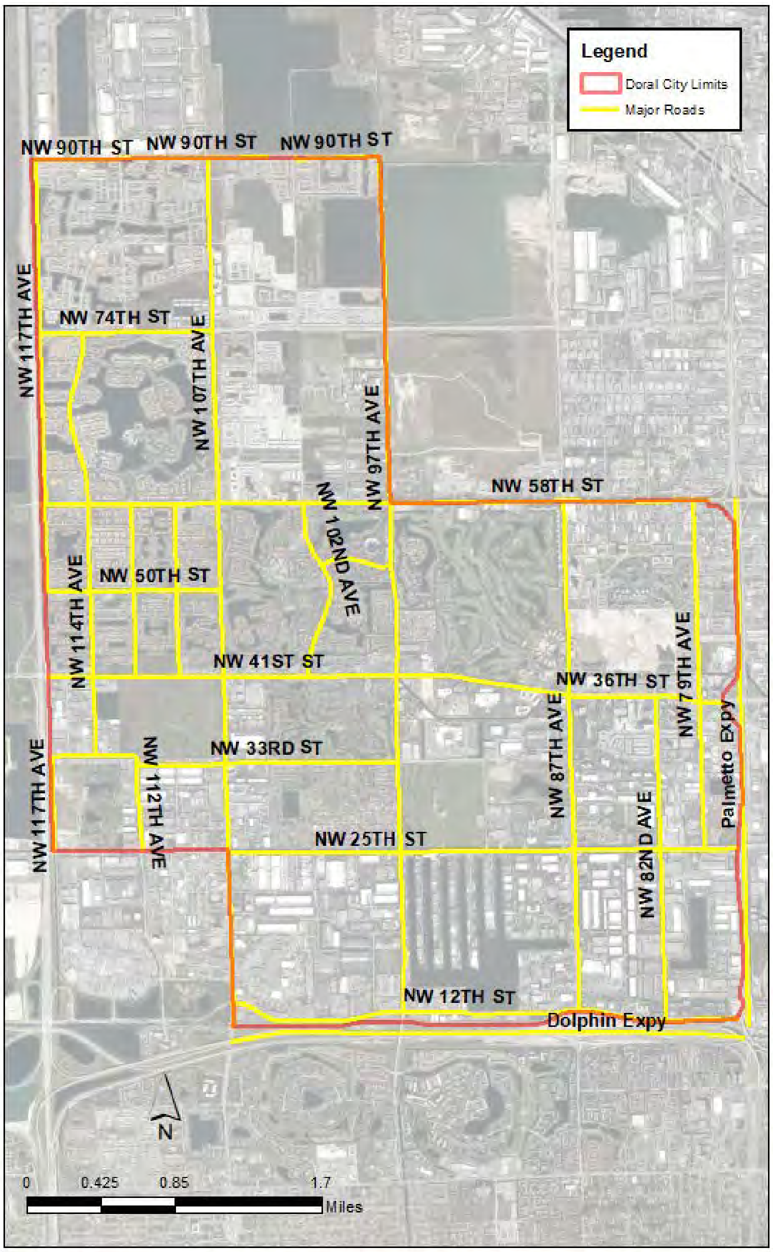


Figure 2-1 – City of Doral Limits and Major Roads

The City's residential, mixed-use, and commercial/industrial land uses account for approximately 88% of the City's total area. This information is based on the current Miami-Dade County Geographic Information System (GIS) land use shapefile, which was obtained from the County's available online sources. **Table 2-1** summarizes the existing land use distribution within the City.

Table 2-1 – Land Use Distribution within the City of Doral

LAND USE	AREA (SQ.MI.)	% OF CITY
AGRICULTURE	0.46	3.06
Cemeteries	0.20	1.30
Communications, Utilities, Terminals, Plants	0.94	6.20
Expressway Right of Way Open Areas	0.09	0.60
Industrial	2.40	15.86
Industrial Extraction	0.21	1.39
Institutional	0.26	1.71
Low-Density Multi-Family	0.38	2.50
Multi-Family, Migrant Camps	0.06	0.43
Office	0.60	3.99
Parks (Including Preserves & Conservation)	1.47	9.73
Shopping Centers, Commercial, Stadiums, Tracks	0.63	4.19
Single-Family	0.72	4.79
Streets/Roads, Expressways, Ramps	1.72	11.38
Streets/Roads/Canals R/W	0.04	0.25
Townhouses	0.32	2.09
Transient-Residential (Hotels/Motels)	0.14	0.95
Two-Family (Duplexes)	0.00	0.01
Vacant Unprotected	2.86	18.93
Vacant, Government Owned	0.15	1.01
Water	1.45	9.57
Void	0.01	0.07
Total	**15.1**	**100.0**

The City falls within the boundaries of the South Florida Water Management District (SFWMD) C-4 and C-6 Basins – see **Figure 2-2.** These basins are drained by the C-4 and C-6 canals, which are both classified as primary canal systems by the SFWMD. More specifically, both canals primarily flow south-easterly from the Everglades Water Conservation Area (WCA) 3B in the west prior to discharging into Biscayne Bay to the south-east. In addition to these canals, there are three (3) secondary canals that receive rainfall runoff from the City, including:

- C-2 Extension Canal (Snapper Creek Canal) which typically flows north to south along with the western bounds of the City;
- Northline Canal located immediately north of 25th Street, which flows towards and discharges into the C-4 Canal; and
- Dressels Dairy Canal, which drains towards and into the C-6 Canal.

These canals are owned, operated by Miami-Dade County. The City of Doral and Miami-Dade County also maintain the secondary canals within the Doral jurisdiction. **Figure 2-2** shows the location and extent of these canal systems.

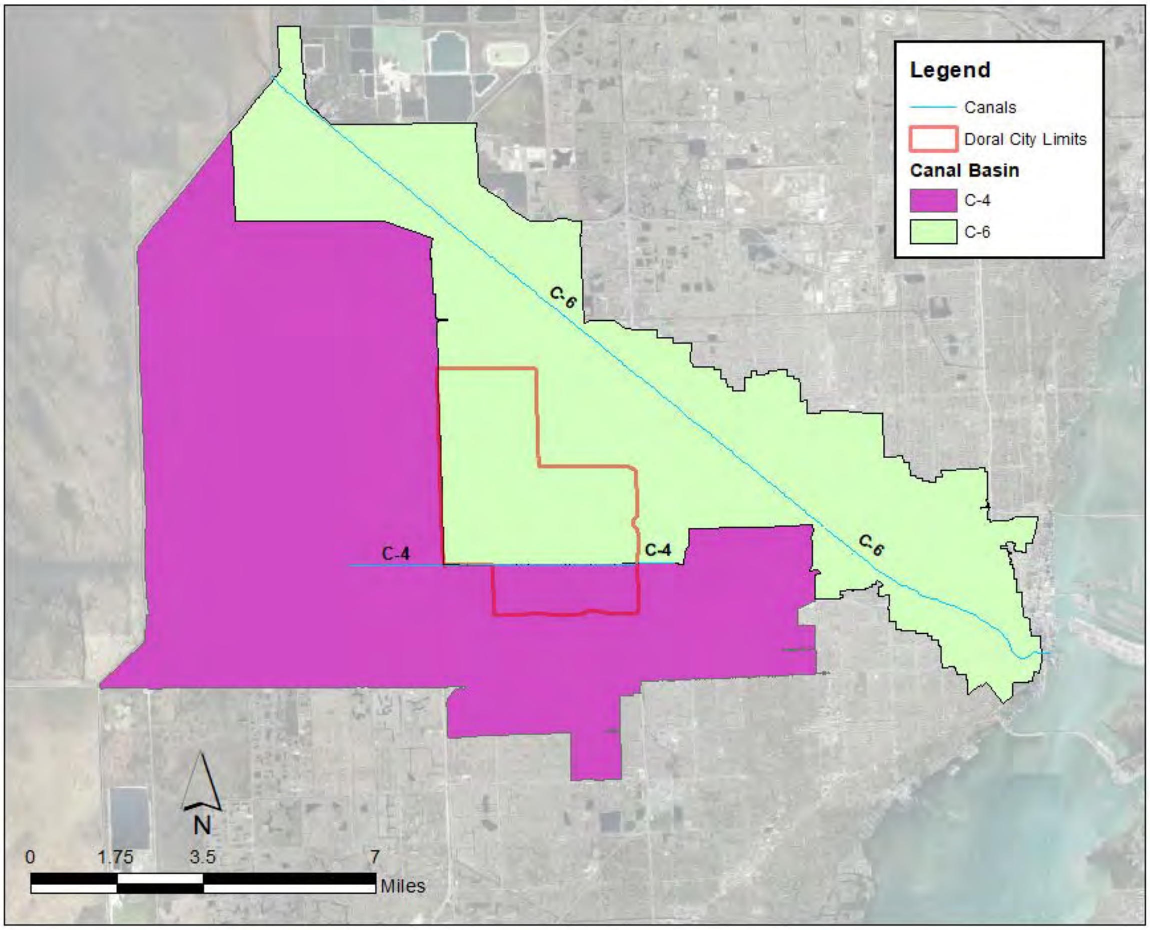


Figure 2-2 – SFWMD Canal Basins & City of Doral Limits

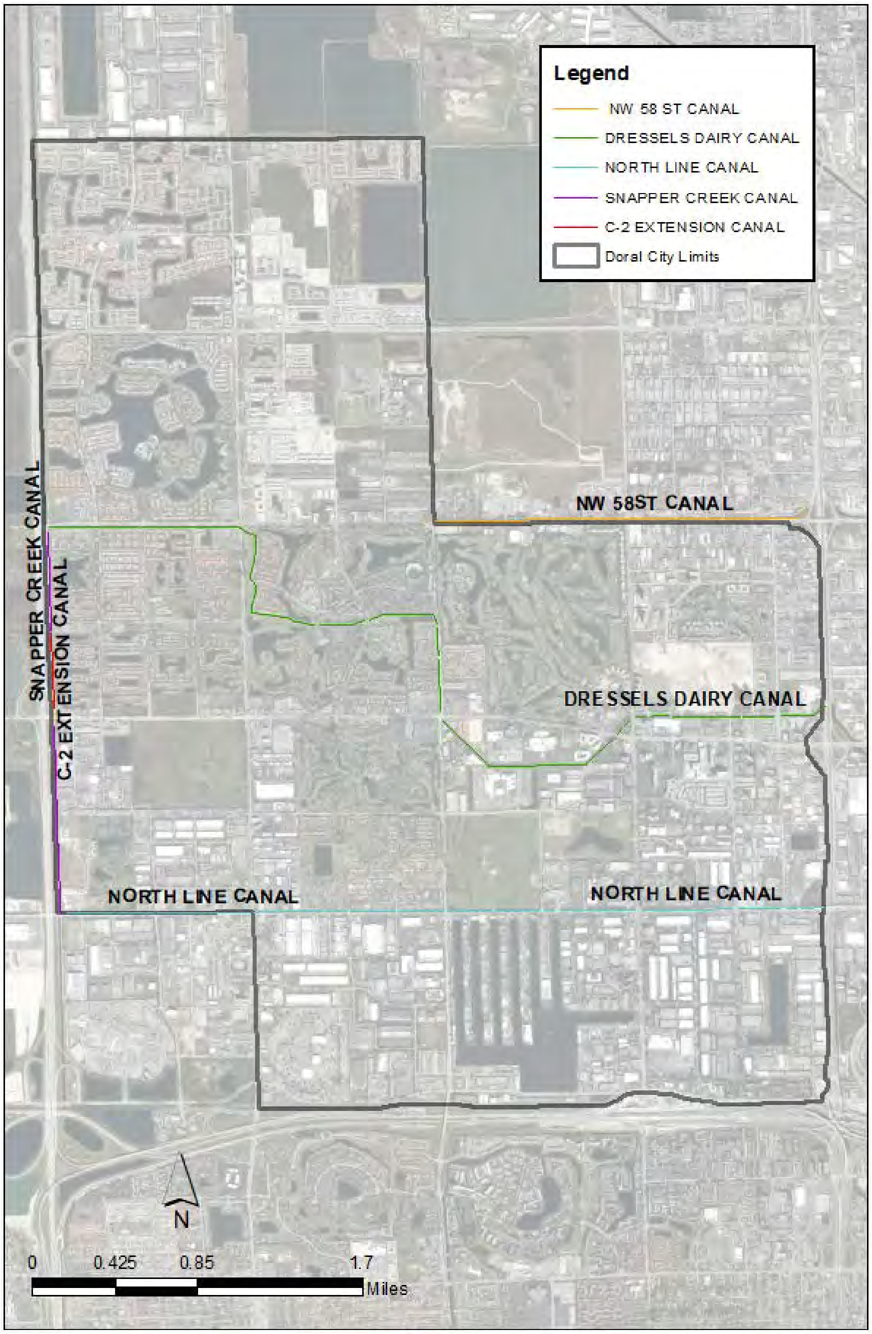


Figure 2-3 – Canals within the City of Doral

The issues related to both the C-4 and C-6 Canal basins, as well as the major conveyance systems associated with these canals and drainage basins, are well documented in the C-4 and C-6 Canal Basin Stormwater Master Plans prepared by Miami-Dade County. The documented issues include flooding of low-lying areas, over-development leading to an increase in rainfall-runoff, and undersized or non-existing drainage systems in need of improvement or construction, respectively. The City of Doral also shares these same issues that were identified in the C-4 and C-6 Canal Basin Stormwater Master Plans. In addition, sea level and groundwater rise are impacting the available soil storage and conveyance capacity of the City's existing drainage systems. These conditions will further affect the ability of the City to discharge to the gravity system of the canals effectively. The Southeast Florida Regional Compact is also predicting that these conditions are going to continue to worsen based on the recently published 2019 sea-level rise projections.

The City prepared its first Stormwater Master Plan (SWMP) in 2006, which consisted of two (2) phases. The first phase focused on the collection of existing information from non-City entities, development of basin and sub-basin delineations within the City, and prioritization of identified stormwater management problems. In turn, Phase II focused on the development of an XP-SWMM hydrologic, hydraulic, and water quality planning model to simulate the City's existing and future stormwater management conditions. As part of this effort, proposed stormwater management improvements to the existing systems were identified and prioritized to address existing drainage deficiencies.

In 2009, the SWMP was updated to revise the City's stormwater Capital Improvement Plan (CIP) developed as part of the 2006 SWMP effort. Moreover, the update included the incorporation of drainage improvement projects that have implemented through 2008 while also identifying eight (8) additional high-priority projects that were to be included in the updated CIP.

In 2014, the City further updated the 2006 SWMP to amend the LOS and water quality LOS within the City. The objective of this effort was to reflect the improved drainage conditions within the City that were realized as part of the stormwater improvement projects that have been completed through 2014. It should be noted that the 2014 update included a revised 5-Year stormwater CIP, which considered the City's capital budget to address current high priority stormwater problem areas in a systematic manner, thereby maximizing benefits per unit cost. The 2014 SWMP update also included preliminary conceptual schematics along with planning-level cost estimates for the high-priority projects.

2.2 Purpose and Scope

Per the Federal Emergency Management Agency's (FEMA) requirements, stormwater master plans need to be updated every five (5) years to revise the FPLOS and to identify new stormwater improvement project priorities. The new priority areas should reflect the improvements that have been implemented as part of the prior SWMP 5-year CIP. To date, the City has implemented the majority of projects outlined in the 2014 SWMP 5-Year CIP. Nonetheless, it should be noted that the prior SWMP updates did not consider the rise in sea level and groundwater that have been observed and are anticipated to increase throughout the County.

Therefore, the purpose of this project is to update the City's 2014 SWMP to identify the current FPLOS within the City by accounting for all stormwater improvement projects that have been completed to date. Furthermore, the SWMP update will also account for the construction of newly developed parcels since 2014, as well as parcels currently under construction. Most importantly, the SWMP update will evaluate the reduced FPLOS based on future projections of sea level and groundwater rise.

To better assess the current and future FPLOS, the prior one-dimensional (1D) Hydrologic and Hydraulic (H&H) model (XP-SWMM) used for the previous SWMP updates will be replaced with a fully integrated one-dimensional (1D) and two-dimensional (2D) hydrologic and hydraulic model using ICPR Version 4 (ICPRv4). As for the prior SWMP updates, the latest SWMP update will include a revised 5-year stormwater CIP that will take into consideration sea level and groundwater rise projections as well as the City's capital budget, to address current high priority stormwater problem areas in a systematic manner, thereby maximizing benefits per unit cost. This SWMP update will also include preliminary conceptual schematics with planning-level cost estimates for the high-priority projects that will be included in the updated stormwater CIP.

BCC Engineering, LLC. (BCC) was contracted by the City to complete the SWMP update. To meet the objectives of this project, the SWMP update was subdivided into eight (8) tasks, with the final task consisting of preparing the final SWMP Update Report. The results and findings of critical tasks will be summarized into six (6) task-specific Technical Memorandums (TM). The Technical Memorandums that were prepared as part of this SWMP are as follows:

- **Technical Memorandum No. 1** – Data Collection and Evaluation
- **Technical Memorandum No. 2** – Existing Conditions Hydrologic and Hydraulic Model (H&H) Update
- **Technical Memorandum No. 3** – Identification and Ranking of Problem Sub-basins
- **Technical Memorandum No. 4** – Sea Level and Groundwater Rise Assessment
- **Technical Memorandum No. 5** – Stormwater Improvement Project Formulation and Conceptual Design
- **Technical Memorandum No. 6** – Capital Improvement Plan

The work completed and documented in these technical memorandums are incorporated in this report as key sections of the report. The following sections summarize the criteria, methodology, and results of each of these technical memorandums.

3.0 DATA COLLECTION AND EVALUATION

The data collection task required collecting data from the various entities with jurisdiction or that maintain data within and around the City's limits. Data was requested and/or collected from the flowing entities:

1. City of Doral
2. Miami-Dade County Regulatory and Economic Resources (RER)
3. Other sources:
   - South Florida Water Management District (SFWMD)
   - A&P Consulting Engineers (APCTE)
   - National Oceanic and Atmospheric Administration (NOAA)
   - National Resources Conservation Service (NRCS)
   - U.S. Army Corps of Engineers (USACE)
   - Federal Emergency Management Agency (FEMA) - National Flood Insurance Program
   - United States Geological Survey (USGS)
   - Southeast Florida Regional Climate Change Compact

3.1 City of Doral

BCC collected readily available data from the City. Below is a summary of the data requested from the City, and the following subsections describe the key data collected from the City. The data catalog presented in **Appendix A** includes a listing of all the data collected from the City for incorporation into the hydrologic/hydraulic models. The data catalog in **Appendix A** also includes a section of pertinent City of Doral GIS data collected from the City.

The following information was requested from the City:

1. All available digital and hard copy reports and data associated with the 2014 City of Doral Stormwater Master Plan update. This includes reports, GIS shapefiles, CAD data, XP-SWMM models.
2. As-built plans and Drainage Report for projects completed since the 2014 SWMP update (assumed 20 projects)
3. As-built design plans of all canal bank stabilization projects within the City
4. Latest Drainage Infrastructure GIS shapefiles
5. Updated Land Use Maps showing newly developed properties since 2014 and future land use maps
6. Permits for ongoing land development projects
7. Latest high-resolution aerials
8. Citizen flood/stormwater drainage complaints
9. Rainfall data from rain gauges within the City
10. Percolation
11. Pertinent GIS data/coverages that will support the development of the stormwater master plans

The City of Doral provided completed construction files for the below projects, which were completed since the last SWMP update in combination with design and as-built documents – see **Table 3-1.** Project data was primarily provided as PDF files in addition to some electronic CAD files.

Table 3-1 – Project Data from the City of Doral

PROJECT LOCATION	PROJECT YEAR
NW 52ND, 53RD, 54TH, & 55TH b/w NW 79TH Avenue & 77TH Avenue	2016
NW 97TH Avenue b/w 70TH Street & 74TH Street	2016
NW 82ND Avenue & NW 12TH Street	2016
NW 28TH Terrace b/w 99TH Avenue & 102ND Avenue	2017
NW 31ST Street & NW 82ND Avenue	2017
27TH Terrace & 98TH Avenue	2017
27TH Street b/w 98TH Avenue & 99TH Avenue	2017
26TH Street & 102ND Avenue	2017
NW 102ND Avenue b/w NW 27TH Terrace & NW 28TH Terrace	2017
NW 27TH Terrace b/w NW 100TH Avenue & NW 102ND Avenue	2017
NW 114TH Avenue b/w NW 72ND Street & NW 74TH Street	2017
NW 77TH Terrace & NW 113TH Avenue	2017
NW 82ND Terrace & NW 113TH Court	2017
NW 102ND Place b/w NW 21ST Street & NW 25TH Street	2017
NW 21ST Street b/w NW 102ND Place & NW 102ND Avenue	2017
NW 108TH Avenue & NW 29TH Street	2017
NW 21ST Street & NW 99TH Avenue	2017

3.1.1 Rainfall and Canal Stage Data

The City provided a list of active rain gauges and canal point gauges within the City. The canal point gauges provide canal stage data. **Table 3-2** shows the gauges and type of gauge within the City, and **Figure 3-1** shows the location of these gauges. The data from these gauges can be reviewed and downloaded through the VTScada software. **Figure 3-2** shows a screen capture of the VTScada software.

Table 3-2 – Active VTScada Gauges within the City of Doral

STATION	CLASS
S116	Rain Gauge
S145	Rain Gauge
S155	Rain Gauge
S199	Rain Gauge
S203	Rain Gauge
S398	Rain Gauge
NW_25ST	Canal Point
NW_58ST	Canal Point

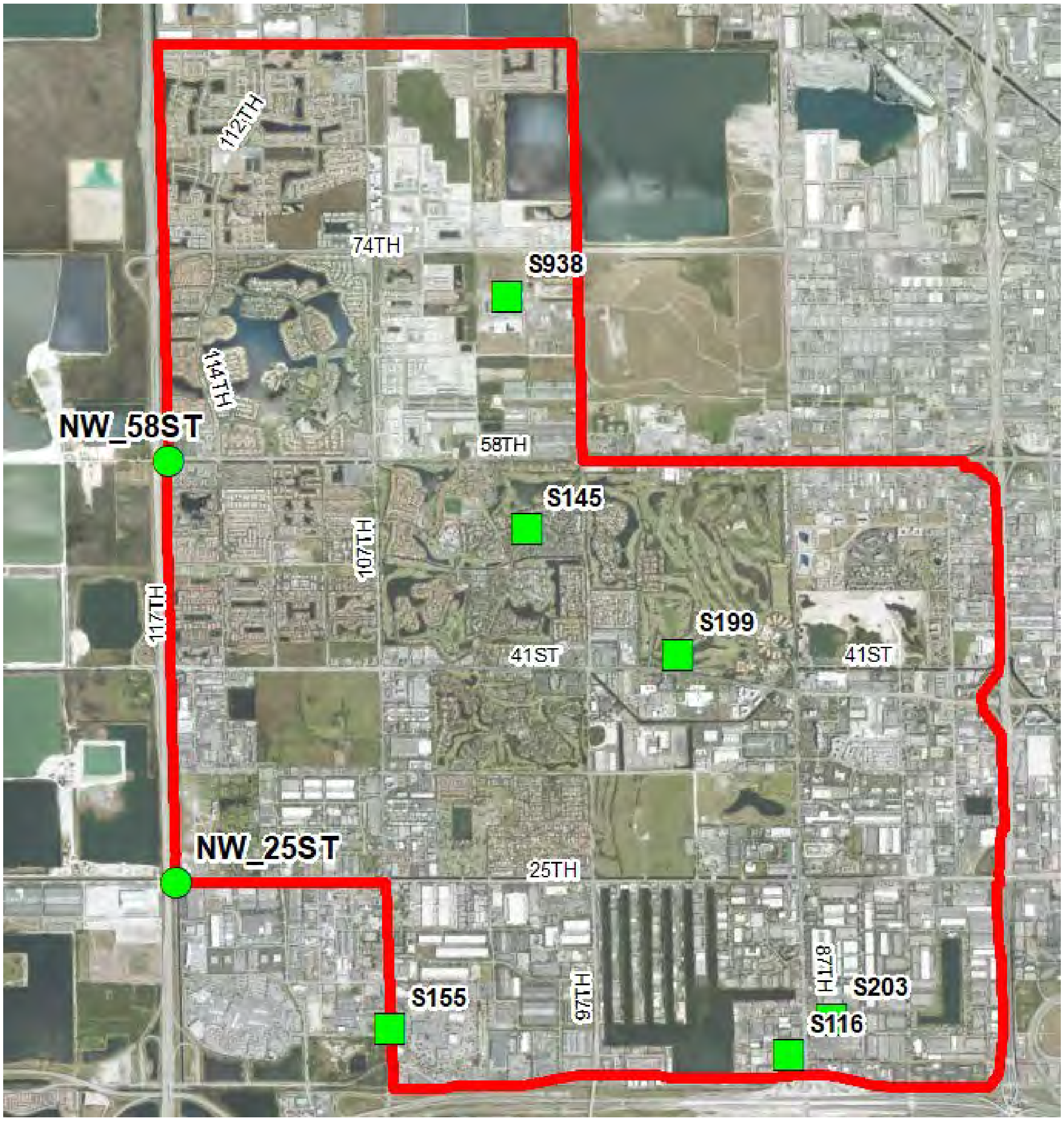


Figure 3-1 – Map of Rain Gauges and Canal Points in the City of Doral

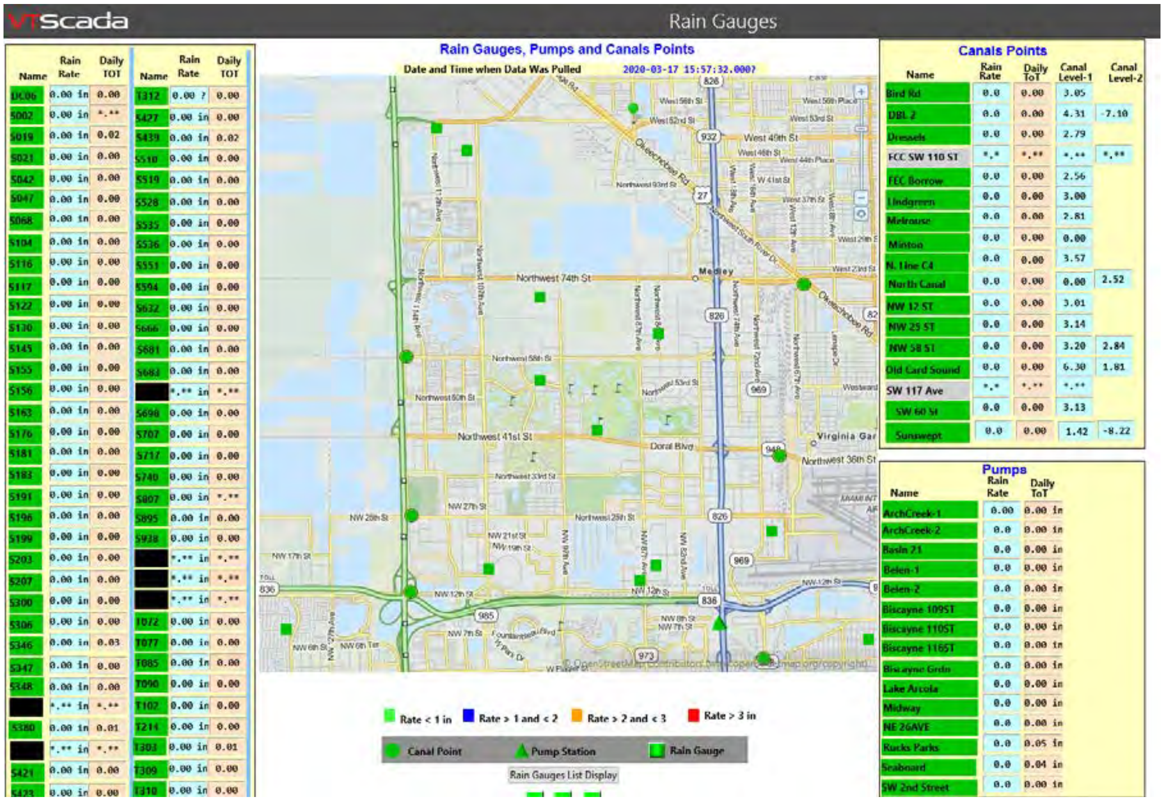


Figure 3-2 – VTScada software Data Collection Tool

The City of Doral provided a list of dates in which high rainfall precipitation and flooding were observed. This information will be used to validate the 1D/2D hydrologic/hydraulic model to be developed as part of Technical Memorandum No. 2.

1. January 23rd, 2017
2. August 25th, 2017
3. May 9th, 2018
4. July 9th, 2019
5. November 15th, 2019

3.1.2 2014 Stormwater Master Plan Update

The City of Doral provided all readily available data from the 2014 SWMP update. The data included in the Stormwater Master Plan comprised the following:

1. Doral Stormwater Master Plan Complete Reports
2. GIS shapefiles
    a. Doral City Limits
    b. Dade Basins and Sub-Basins
    c. Land Use
    d. Future Land Use-basin
    e. Doral Water
    f. Streets clip

    g. Doral Topography
    h. Flood 5-year
    i. Flood 10-year
    j. Flood 25-year
    k. Flood 100-year
    l. Stormwater Infrastructure
    m. Drainage Type
    n. Doral Canals
    o. Doral Pipes
3. Rainfall data (Mia-C4, Pen-C4, and Mia-C6)
4. XP-SWMM Original Models 2006
    a. Doral 5-year flood and Alternative 1
    b. Doral 10-year flood and Alternative 1
    c. Doral 25-year flood and Alternative 1
    d. Doral 100-year flood and Alternative 1

3.2 Miami-Dade County

The following information was requested from Miami-Dade County, which, besides the City, has the most pertinent and applicable data needed to complete the SWMP update:

1. Latest bare-earth LiDAR data for the C-4 and C-6 Basins in NAVD88 datum
2. Drainage infrastructure GIS shapefiles for the C-4 and C-6 basins
3. Existing and future land use GIS shapefiles
4. Land use tables for the following conditions:
    a. % impervious for each land use
5. Latest Miami-Dade County parcel GIS shapefiles and database
6. C-4 and C-6 Basin revised basin GIS shapefile
7. Canal Culvert crossings data within the City
8. C-2 Canal Cross sections north of NW 58^{th} Street (east of the FL. Turnpike)
9. NW 25^{th} and 58^{th} Street Control Structure information and operating conditions/criteria
10. Average wet season groundwater elevations shapefiles used in the C-4 and C-6 Basin Models for the following conditions:
    a. Current average October elevation
    b. Groundwater elevations for the calibration event
    c. Groundwater elevations for projected sea-level rise conditions
11. Design plans for recently constructed or projects to be constructed within the City
12. Latest C-4 and C-6 Basin Stormwater Master Plan model boundary conditions for all applicable design storm events and results for existing conditions, calibration event, and projected sea-level rise analyses:
    a. Calibration event
    b. Existing conditions design storm events
    c. Projected sea-level rise design storm events

Data from Miami-Dade County was acquired via two separate departments: RER and the Miami-Dade Enterprise Technology Services Department (ETSD). **Appendix B** includes a catalog of the digital data provided by Miami-Dade County.

Additionally, ETSD provided GIS data, which included shapefiles of County canals, roadways, soils, hurricane evacuation routes, as well as the 2009 SID aerial images of the County. The majority of Miami-Dade County's GIS data is also accessible via the web, at the following location:

- Miami-Dade County GIS data portal
    - https://gis-mdc.opendata.arcgis.com/

Screen capture of the Miami-Dade County GIS data portal is shown in **Figure 3-3**. A catalog of the GIS data collected is also included in **Appendix B**.

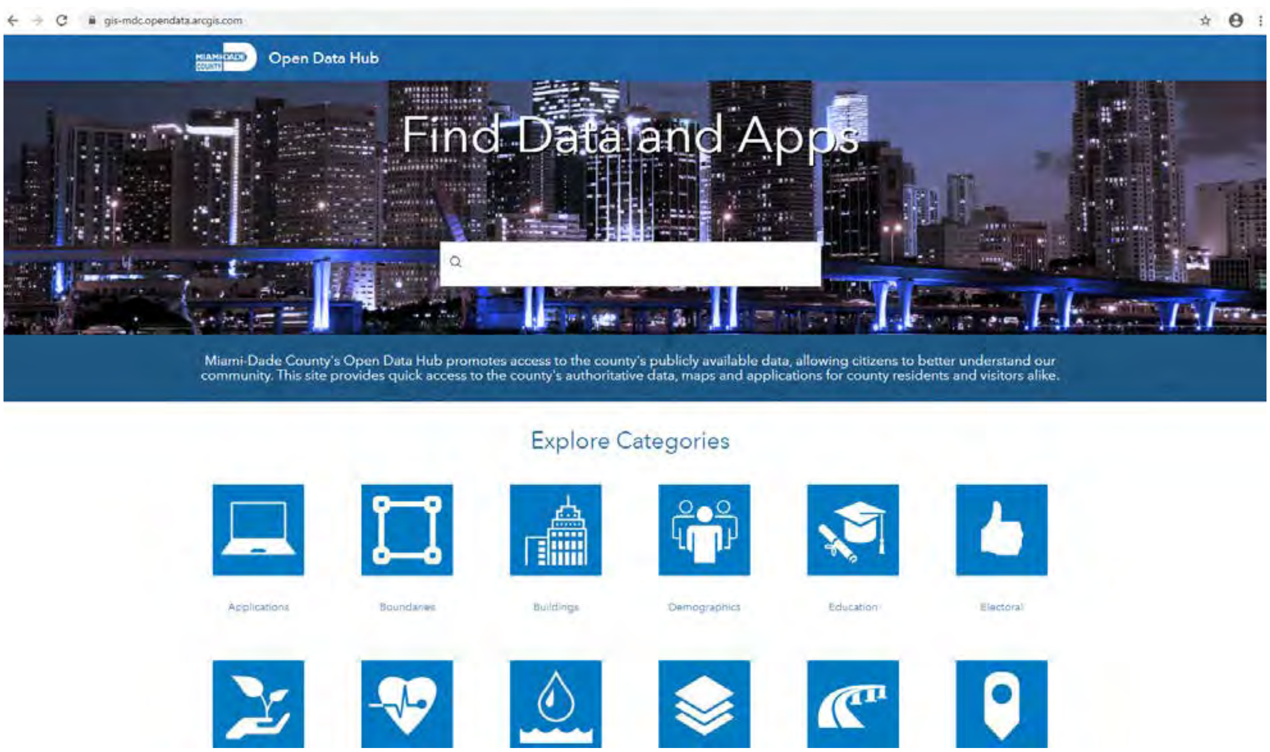


Figure 3-3 – Miami-Dade County GIS data portal

3.3 Data from Other Sources

In addition to the primary data contributions from the City of Doral and Miami-Dade County, other sources of information were accessed to help support the development of the Stormwater Master Plan Update. The following subsections provide a description of the entity and applicable data collected to support the development of the City's SWMP update. Data collected from other sources were based on researching available web-data portals and BCC's data catalogs. Data from these sources were assessed on a case-by-case basis for pertinence to support developing the City's SWMP update. **Appendix C** includes a catalog of the digital data collected from other sources.

3.3.1 South Florida Water Management District (SFWMD)

The SFWMD maintains an extensive water resources database, titled DBHYDRO, which includes hydrologic, meteorological, hydrogeologic, and water quality data. The data contained within DBHYDRO includes historical and current data for the 16 counties governed by the SFWMD. To facilitate the access of this data, the SFWMD has developed a browser accessible via the web, at the following location:

- Main DBHYDRO portal:
    - o https://www.sfwmd.gov/science-data/dbhydro
- DBHYDRO Browser Menu for accessing all SFWMD data:
    - o http://my.sfwmd.gov/dbhydroplsql/show_dbkey_info.main_menu

Screen capture of both the main DBHYDRO portal and the DBHYDRO Browser Menu website are shown in **Figure 3-4** and **Figure 3-5**. A listing of the rain gauge and canal point stations within the City are shown in **Table 3-2**.

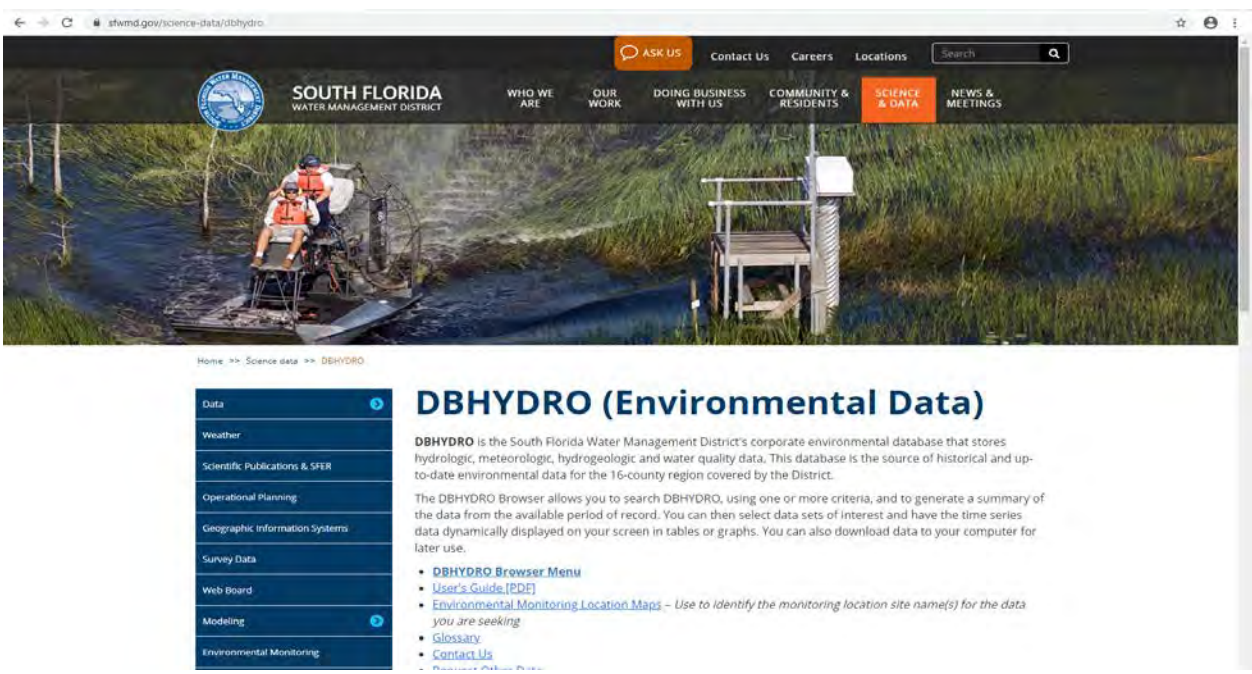


Figure 3-4 – Main SFWMD DBHYDRO Portal

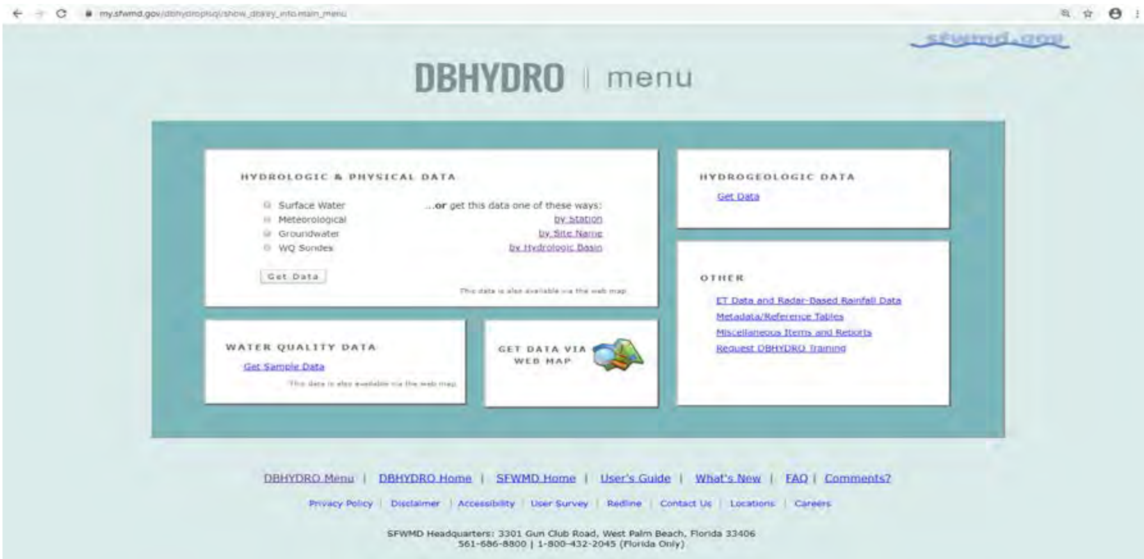


Figure 3-5 – DBHYDRO Browser Menu

The SFWMD maintains a GIS data repository for all GIS data for the SFWMD – see **Figure 3-6**. This GIS data catalog contains all the DBHYDRO stations where observations, samplings, or monitoring are collected. Existing stormwater and environmental permitting information are also available via the SFWMD ePermitting website. This spatial dataset is available at the following website:

- GIS Data distribution site:
  - o https://apps.sfwmd.gov/WAB/SFWMDMapping/index.html

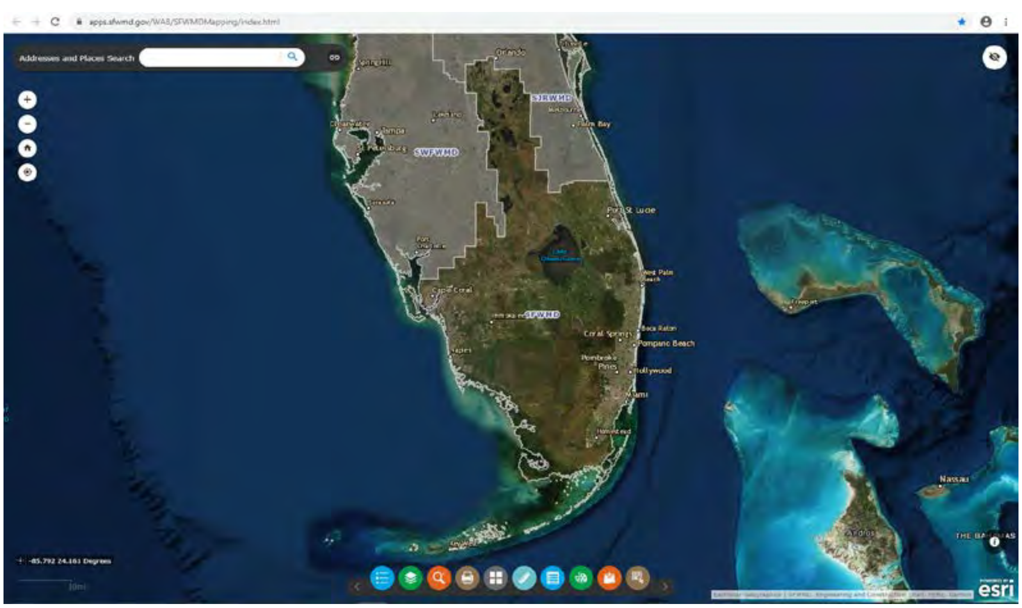


Figure 3-6 – SFWMD GIS Data Distribution Site

Additionally, the SFWMD data repository is a viable source for additional data that is often directly available from other sources such as land use, soils, aerial imagery, etc. Although this data may not be maintained regularly, this data may be used if alternate sources are not accessible.

3.3.2 A&P Consulting Engineers (APCTE)

Data requests were extended to APCTE. APCTE provided relevant project data for the NW 25th Street Viaduct construction project. The data APCTE provided includes revised drainage plans, proposed engineering reports, and a permit modification drainage report.

3.3.3 National Oceanic and Atmospheric Administration (NOAA)

All elevation results for the 2020 update to the SWMP will be reported in feet relative to the North American Vertical Datum of 1988 (ft-NAVD 88). The NOAA has an online version of the VERTCON software developed by USACE. The NGVD conversion to NAVD can be obtained by inputting the coordinates of the City of Doral.

- NOAA Orthometric Height Conversion (VERTCON):
    - o https://www.ngs.noaa.gov/cgi-bin/VERTCON/vert_con.prl

A screen capture of the NOAA's VERTCON Orthometric Height Conversion website is shown in **Figure 3-7.**

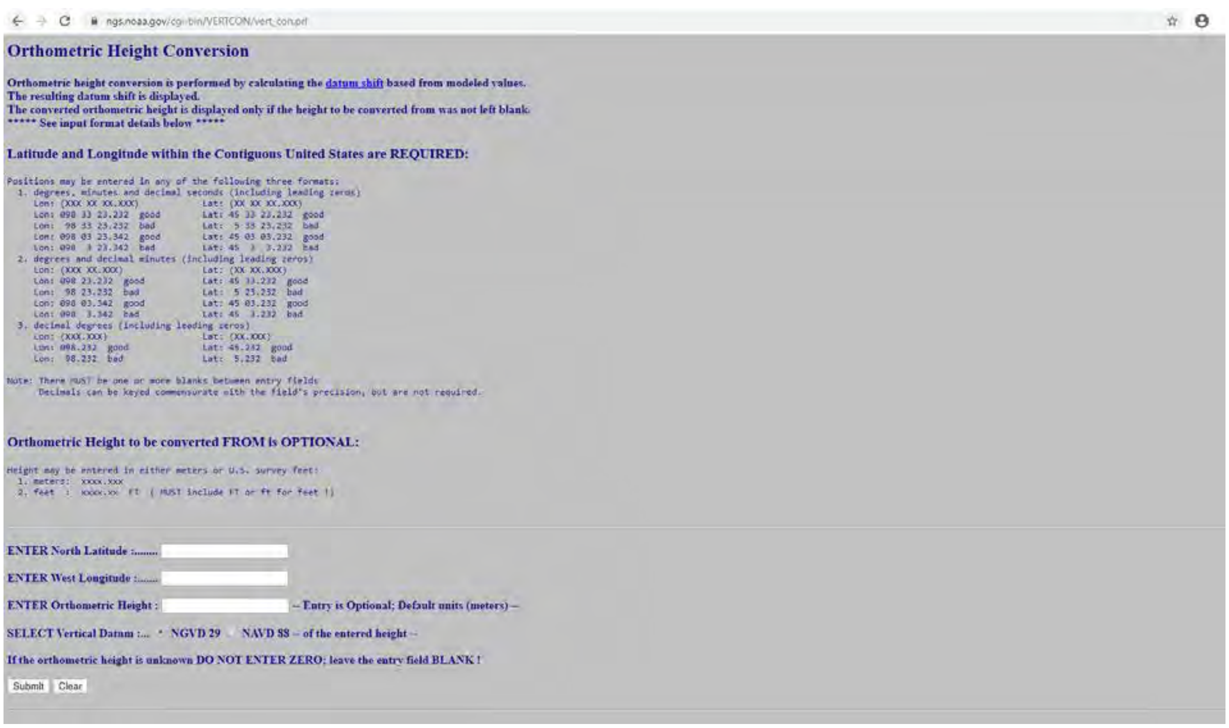


Figure 3-7 – NOAA VERTCON Conversion Site

3.3.4 United States Army Corps of Engineers (USACE)

In July 2009, the USACE prepared an Engineer Circular, which discussed future potential sea-level changes and their effects on managing, planning, engineering, designing, constructing, operating, and maintaining USACE projects and systems of projects in coastal regions. This document references various locations in South Florida. This document is available via the web at the following location:

- USACE Main Engineer Circular Portal:
  - https://www.publications.usace.army.mil/USACE-Publications/Engineer-Circulars/
- USACE Sea Level Change Engineer Circular (EC 1165-2-211)
  - https://planning.erdc.dren.mil/toolbox/library/ECs/EC11652212Nov2011.pdf

3.3.5 Natural Resources Conservation Service (NRCS)

The NRCS is a federal agency under the United States Department of Agriculture (USDA), which performs and maintains soil survey information for the United States. Through the USDA's Geospatial Data Gateway site, soil maps and data are available online for more than 95 percent of the nation's counties – see **Figure 3-8**. The site is updated and maintained online as the single authoritative source of soil survey information and can be accessed via the web.

- Main Geospatial Data Gateway Portal:
  - http://datagateway.nrcs.usda.gov/

Additional data is available through this system, including digital ortho imagery, digital elevation models, and other cultural and demographic data.

NRCS also published the publication Urban Hydrology for Small Watersheds TR-55 that includes methods for calculating runoff based on precipitation and soil storage with the Soil Conservation Service (SCS) Curve Number (CN) method. The publication also contains average velocities for estimating travel time for shallow concentrated flow based on the watercourse slope.

- Urban Hydrology for Small Watersheds TR-55:
  - http://datagateway.nrcs.usda.gov/

Figure 3-8 – USDA's Geospatial Data Gateway site

3.3.6 Federal Emergency Management Agency (FEMA)

As stated by FEMA in the National Flood Insurance Program (NFIP) Description document:

> "The U.S. Congress established the National Flood Insurance Program (NFIP) with the passage of the National Flood Insurance Act of 1968. The NFIP is a Federal program enabling property owners in participating communities to purchase insurance as a protection against flood losses in exchange for State and community floodplain management regulations that reduce future flood damages. Participation in the NFIP is based on an agreement between communities and the Federal Government. If a community adopts and enforces a floodplain management ordinance to reduce future flood risk to new construction in floodplains, the Federal Government will make flood insurance available within the community as financial protection against flood losses. This insurance is designed to provide an insurance alternative to disaster assistance to reduce the escalating costs of repairing damage to buildings and their contents caused by floods."

Additionally, the Community Rating System (CRS) is described as follows in the same document:

> "The NFIP's Community Rating System (CRS) provides discounts on flood insurance premiums in those communities that establish floodplain management programs that go beyond NFIP minimum requirements. Under the CRS, communities receive credit for more restrictive regulations, acquisition, relocation, or flood-proofing of flood-prone buildings, preservation of open space, and other measures that reduce flood damages or protect the natural resources and functions of floodplains."

The NFIP Flood Insurance Manuals were collected from the following FEMA website:

- FEMA Flood Insurance Manual portal:
  - http://www.fema.gov/business/nfip/manual.shtm

These manuals provide direction with regards to improving the City's CRS rating and thus increasing the discount available to City residents through NFIP. These manuals also provide guidelines and requirements for stormwater master plans to improve CRS ratings. A comparison will also be performed using the 100-year flood plains resulting from this SWMP's ICPR4 model runs to verify agreement with the FEMA Flood Zone shapefiles collected from FEMA. These flood zones are used in FEMA Flood Insurance Rate Maps, otherwise more commonly known as FIRMs. Congruence between the two data sets will be assessed based on the approximate boundaries of the FEMA Flood Zones for zones A, AE, and AH and the flood plains to be developed.

3.3.7 United States Geological Survey (USGS)

Created by an act of Congress in 1879, USGS has evolved over the ensuing 125 years, matching its talent and knowledge to the progress of science and technology. USGS is the sole science agency for the Department of the Interior. It is sought out by thousands of partners and customers for its natural science expertise and its vast earth and biological data holdings. The USGS serves the Nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life. USGS is a world leader in the natural sciences through our scientific excellence and responsiveness to society's needs.

As the Nation's largest water, earth, and biological science and civilian mapping agency, USGS collects, monitors, analyzes and provides science about natural resource conditions, issues, and problems. Their expertise enables this agency to carry out large-scale, multidisciplinary investigations and provide impartial scientific information to resource managers, planners, and other customers.

USGS, in cooperation with Miami-Dade County, prepared a study titled "Hydrologic Conditions in Urban Miami-Dade County, Florida, and the Effect of Groundwater Pumpage and Increased Sea Level on Canal Leakage and Regional Groundwater Flow, Version 1.2 July 2016." This study estimated groundwater rise conditions in the region. USGS report of the change in water-table elevations from one foot of sea-level rise for projected sea-level rise in 2045. This report can be used to estimate the amount of groundwater rise in the City for future sea-level conditions.

- Hydrologic Conditions in Urban Miami-Dade County, Florida, and the Effect of Groundwater Pumpage and Increased Sea Level on Canal Leakage and Regional Groundwater Flow, Version 1.2 July 2016.:
    - o https://pubs.usgs.gov/sir/2014/5162/pdf/sir2014-5162.pdf

3.3.8 Southeast Florida Regional Climate Change Compact

In January 2010, Broward, Miami-Dade, Monroe, and Palm Beach Counties united to form the Southeast Florida Regional Climate Change Compact as a way to coordinate mitigation and adaptation activities across county lines. Since then, the four Compact counties have advanced local and regional responses to—and preparations for—the effects of climate change, including sea-level rise, flooding, and economic and social disruptions. They have expanded to work with a growing number of federal, state, regional, municipal, nonprofit, academic, and private sector partners.

Today, the Compact represents a new form of regional climate governance designed to allow local governments to set the agenda for adaptation while providing state and federal agencies with access to technical assistance and support. The Compact's work is widely recognized as one of the nation's leading examples of regional-scale climate action, and it continues to serve as an exemplary mechanism for collaboration on climate adaptation and mitigation efforts.
The Compact calls on the counties to work cooperatively to:

- Develop annual legislative programs for presentation to and approval by the respective County Boards, and jointly advocate for state and federal policies and funding.
- Dedicate staff time and resources to create a Southeast Florida Regional Climate Action Plan, which outlines recommended mitigation and adaptation strategies to help the region pull in one direction and speak with one voice.
- Meet annually at the Southeast Florida Regional Climate Leadership Summits to mark progress and identify emerging issues.

The Southeast Florida Regional Climate Change Compact first produced a Regionally Unified Sea Level Rise Projection for Southeast Florida in 2011. The Projection was updated in 2015. In 2019, the Compact again convened an ad hoc Sea Level Rise Work Group to update the Projection, composed of scientific experts within the academic community, as well as local, regional, and federal government.

The Climate Compact's Regionally Unified Sea Level Rise Projection and accompanying Guidance Report are adopted for use by each of the four counties Boards of County Commissioners. The Compact completed County adoption of the 2019 Projection to be by the Spring of 2020, after which the Compact released the Guidance Report supporting the Projection – See **Figure 3-9**, containing directions and specific examples of how the projection can be used by local governments, planners, designers, engineers, and developers. The Projection is reviewed and updated every five years or sooner as a result of ongoing advances in scientific knowledge and modeling via the peer-reviewed literature related to global climate change.

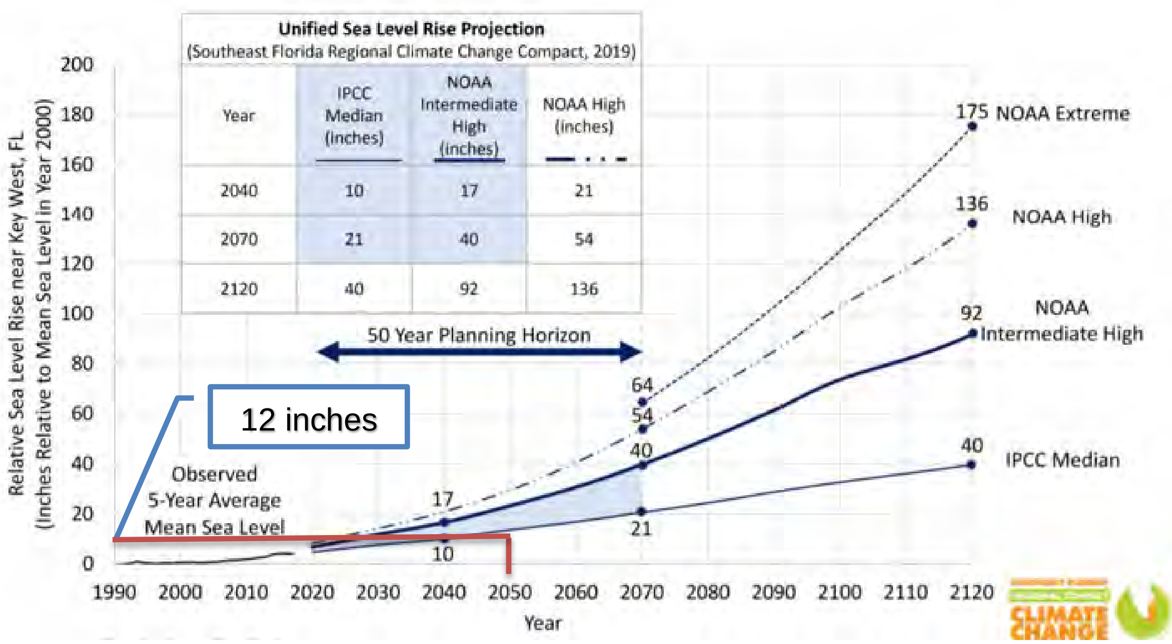


Figure 3-9 – Unified Sea Level Rise Projections for Southeast Florida (2019)

The Regionally Unified Sea Level Rise Projection is a key planning tool produced by the Compact to aid in the understanding of vulnerabilities and to provide a basis for adaptation strategies, policies, and infrastructure design in the Southeast Florida region. Prior to producing a unified projection for the region, the diversity of local sea-level rise projections was a barrier to achieving regionally consistent adaptation strategies and policies and effectively influence supportive policies at the state and federal levels. The Stormwater Vulnerability Study is also being incorporated into the SWMP update.

3.4 Data Evaluation

The data collected from the City of Doral and other sources were evaluated to define the completeness and viability of the data as well as to identify the pertinent items that would be applicable to the SWMP update process. The following subsections detail the relevant components of the data collected and their potential role in the development of this stormwater master plan update.

3.4.1 City of Doral Data

With regards to the City of Doral Data, the City provided project data for recent stormwater management projects as well as the previous SWMP and supporting data and models. The project data for those projects will be incorporated as part of Technical Memorandum No. 2, and their inclusion in the SWMP is dependent on the type of system implemented and the overall function of the system. It should be noted that typically, planning-level models such as the ones that will be used for this SWMP do not represent minor components within a given stormwater management system, and as such, smaller self-contained localized projects will not be fully implemented in the ICPR4 models.

The XP-SWMM models from the prior SWMP will be converted to a 1D/2D hydrologic/hydraulic modeling using the ICPR V4 model. Additionally, the City provided stormwater infrastructure data that will be used to help verify the connectivity of the proposed model. The updated ICPR4 models to be developed will be used to assess the current flood protection level of service for the City and to evaluate future improvement projects and their associated benefits.

3.4.2 Data from Other Sources

The data collection effort associated with this task was primarily focused on collecting the necessary data to ensure the SWMP update can be completed. The most important data collected from Miami Dade RER included the boundary conditions based on the Stormwater Master Plans for the C-4 and C-6 Canal Basins.

Additionally, project data for FDOT projects within and adjacent to the City of Doral will be used to update the City of Doral model to reflect current conditions given the extent and complexity of the FDOT projects. This is specifically important because projects such as the NW 25th Street Viaduct and the SR 826/836 Interchange improvement projects may impact the discharge conveyance capacity from the City into the SFWMD primary canals.

3.5 Conclusions and Recommendations

Based on the readily available data collected as part of this task, there is enough data to complete the stormwater master plan update for the City. Additional pertinent data that may become available during the development of the SWMP will be incorporated into the data documentation and evaluation section of the draft Stormwater Master Plan Report to be prepared upon the completion of the remaining Technical Memorandums.

Although there is adequate data at this time to develop a robust SWMP for the City, it would be beneficial to have additional rainfall and stage data within the City to better calibrate and validate the ICPR4 hydrologic/hydraulic models in the future. The City currently maintains stormwater infrastructure data in GIS and Google Map formats. The information is updated regularly using field verified data collected during maintenance activities and/or field surveys.

It is recommended that the City continue these activities and expand the data collection activities to include the verified locations of all inlets, manholes, outfalls, and stormwater management facilities such as exfiltration trenches, pollution control structures, and stormwater retention areas that are owned, maintained and operated by the City. It is also important to verify pipe sizes, connectivity, and inverts of the drainage systems.

4.0 EXISTING CONDITIONS HYDROLOGIC AND HYDRAULIC (H&H) MODEL SETUP

The 2014 SWMP update used the one-dimensional (1D) XP-SWMM H&H model to assess the FPLOS within the City and to develop a 5-year CIP. The 2014 model was a refinement of the 2006 SWMP update. However, the 2006 and 2014 XP-SWMM models did not simulate the hydraulic conveyance of the secondary canals nor the primary roadway culverts that are part of the City's drainage system. Instead, the models used time-stage boundary conditions for the canals and culverts, which were derived from the Miami-Dade County regional C-4 and C-6 Basin XP-SWMM model results developed back in 2006. Moreover, there are two (2) other key deficiencies with 1D XP-SWMM used for both the 2006 and 2014 SWMP development:

- A single elevation was obtained and applied to the entirety of each sub-basin, which could under– or over-estimate the amount of flooding within each sub-basin.
- The secondary positive drainage systems (i.e., drainage inlets and storm pipes) were not included in the models.

To better assess the current and future flood protection LOS under these conditions, the prior one-dimensional (1D) hydrologic/hydraulic model (XP-SWMM) used for the previous SWMP updates will be replaced with a fully integrated one-dimensional (1D) and two-dimensional (2D) hydrologic/hydraulic model using ICPRv4. As for the prior SWMP updated, this SWMP update will include a revised 5-year stormwater CIP and the City's capital budget to address current high priority stormwater problem areas in a systematic manner, maximizing benefits per unit cost. However, this model will also take into consideration sea level and groundwater rise projections, which were not considered in the 2006 and 2014 SWMP updated.

The ICPRv4 computer model is a hydrodynamic model developed by Streamline Technologies, Inc. that simulates hydrologic and hydraulic conditions by generating runoff hydrographs and dynamically routing these hydrographs through dendritic, diverging, looped, and/or bifurcated stormwater management systems. The expert version of the ICPRv4 model includes the two-dimensional (2D) overland flow and groundwater components that are used as either a substitute or a complement to the traditional 1D basin runoff method. For the 2D component, ICPRv4 generates a flexible triangular mesh based on a specified resolution and several types of landscape features, such as land use, topography, and overland flow roughness. Honeycombs (or control volumes) are formed around the vertices of the triangles and produce different hydrological responses based on specified parameters and the mapping of various landscape characteristics. Mass balance is accounted for in each control volume to determine excess rainfall. The Manning's equation was used to calculate runoff velocities using the slopes from the interpolated topography along the sides of the mesh triangles. Analogous to the 1D node-link computational schematic, the vertices of the triangles are treated as nodes, and the sides of triangles represent the overland flow links.

The layers that are used to define the parameters which generate the overland flow hydrological unit response in each honeycomb are:

1. Ground Elevations
2. Soil Parameters
3. Land Cover (% imperviousness)
4. Overland Flow Manning's Roughness Coefficients
5. Rainfall Zones

It should be noted that the ICPRv4 (Expert) model is approved by FEMA to generate flood maps in Florida.

The data collected as part of TM No. 1 was evaluated to define the completeness and viability of the sourced information. In addition, pertinent items that would be applicable to the SWMP updated process were identified. The following subsections detail the relevant components of the data collected and their role in developing this stormwater master plan update. The existing conditions hydrologic/hydraulic conditions were developed using the ICPRv4 (Expert) model, Version 4.07.01. Model inputs include:

1. Measured Rainfall Event Validation Data
2. Runoff Curve Numbers (CN)
3. Digital Terrain Model (DTM) from available LiDAR Data
4. 2D Overland Flow Roughness Coefficients
5. 1D Hydraulic Nodes and Links (i.e., drainage infrastructure)
6. 1D Boundary Conditions and 2D Overland Flow Boundary Conditions

The 1D hydraulic elements of the model include hydraulic nodes and links to represent the existing storm sewer network and catch basins, where runoff flows are exchanged between the 1D and 2D components of the model. The 2D model elements were derived from the available DTM, which was developed from LiDAR data. Overland boundary stage lines were included in the 2D model, where the flow is exchanged between land areas and water bodies. The existing conditions model was tested using a known measured rainfall event and verified based on observed inundation conditions and measured flood depths during the event.

The following sections and sub-sections describe the data used, and the approach followed in establishing and validating the existing conditions model to develop flood maps for various design storm events.

4.1 Drainage Basin Delineation

The 2014 SWMP update refined the sub-basin delineations developed as part of the 2006 SWMP. Based on the 2014 SWMP update, 70 drainage sub-basins were identified. The integrated 1D/2D H&H modeling approach does not utilize sub-basins to establish runoff amounts or determine the depth of flooding. However, the sub-basin delineations developed as part of the 2014 SWMP update will be used to establish the FPLOS for each sub-basin to re-establish the level of priority for each of the sub-basins.

The City of Doral contains large areas which are considered private and do not fall within the City's responsibility in terms of maintenance or flood protection requirements. These areas include private developments where not only structures, lakes, and open/common areas are privately owned, but also roadways and underlying stormwater management infrastructure.

4.2 Hydrologic Model Setup

In ICPRv4, the 2D overland flow component, as opposed to the traditional manual basin approach, is used to generate runoff. The key elements for establishing the ICPRv4, 2D flexible mesh, and 2D model components include:

1. Overland Flow Region
2. Topography
3. Land Use
4. Soil Zones
5. Curve Number Values
6. Overland Flow Manning's Roughness Coefficients
7. Pond Control Volumes
8. Channel Control Volumes
9. Extrusion Zones
10. Breaklines
11. Breakpoints
12. Rainfall Zones

4.2.1 Overland Flow Region

The overland flow region defines the limits of the 2D model domain. The overland flow region was set to extend 100-feet beyond the City's boundaries. **Figure 4-1** shows the limits of the 2D model overland flow region.

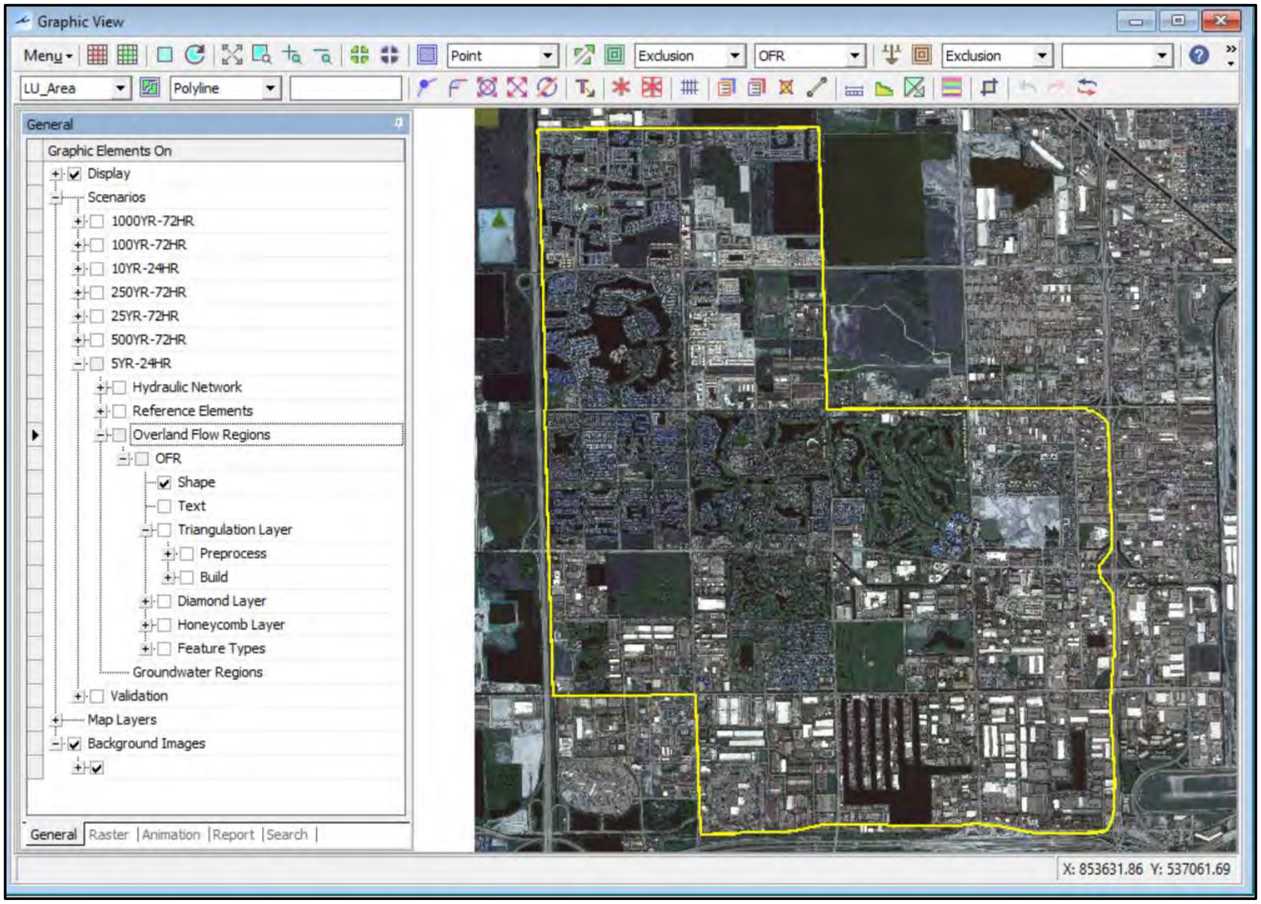


Figure 4-1 – Limits of 2D Model Overland Flow Region

4.2.2 Topography

LiDAR topography was downloaded from the Miami-Dade County Open Data Hub in the form of a digital elevation model (DEM). The DEM is based on LiDAR data collected in 2018 by Miami-Dade County's Information Technology Department (ITD) and consists of five (5) foot grid patterns that represent the bare-earth ground elevations encountered within the County. The vertical control of the dataset is in reference to the North American Vertical Datum of 1988 (NAVD88). The City of Doral portion of the data is displayed in **Figure 4-2.**

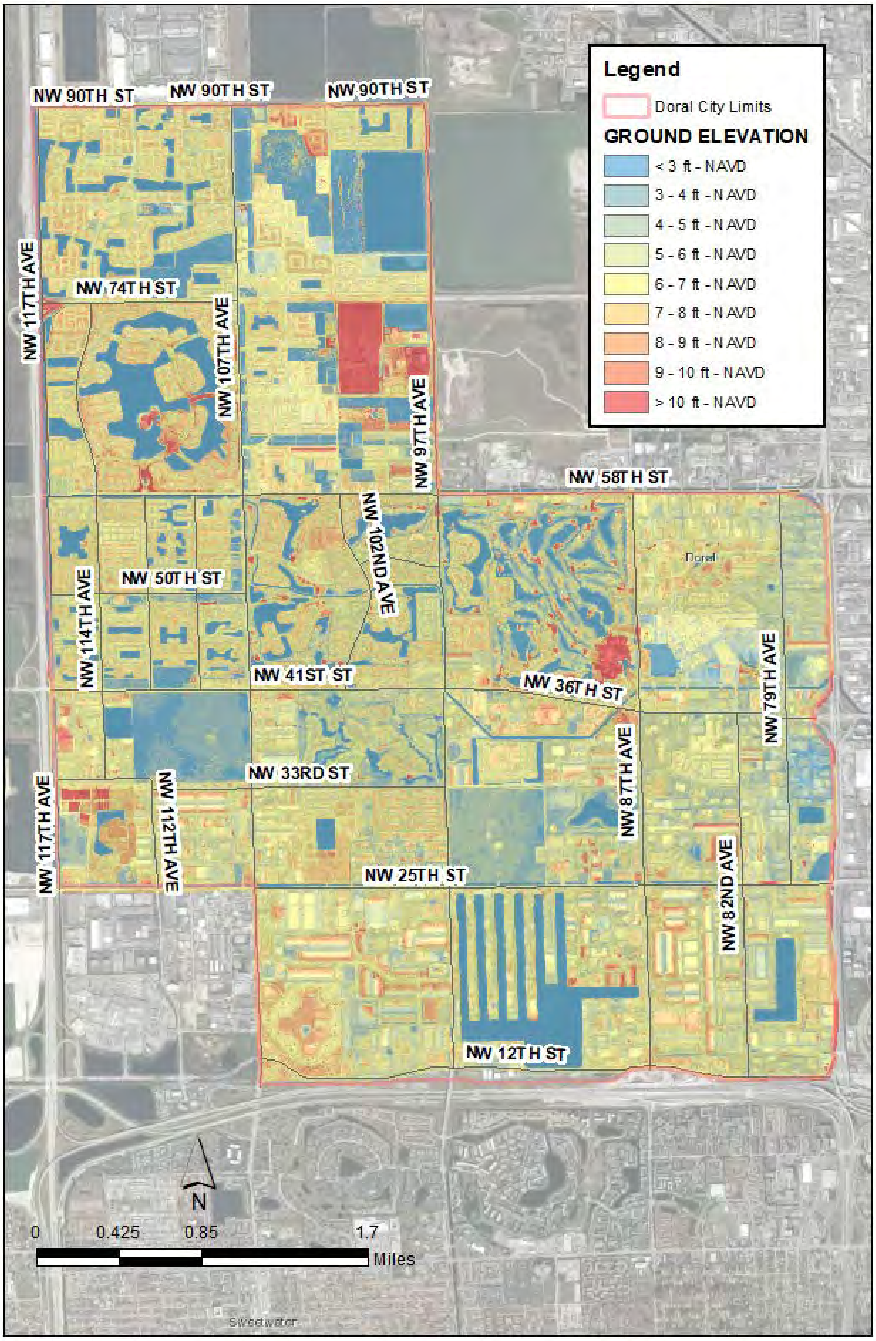


Figure 4-2 – City of Doral Topography

4.2.3 Land Use Coverage

Land use coverage for the model domain was obtained from the City of Doral's Public Works department. The land use classifications are shown in **Figure 4-3**, and the land use distributions are summarized in **Figure 4-3**.

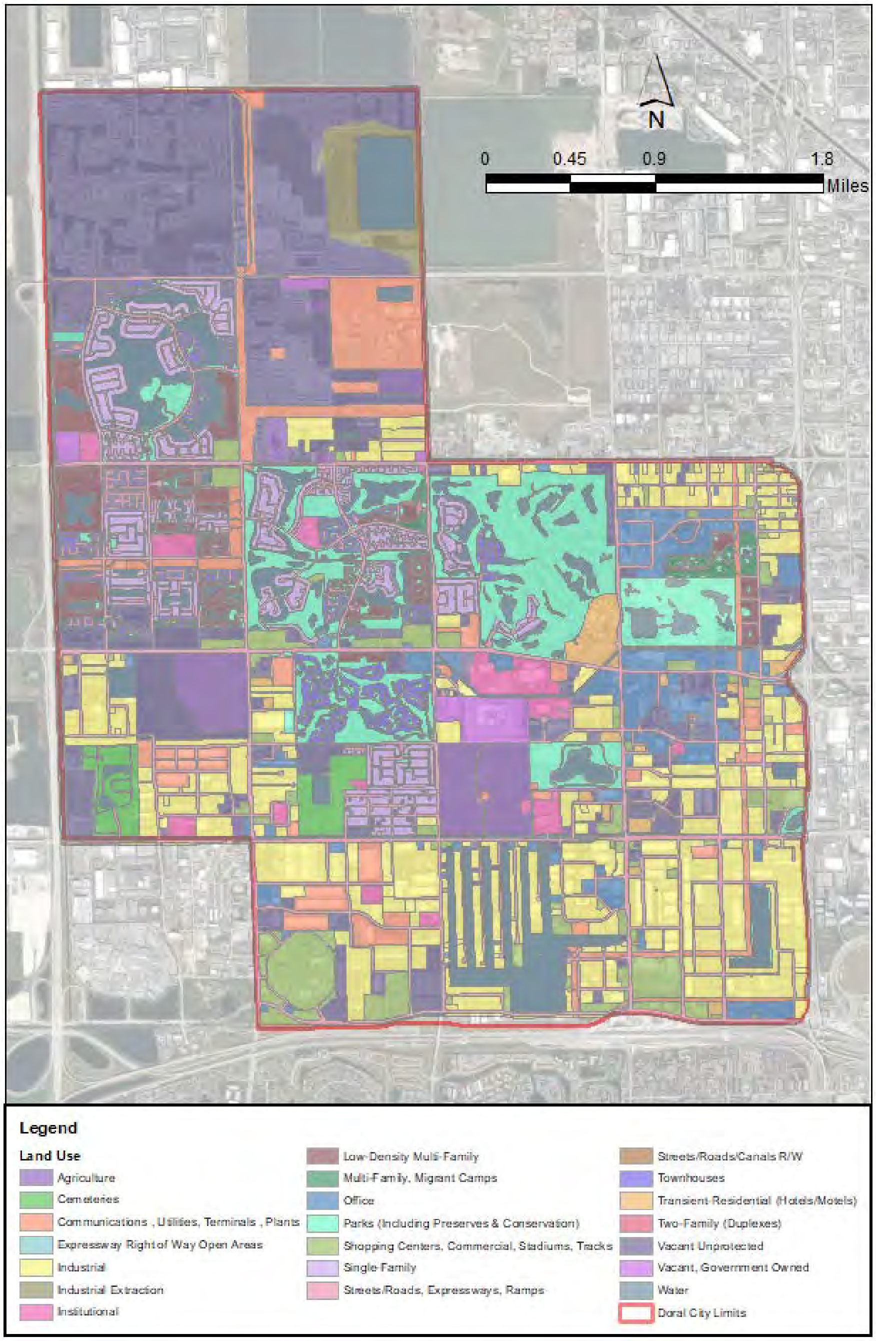


Figure 4-3 – City of Doral Land Use

4.2.4 Soil Zones

Soil zones were defined according to the unsaturated soil depth above the design highwater (DHW) elevation. This depth was correlated to the soil storage as specified in the SFWMD Environmental Resource Permit (ERP) Applicant's Handbook Volume II for coastal compacted soils, based on Soil Conservation Service (SCS) estimates. The soil zones vary depending on the type of simulation being performed: validation event or design storm events. These values are defined in **Section 4.6** and **Section 4.11**, respectively.

1. Zone 1 - Elevations below 1 ft-NAVD88
2. Zone 2 - Elevations between 1 and 2 ft-NAVD88
3. Zone 3 - Elevations between 2 and 3 ft-NAVD88
4. Zone 4 - Elevations between 3 and 4 ft-NAVD88
5. Zone 5 - Elevations above 5 ft-NAVD88

4.2.5 Curve Number Values

The calculated Curve Number (CN) values within the ICPRv4 model are based on the available soil storage and percent (%) imperviousness. The SCS equation for establishing the CN values per land use and available soil storage (*S*):

$$CN = \frac{1000}{S + 10}$$

Table 4-1 summarizes the applicable percent (%) impervious per land use within the City. These values are consistent with the approach being implemented by Miami-Dade County in the stormwater master development for the C-4 and C-6 Basins.

Table 4-1 – Percent Impervious and Pervious per Land Use within the City

LAND USE	AREA (SQ.MI.)	% OF CITY	% IMPERVIOUS AREA	% PERVIOUS AREA
Agriculture	0.46	3.06	0.0	100.0
Cemeteries	0.20	1.30	10.0	90.0
Communications, Utilities, Terminals, Plants	0.94	6.20	80.0	20.0
Expressway Right of Way Open Areas	0.09	0.60	5.0	95.0
Industrial	2.40	15.86	82.6	17.4
Industrial Extraction	0.21	1.39	27.0	73.0
Institutional	0.26	1.71	56.1	43.9
Low-Density Multi-Family	0.38	2.50	64.6	35.4
Multi-Family, Migrant Camps	0.06	0.43	69.6	30.4
Office	0.60	3.99	75.5	24.5
Parks (Including Preserves & Conservation)	1.47	9.73	3.0	97.0
Shopping Centers, Commercial, Stadiums, Tracks	0.63	4.19	82.6	17.4
Single-Family	0.72	4.79	64.6	35.4
Streets/Roads, Expressways, Ramps	1.72	11.38	95.0	5.0
Streets/Roads/Canals R/W	0.04	0.25	70.0	30.0
Townhouses	0.32	2.09	70.5	29.5
Transient-Residential (Hotels/Motels)	0.14	0.95	61.5	38.5
Two-Family (Duplexes)	0.00	0.01	69.6	30.4
Vacant Unprotected	2.86	18.93	1.0	99.0
Vacant, Government Owned	0.15	1.01	1.0	99.0
Water	1.45	9.57	100.0	0.0

ICPRv4 determines the soil storage and CN based on the depth to the DHW elevation. ICPRv4 uses the spatial coverages of the land cover zones and the soil zones during the 2D overland flow runoff calculations. **Table 4-2** summarizes the CN calculations per land use. The DHW elevation is based on the analysis being performed: model validation and design storm simulations. The approach for establishing the DWH for these conditions is described in **Section 4.6** and **Section 4.11**, respectively.

Table 4-2 – CN Calculation per Zone per Land Use

LAND USE	CN ZONE 1	CN ZONE 2	CN ZONE 3	CN ZONE 4	CN ZONE 5
Agriculture	96	90	75	60	55
Cemeteries	96	91	76	63	58
Communications, Utilities, Terminals, Plants	99	98	94	88	86
Expressway Right of Way Open Areas	96	90	76	62	56
Industrial	99	98	94	90	88
Industrial Extraction	97	92	80	68	63
Institutional	98	95	87	78	74
Low-Density Multi-Family	98	96	89	81	78
Multi-Family, Migrant Camps	99	97	91	83	80
Office	99	97	92	86	83
Parks (Including Preserves & Conservation)	96	90	75	61	56
Shopping Centers, Commercial, Stadiums, Tracks	99	98	94	90	88
Single-Family	98	96	89	81	78
Streets/Roads, Expressways, Ramps	100	99	98	97	96
Streets/Roads/Canals R/W	99	97	91	84	80
Townhouses	99	97	91	84	81
Transient-Residential (Hotels/Motels)	98	96	88	80	76
Two-Family (Duplexes)	99	97	91	83	80
Vacant Unprotected	96	90	75	61	55
Vacant, Government Owned	96	90	75	61	55
Water	100	100	100	100	100

4.2.6 Overland Flow Runoff Roughness

The Overland Flow Roughness Zones intersect the honeycomb mesh and roughness set to establish area-weighted Manning's dampening thresholds (n). They are spatially defined by the roughness zone map layer, which for this model, is identical to the land use cover map layer. Manning's roughness coefficients were assigned according to each land use. **Table 4-3** summarizes the overland flow roughness values applied for each land use case. These values are consistent with the roughness values being applied by Miami-Dade County for the C-4 and C-6 SWMP models. The roughness zone map layer has a corresponding lookup table that provides further detail regarding the hydrologic characteristics of each feature within the layer. **Figure 4-4** shows an example of the roughness map layer set-up in ICPRv4.

Table 4-3 – Overland Flow Roughness Applied per Land Use

Roughness Set Data

Roughness Zone	Shallow Manning's N	Deep Manning's N	Depth Range	Damping Threshold	Area Reduction Factor
Agriculture	0.2	0.1	3	0	1
Cemeteries	0.2	0.1	3	0	1
Communications , Utilit…	0.06	0.03	3	0	1
Expressway Right of …	0.2	0.1	3	0	1
Industrial	0.06	0.03	3	0	1
Industrial Extraction	0.06	0.03	3	0	1
Institutional	0.06	0.03	3	0	1
Low-Density Multi-Family	0.06	0.03	3	0	1
Multi-Family, Migrant …	0.06	0.03	3	0	1
Office	0.06	0.03	3	0	1
Parks (Including Prese…	0.2	0.1	3	0	1
Shopping Centers, Co…	0.06	0.03	3	0	1
Single-Family	0.06	0.03	3	0	1
Streets/Roads, Expre…	0.06	0.03	3	0	1
Streets/Roads/Canals …	0.06	0.03	3	0	1
Townhouses	0.06	0.03	3	0	1
Transient-Residential (…	0.06	0.03	3	0	1
Two-Family (Duplexes)	0.06	0.03	3	0	1
Vacant Unprotected	0.2	0.1	3	0	1
Vacant, Government …	0.2	0.1	3	0	1
Water	0.2	0.1	3	0	1
Void	0.06	0.03	3	0	1

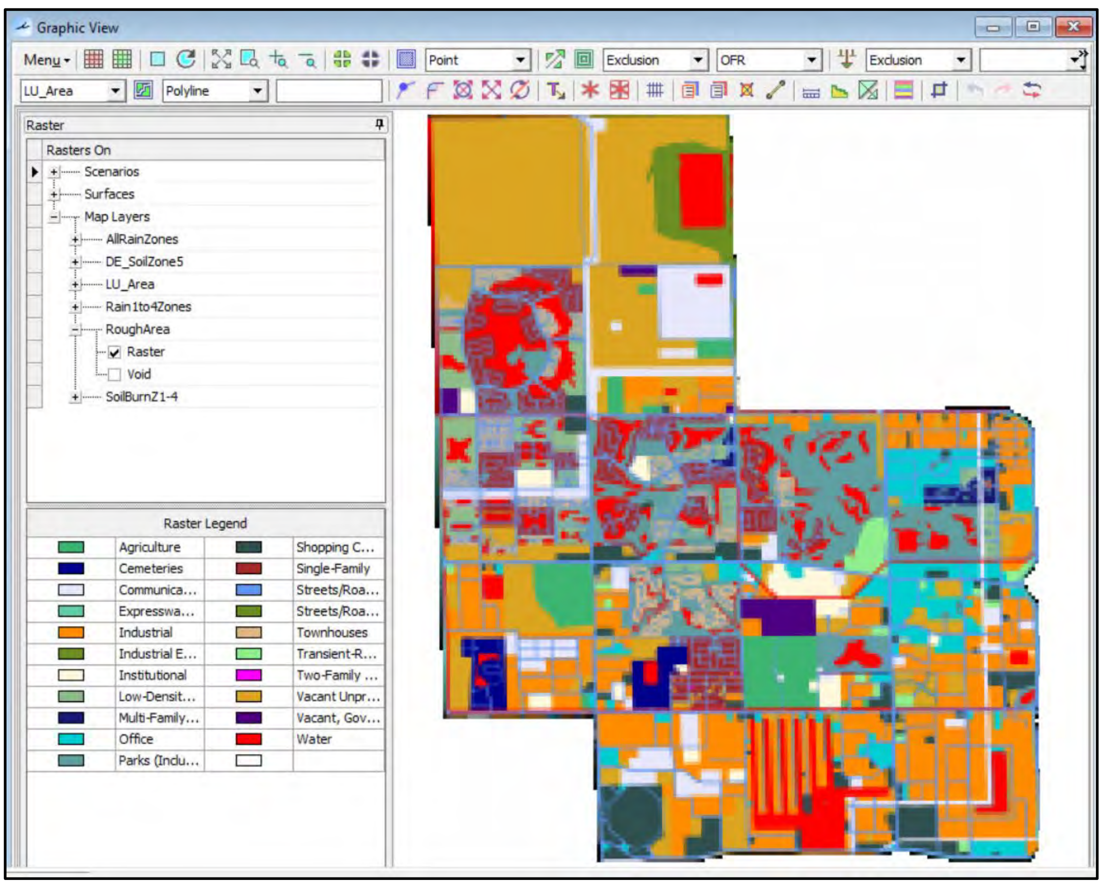


Figure 4-4 – The Roughness Zone Map Layer

4.2.7 Pond Control Volumes

The Pond Control Volumes are used to incorporate "level pool" hydraulics inside a 2D overland flow region. The mesh inside the pond control volume is used strictly to build the honeycomb for infiltration calculations of excess rainfall (i.e., hydrologic purposes). Pond Control Volumes in this model were developed for all private properties and areas that do not discharge to any of the City's systems. Environmental Resource Permits (ERPs) were used to determine applicable positive drainage systems for private properties. A stage-area relationship was developed for each pond control volume node from the ground surface DEM. **Figure 4-5** shows the pond control volumes in the ICPRv4 model that are located within the City's limits.

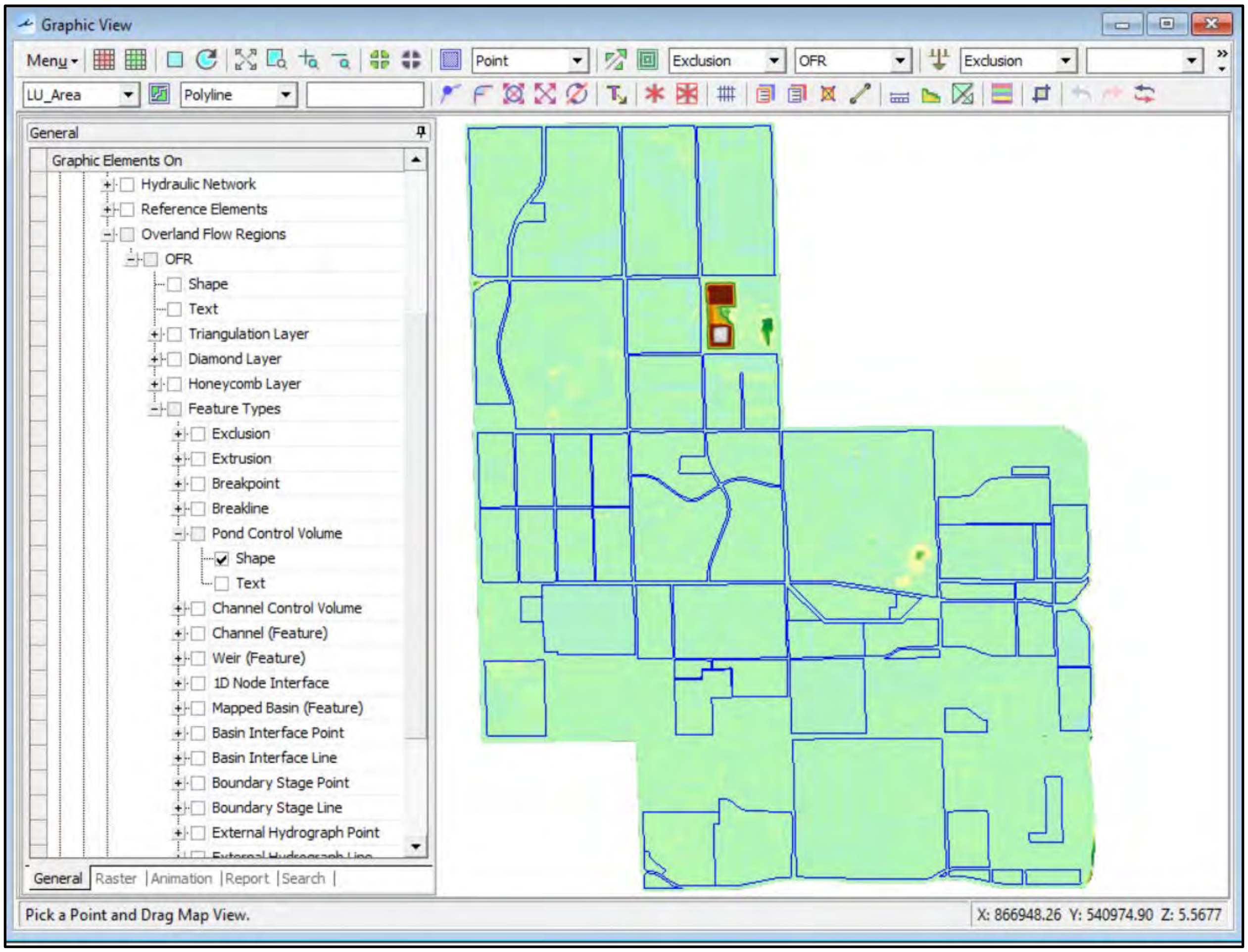


Figure 4-5 – Pond Control Volume Map Layer

4.2.8 Channel Control Volumes

The Channel Control Volume feature is used in the model as the mechanism to interface 1D and 2D hydraulics of channels. The outer edges of the channel control volume generally follow the TOB of the channel. Flow is transferred between the 2D overland flow links and 1D nodes along the edges of the channel control volume. **Figure 4-6** shows the channel control volumes for the canals within the City's model domain in ICPRv4.

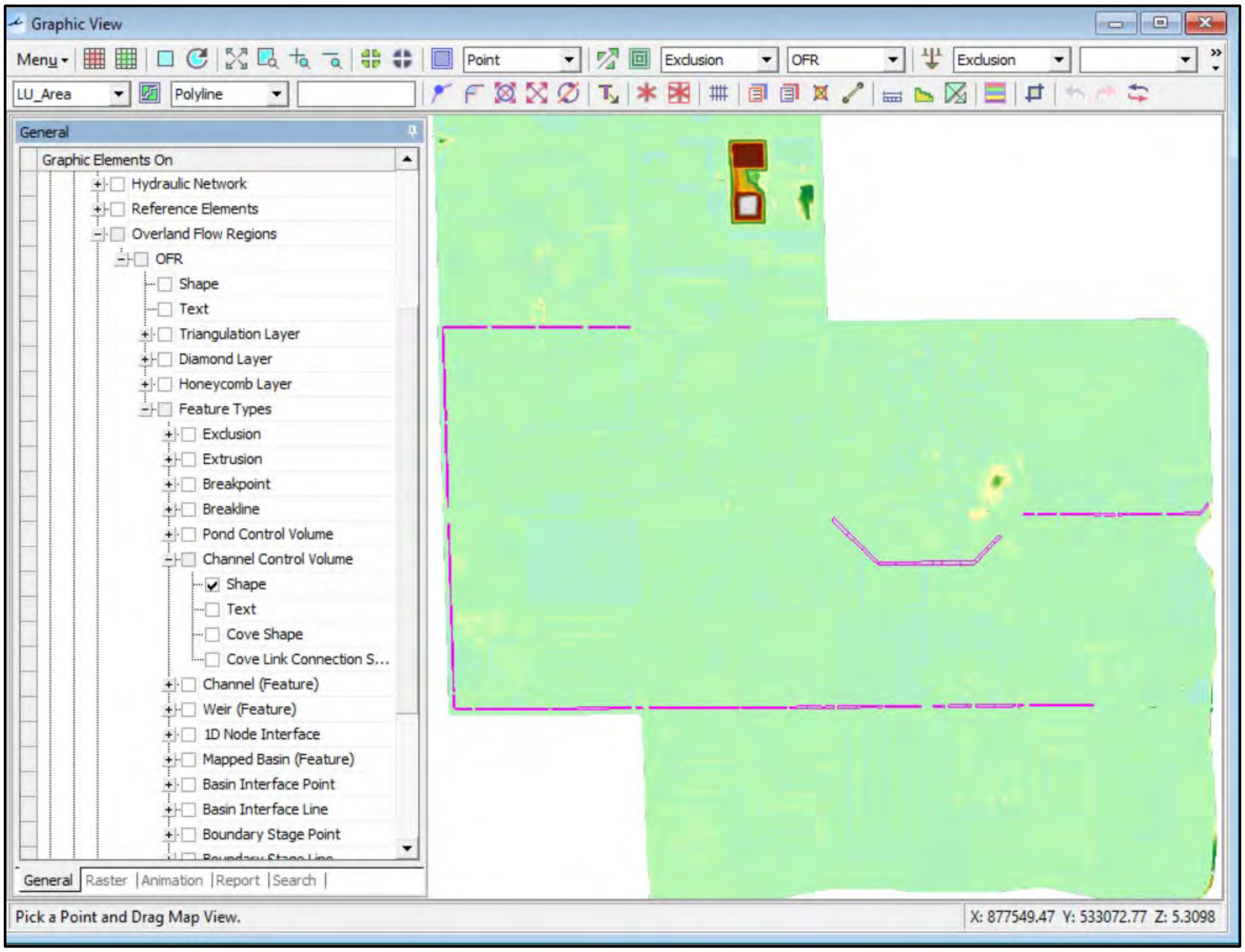


Figure 4-6 – Channel Control Volume Map Layer

4.2.9 Extrusion Zones

Extrusion Zones, in the form of closed polygons, were implemented into the model to represent physical impediments to flow (i.e., building structure). For these zones, overland flow is not permitted to cross the polygon boundary, though the flow is permitted along its perimeter. ICPRv4 assumes the extrusion area is 100% impervious with no initial abstractions. Moreover, stormwater runoff generated within the bounds of the extrusion zone is permitted to flow out of the polygon, with flows being proportionally distributed along its perimeter. The area enclosed by the extrusion polygon does not interact with the 2D overland flow model. The extrusion zones for the City's model were only considered for areas that fell outside of pond control volumes. **Figure 4-7** shows the extrusions for the building structures within the City's model domain in ICPRv4.

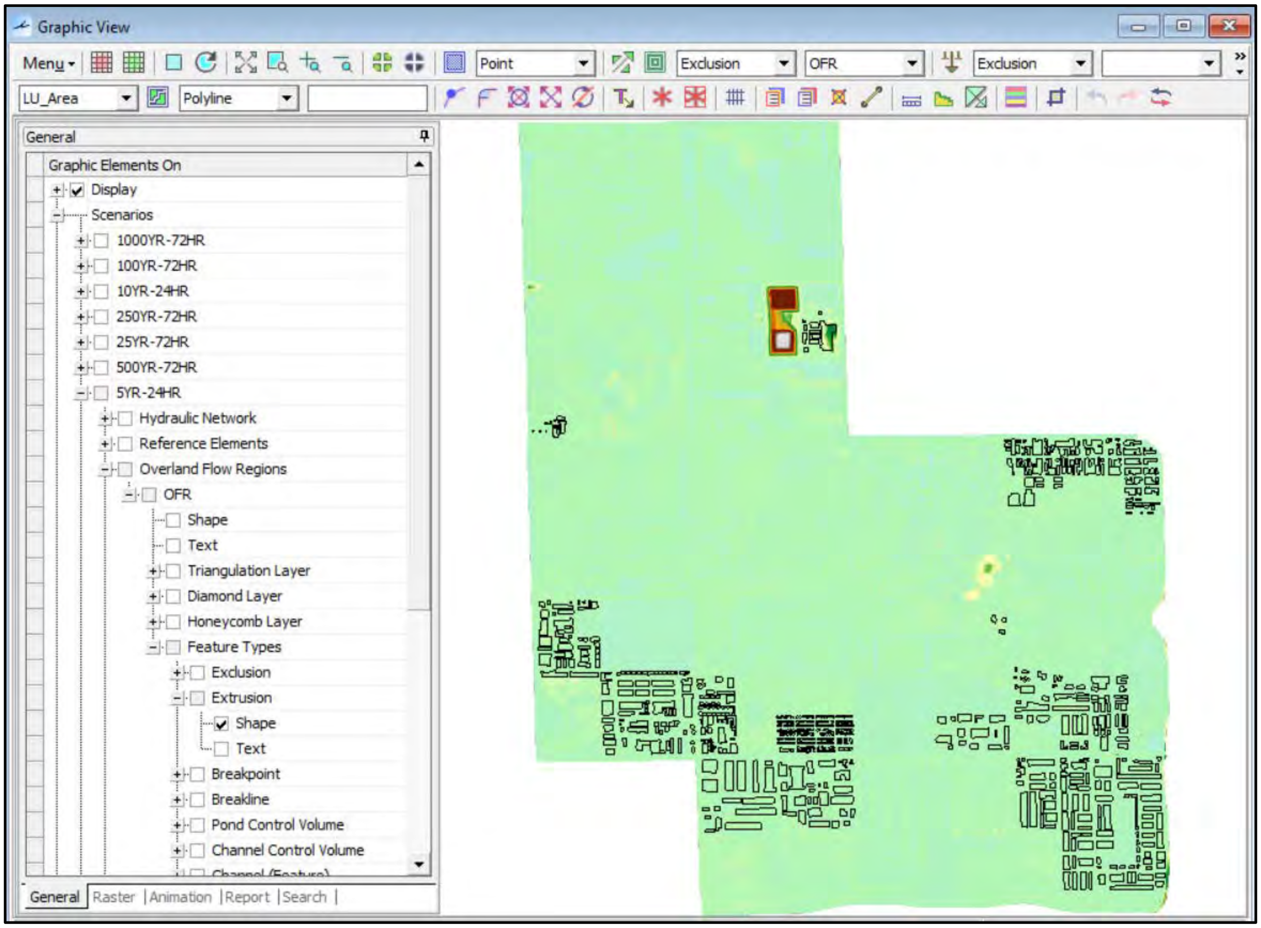


Figure 4-7 – Extrusion Zone Map Layer

4.2.10 Breaklines

The Breaklines are used to refine the triangular mesh within the ICPRv4 model. Breaklines were incorporated into the 2D model to more accurately represent roadways and to ensure that the triangular mesh edges run along the correct flow paths. A road centerline shapefile provided by the City was imported into ICPRv4 to delineate the breaklines. **Figure 4-8** shows an example of the breaklines for a section of the City's domain in ICPRv4.

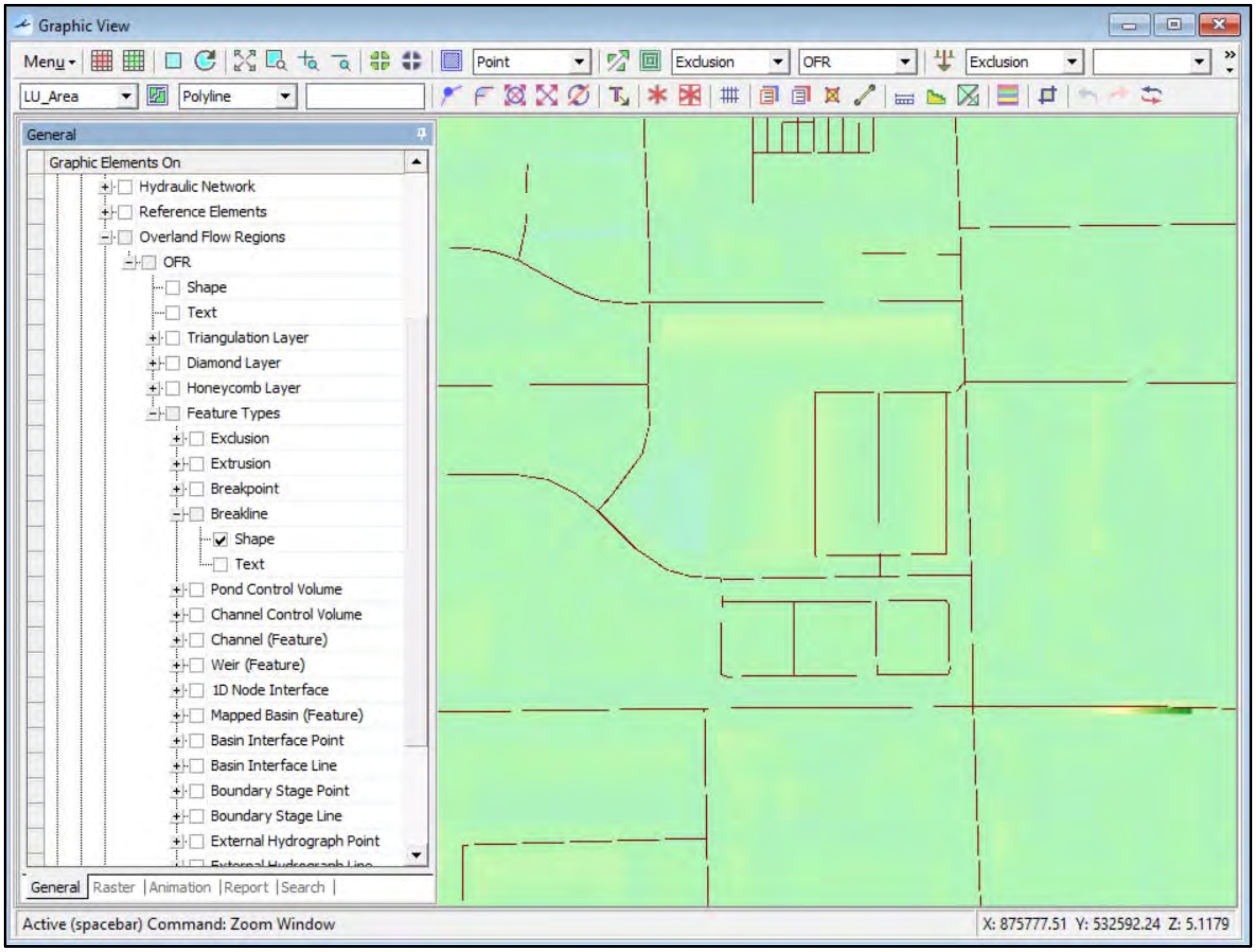


Figure 4-8 – Breakline Map Layer for a Section of the City's Domain

4.2.11 Breakpoints

The Breakpoints were added into the 2D model for refinement of the triangular mesh. Breakpoints were placed evenly throughout the model domain using a 50-foot spacing buffer. This ensured the presence of triangle vertices (2D nodes) every 50 feet. It should be noted that several smaller spacing intervals were evaluated. However, breakpoint intervals of less than 50 feet generated models with extensive simulation run times of greater than 30 hours. **Figure 4-9** shows an example of the breakpoint's placement (yellow) for a section of the City's domain in ICPRv4.

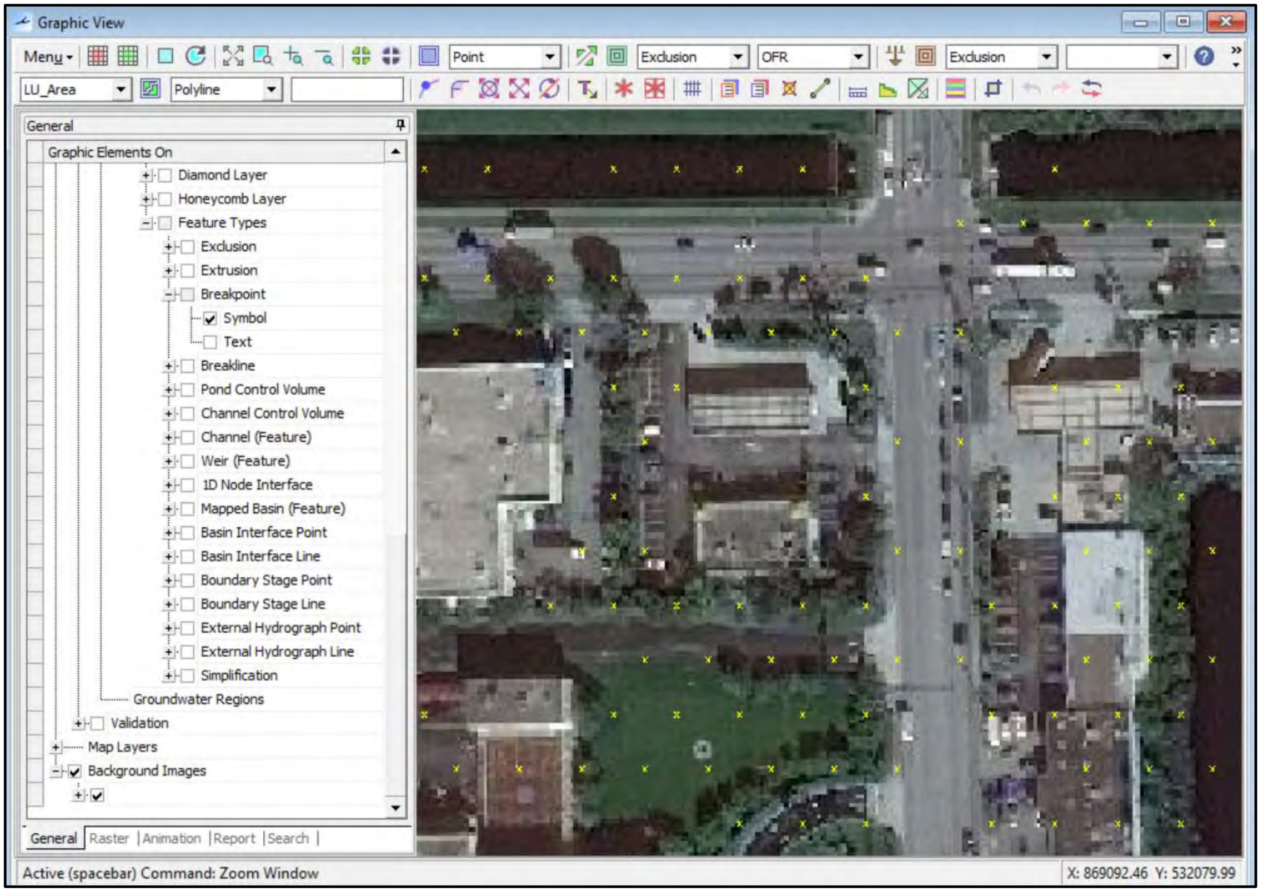


Figure 4-9 – Breakpoint Map Layer for a Section of the City's Domain

4.2.12 Rainfall Zones

The rainfall zones are specific to the analysis being performed: model validation or design storm event simulations. The approach for establishing the rainfall zones for these scenarios is described in **Section 4.9** and **Section 4.12.2**, respectively.

4.3 2D Mesh Development

Each model domain described in **Section 4.6** and **Section 4.11** was modeled as a separate Overland Flow Region within the 2D component of ICPRv4. Overland Flow Regions are characterized by their land use classifications, soil zone classifications, roughness values, elevation raster values (i.e., DEM), and rainfall zone values. The soil zone, land cover zone, roughness zone, and rainfall zone parameters are intersected to characterize the infiltration capabilities and precipitation amount for each 2D mesh and honeycomb basin. **Figure 4-10** illustrates the mesh and honeycomb basins in a portion of the validation model. A mass balance for each honeycomb basin was performed, which calculated the total precipitation minus the total infiltration for each honeycomb basin based on the soil zone, land cover zone, roughness zone, and rainfall zone and their associated lookup tables for CN and roughness.

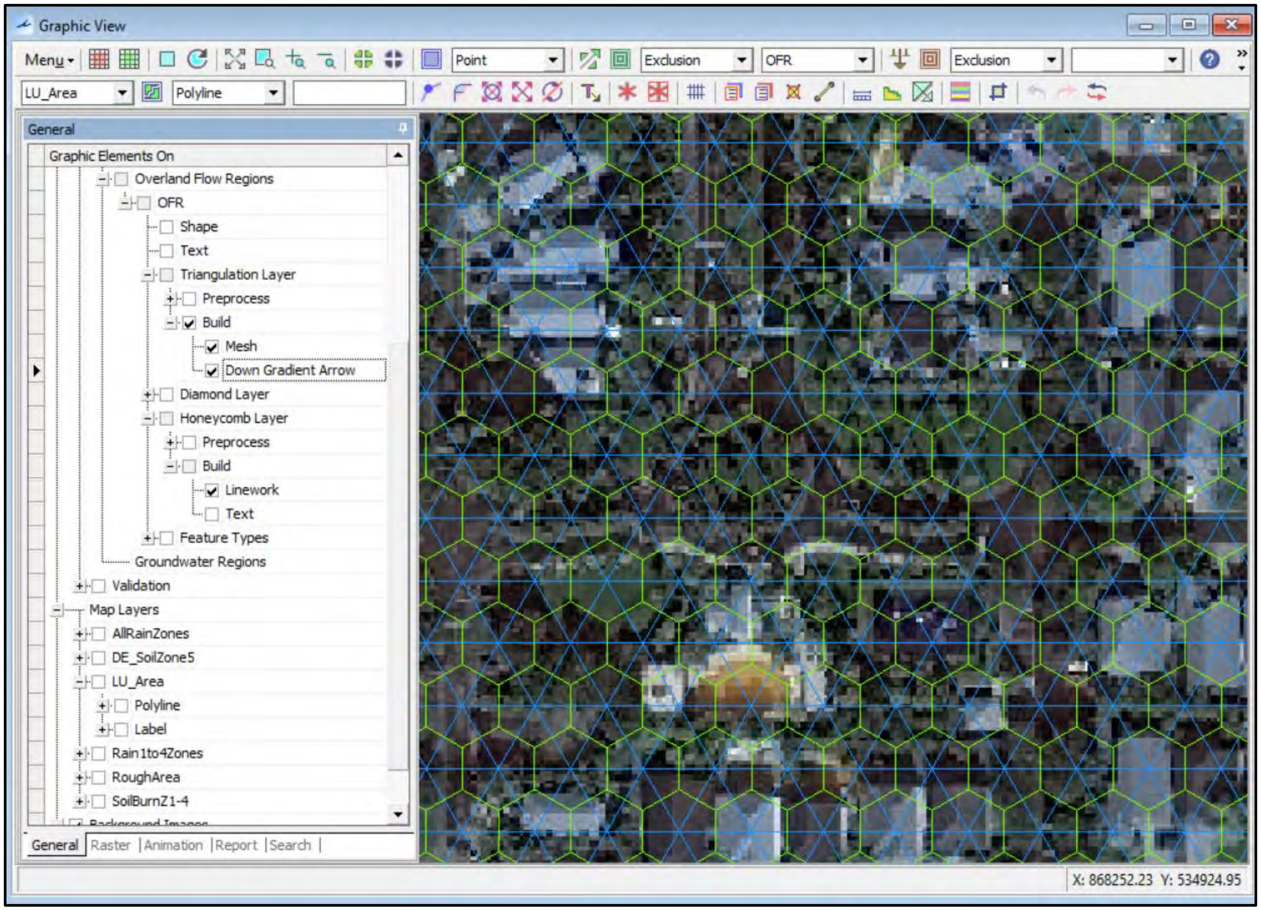


Figure 4-10 – Mesh and Honeycomb for a Section of the City's Domain

The 2D triangular mesh defines the computational resolution of the model, i.e., how accurately the model can read and use the information from the input DEM and the other model layers. Several 2D features can be used to define the mesh. For example, break lines and breakpoints were the most common 2D features used in the development of the model. Breaklines were incorporated into the 2D model to represent the roadways and ensure that the triangular mesh edges run along the correct paths to simulate flow. A road centerline shapefile provided by the City was imported into ICPRv4 to delineate the brake lines as described in **Section 4.2.10**. Breakpoints were placed evenly throughout the model domains 50 feet apart, which guarantees that there will be triangle vertices (i.e., 2D nodes) every 50 feet, as described in **Section 4.2.10**. **Figure 4-11** shows an example of how the triangular mesh (blue) was set-up along with one of the brake lines (yellow) and how the DEM establishes the down-gradient arrows along with the mesh.

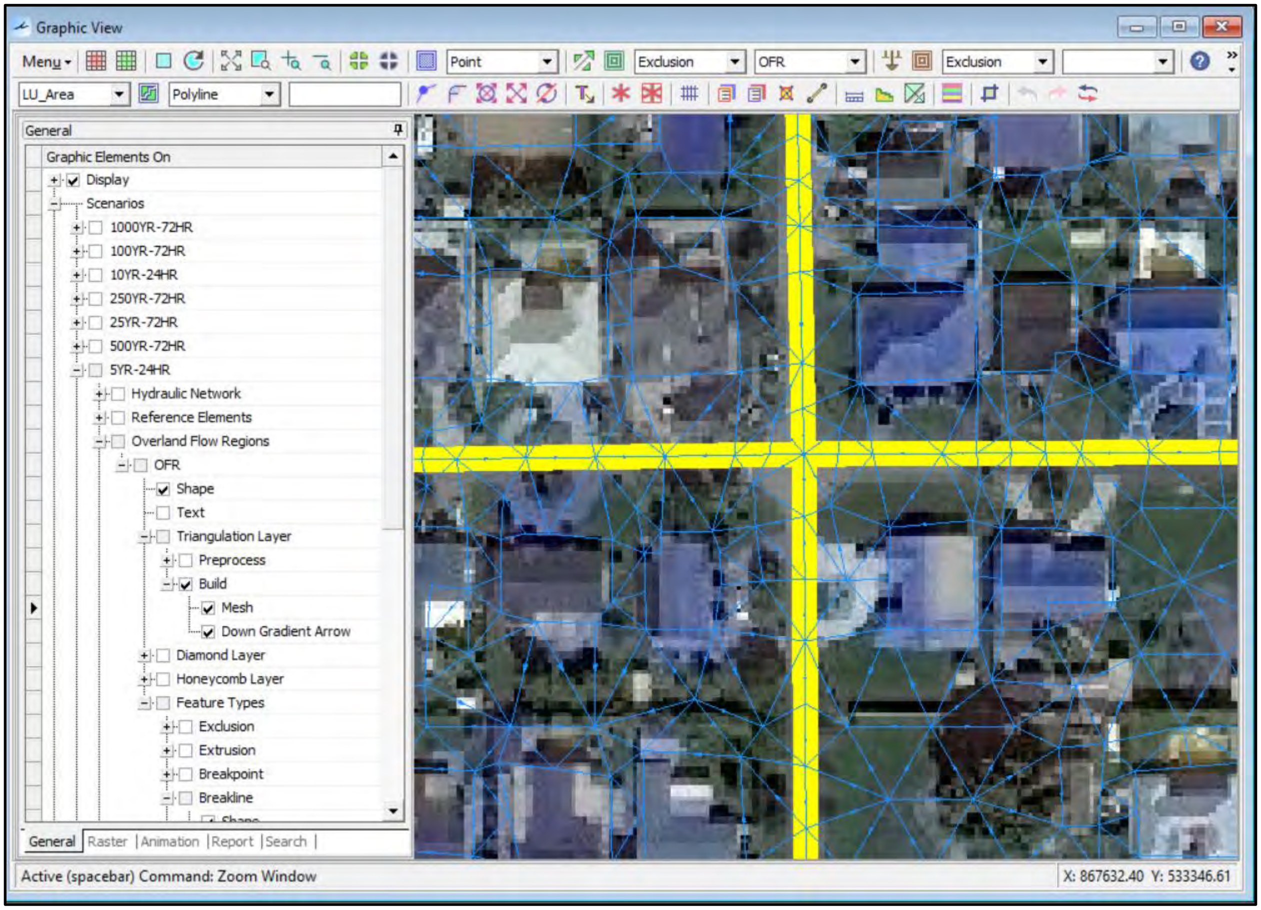


Figure 4-11 – Triangular Mesh and Breakline with Downgradient Arrows

Once the geometry of the mesh was defined, the links of the triangular mesh and the cells of the diamond and honeycomb meshes were given characteristics based on the DEM, soil zone map, land zone map, and roughness zone map. The soil zone, land cover zone, and roughness zone map layers each have a corresponding lookup table to further describe the hydrologic characteristics of the features in the map layers. **Figure 4-12** shows the triangular (blue), diamond (yellow), and honeycomb (green) meshes that characterize the 2D hydraulic model.

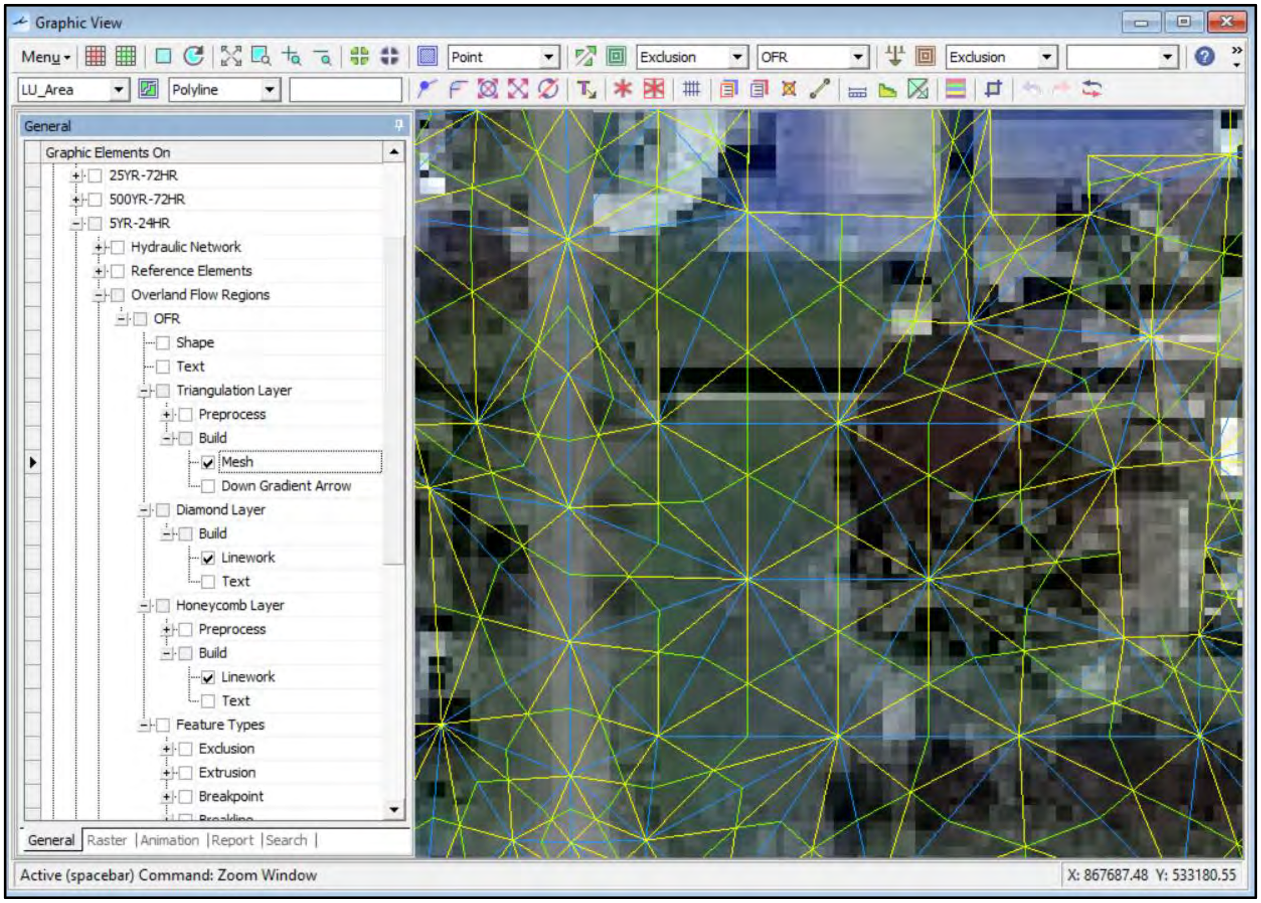


Figure 4-12 – Triangular, Diamond and Honeycomb Meshes

The CN excess rainfall method was used to model soil water storage and the corresponding runoff volume. The CN for each of the honeycomb catchment areas is defined by the soils map layer and land cover map layer, as described in **Section 4.2.5** and **Table 4-2**. Roughness zones characterize the diamond mesh and define the manning's n values for the overland flow links within the diamond-shaped cells. Roughness zones are spatially defined by the respective map layer, which in the case of this model, is identical to the land cover map layer, as described in **Section 4.2.6** and **Table 4-3**.

4.4 1D Hydraulic Model Setup

In ICPRv4, a storm sewer system is modeled via a network of nodes/junctions and links. A node is a discrete location in the drainage system where runoff enters the system, and conservation of mass or continuity is maintained. The nodes simulate the hydrologic conditions within the drainage system. In turn, links represent connections between nodes and are used to convey rainfall runoff through the system. The links are used to model the hydraulic response of the conveyance system for a defined hydrologic condition.

The stormwater pipe, manhole, and inlet spatial datasets obtained from the City of Doral Geodatabase were used to define the 1D features of the hydraulic model within the City ROW. The stormwater pipes shapefile was used in the model for the 1D links, while the manholes shapefile and the inlets shapefile were used to model 1D and 1D interface node features, respectively. The 1D interface node features allow 1D links to be connected to the 2D mesh, thereby permitting excess rainfall to be interchanged between the 1D and 2D model components.

The type of nodes used to represent manholes within the model is referred to as the Stage/Area nodes. In addition, nodes at the basin's outfalls are referred to as time/stage nodes, which are set to the boundary conditions provided by the County and described in **Section 4.9** and **4.12.3** for the validation and design storm events, respectively.

4.4.1 Stormwater Conveyance System

Data for the stormwater conveyance system was obtained from the City's stormwater infrastructure GIS database. The City also provided supplemental as-builts and Computer Aided Design (CAD) files of the completed CIP that were recommended in the 2014 SWMP. **Table 4-4** shows the as-builts that were obtained from the City to supplement the City's stormwater infrastructure GIS database.

Table 4-4 – Project Data from the City of Doral

PROJECT LOCATION	PROJECT YEAR
NW 52ND, 53RD, 54TH, & 55TH b/w NW 79TH Avenue & 77TH Avenue	2016
NW 97TH Avenue b/w 70TH Street & 74TH Street	2016
NW 82ND Avenue & NW 12TH Street	2016
NW 28TH Terrace b/w 99TH Avenue & 102ND Avenue	2017
NW 31ST Street & NW 82ND Avenue	2017
27TH Terrace & 98TH Avenue	2017
27TH Street b/w 98TH Avenue & 99TH Avenue	2017
26TH Street & 102ND Avenue	2017
NW 102ND Avenue b/w NW 27TH Terrace & NW 28TH Terrace	2017
NW 27TH Terrace b/w NW 100TH Avenue & NW 102ND Avenue	2017
NW 114TH Avenue b/w NW 72ND Street & NW 74TH Street	2017
NW 77TH Terrace & NW 113TH Avenue	2017
NW 82ND Terrace & NW 113TH Court	2017
NW 102ND Place b/w NW 21ST Street & NW 25TH Street	2017
NW 21ST Street b/w NW 102ND Place & NW 102ND Avenue	2017
NW 108TH Avenue & NW 29TH Street	2017
NW 21ST Street & NW 99TH Avenue	2017

ERPs were used to determine applicable positive drainage systems for private properties.

4.4.2 Inlets and Storm Drains

A selected number of inlets and storm drains were extracted from the Stormwater geodatabase provided by the City of Doral. Only inlets and manholes that discharge into bodies of water were coded in the model. **Figure 4-13** shows an example of some of the selected drainage infrastructure within the model.

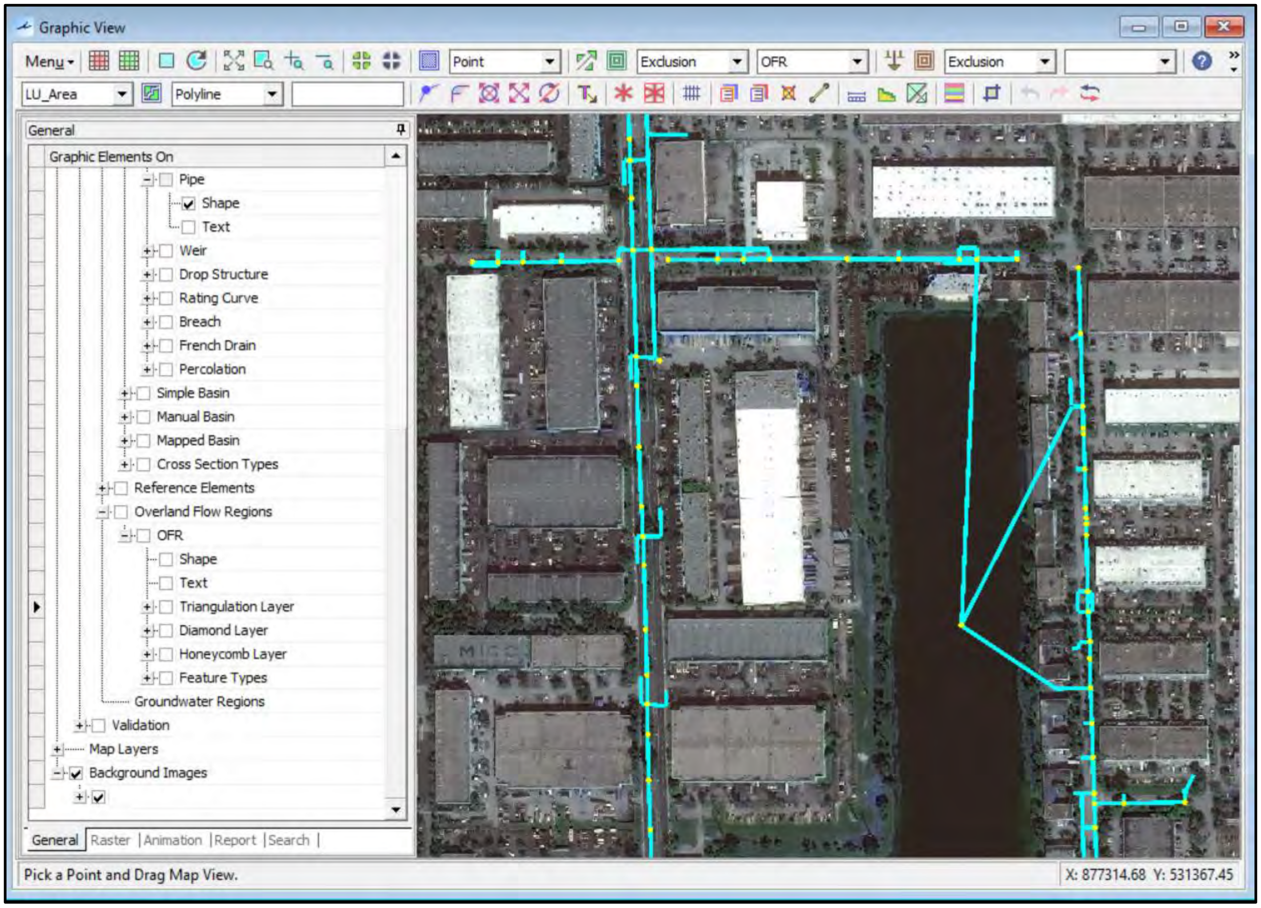


Figure 4-13 – Drainage Infrastructure within a Section of the City's Domain

4.5 Boundary Conditions

Boundary conditions were requested from the County at nine (9) requested locations. **Figure 4-14** shows the boundary locations requested. The County provided peak elevation data for all nine boundary conditions locations requested for all design storm events, except for 250-year, 3-day design storm event. **Table 4-5** provides a summary of peak stages at each of the boundary stage locations.

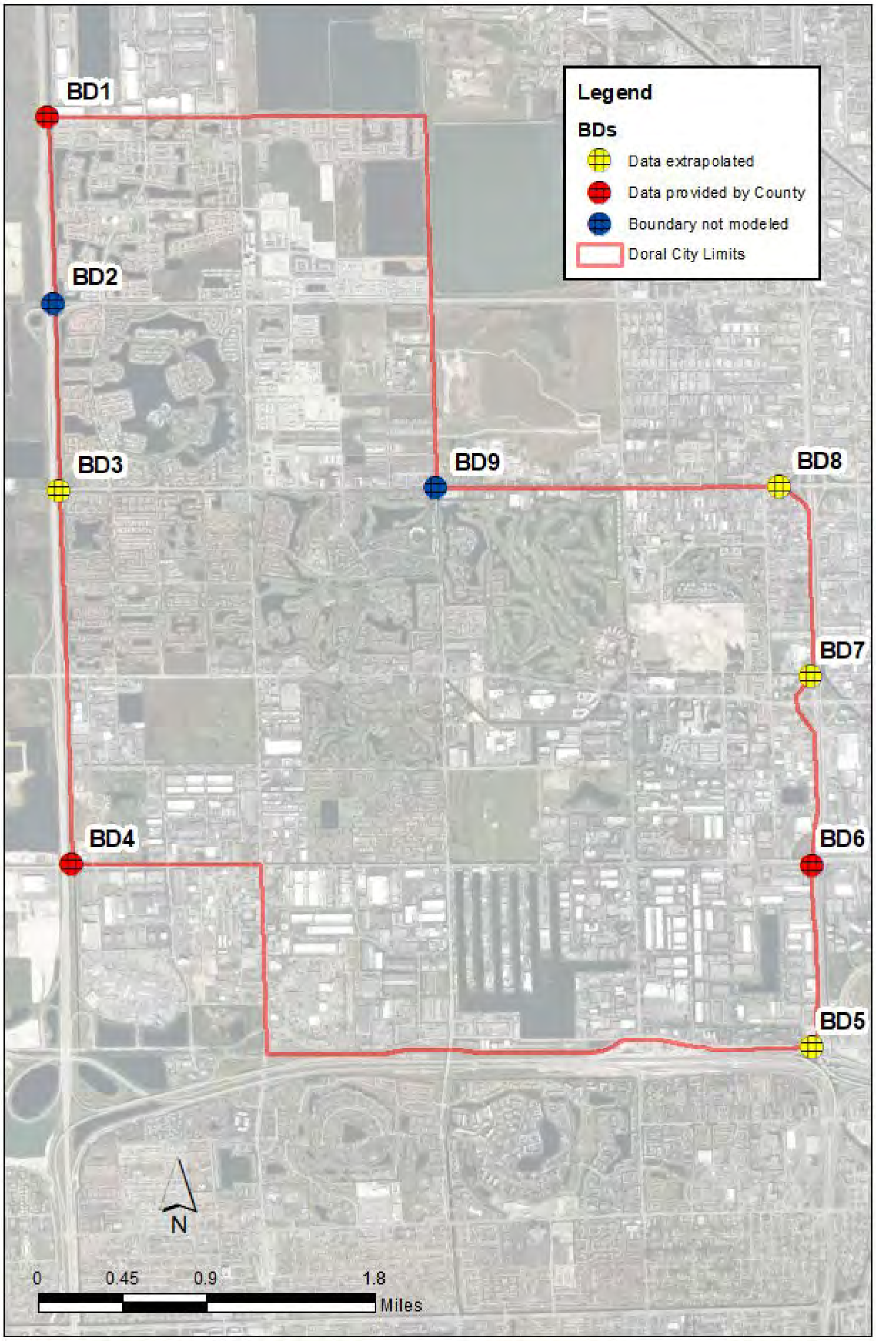


Figure 4-14 – Boundary Locations Requested

The County, however, only provided time-stage hydrographs for only three boundary condition locations: BD1, BD4, and BD6. These three locations are depicted in **Figure 4-14**, and the time-stage hydrographs for these boundary condition locations are included in **Appendix D.** The time-stage hydrographs for the boundary conditions needed for the model that were not provided by the County included BD3, BD5, BD6, and BD7. Boundary conditions BD2 and BD9 were not needed for the model development. The canal time-stage hydrographs for BD3, BD5, BD6, and BD7 were extrapolated and derived from the stage differential between the peak stages provided by the County.

Table 4-5 – Summary of Peak Stages

2020 MODEL RESULTS PEAK STAGE ELEVATIONS (NAVD88)						
Requested Boundary Point	**5YR-24HR**	**10YR-24HR**	**25YR-72HR**	**100YR-72HR**	**500YR-72HR**	**1000YR-72HR**
BD1	3.83	3.84	4.01	4.27	5.29	5.78
BD2	3.83	3.84	4.01	4.32	5.29	5.78
BD3	3.82	3.83	4.02	4.37	5.30	5.81
BD4	3.70	3.73	4.18	5.15	6.24	6.65
BD5	3.54	3.56	4.14	5.56	6.92	7.34
BD6	3.54	3.56	4.33	5.82	7.10	7.41
BD7	3.41	3.61	4.22	5.77	6.57	6.95
BD8	3.43	3.65	4.94	5.94	6.79	7.15
BD9	3.43	3.89	5.15	5.94	6.79	7.15

4.6 Hydrologic and Hydraulic Model Validation

4.7 Validation Event Selection

The model validation period was selected based on rainfall data measured on May 26, 2020, which coincided with heavy rainfall from a tropical storm that transversed across the City and County. Based on communications with the City, it was agreed that the most recent rain event produced flooding conditions in many areas of the City. Thus, the largest rainfall event observed during this time was chosen as the validation period.

4.8 Observed Flooding Conditions

During the heavy rainfall event on May 26, 2020, there was observed flooding through the City and the County. The most prominent flooding conditions were observed in the following areas:

- Certain areas in Vanderbilt reached up to eight (8) inches
- NW 77th Court and NW 56th Street showed four (4) feet of standing water about eight (8) hours after the event
- NW 79th Avenue, between 58th Street and NW 36th Street, exhibited flooding conditions extending over the curb and gutter and into the sidewalk
- NW 84th Avenue and NW 56th Street intersection showed about three to four (3-4) feet of standing water
- Canal stages throughout the City either reached or extended beyond the TOB. On NW 42nd Street, between NW 79th Avenue and NW 87th Avenue, the canal was noted as overflowing with water extending into the existing bike path. Conversely, The north-west portion of the City showed no flooding.

- Finger Lakes flooded (unknown depth)

The City provided rain event maps that show flooding complaints and field observations with pictures, included in **Appendix E.**

4.8.1 Soil Zones

4.8.2 Initial Conditions/Design Highwater

In order to set the initial condition parameters for the 2D mesh and 1D nodes, a Design Highwater (DHW) assumption was made. The DHW for the validation model was calculated by taking the average of the canal stages in the DBHYDRO Snapper Creek Canal at NW 74th Street for the rain events from May 24, 2020, through May 27, 2020. The new DHW was calculated using the following equation:

$$DHW = \frac{(Sum\ of\ canal\ stage\ heights\ for\ rain\ event\ of\ May\ 24, 2020 - May\ 27, 2020)}{4}$$

Table 4-6 shows the Canal Stage data collected between May 24 – 27, 2020.

Table 4-6 – Canal Stage Data between May 24-27, 2020.

DATE	STAGE HEIGHT (FT-NAVD88)
May 24th, 2020	3.89
May 25th, 2020	4.59
May 26th, 2020	4.98
May 27th, 2020	5.35
Average:	**4.50**

Table 4-7 provides a summary of elevations per soil zone based on the DHW.

Table 4-7 – Summary of Elevation per Soil Zone

SOIL ZONE	ELEVATION (FT-NAVD88)
1	< 4.50
2	4.50 – 5.50
3	5.50 – 6.50
4	6.50 – 7.50
5	7.50 <

4.8.3 Rainfall Zones

The rainfall data selected for the validation model is for six hours from May 26, 2020, at 2 pm to May 26, 2020, at 8 pm. The rainfall data were collected from different sources, and the sources were compared to select the data source that most accurately shows the rainfall amount described by the City. The sources included VTScada (provided by City), DBHydro, Nexrad, and Rainvieux, which are all widely used by the County and the SFWMD. Nonetheless, the data retrieved from VTScada was different from the data collected using the other aforementioned sources. Therefore, after discussions with the City on data accuracy, it was agreed that data collected from Rainvieux provided the best representation of observed conditions.

Rain data was retrieved using the Rainvieux platform, which gathers data from 124 gauges that are distributed throughout Miami-Dade County. The Rainvieux software interpolates the information from the rain gauges to cover the entire area via the use of grids. The rain data was selected at 15 minutes intervals with grids covering the entire City. The grid data were then averaged into four (4) major zones, which are shown in **Figure 4-15**. In turn, hydrographs were developed for each rain zone, as shown in **Figure 4-16** through **Figure 4-19**.

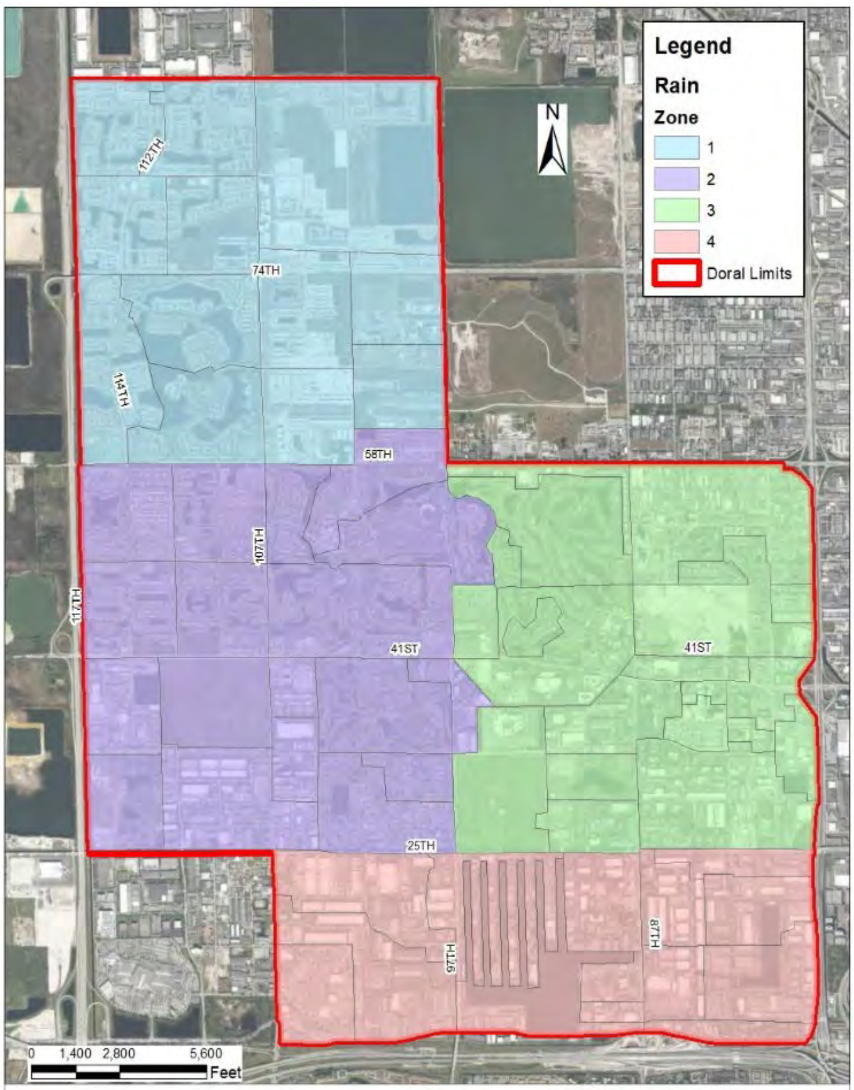


Figure 4-15 – Averaged Rainfall Zones

The rainfall data were consulted from May 23, 2020, to May 27, 2020. Nevertheless, the main rainfall event was observed on May 26, 2020. It is important to note that the rain event associated with May 23rd to May 25th contributed to increasing the initial level in the canals.

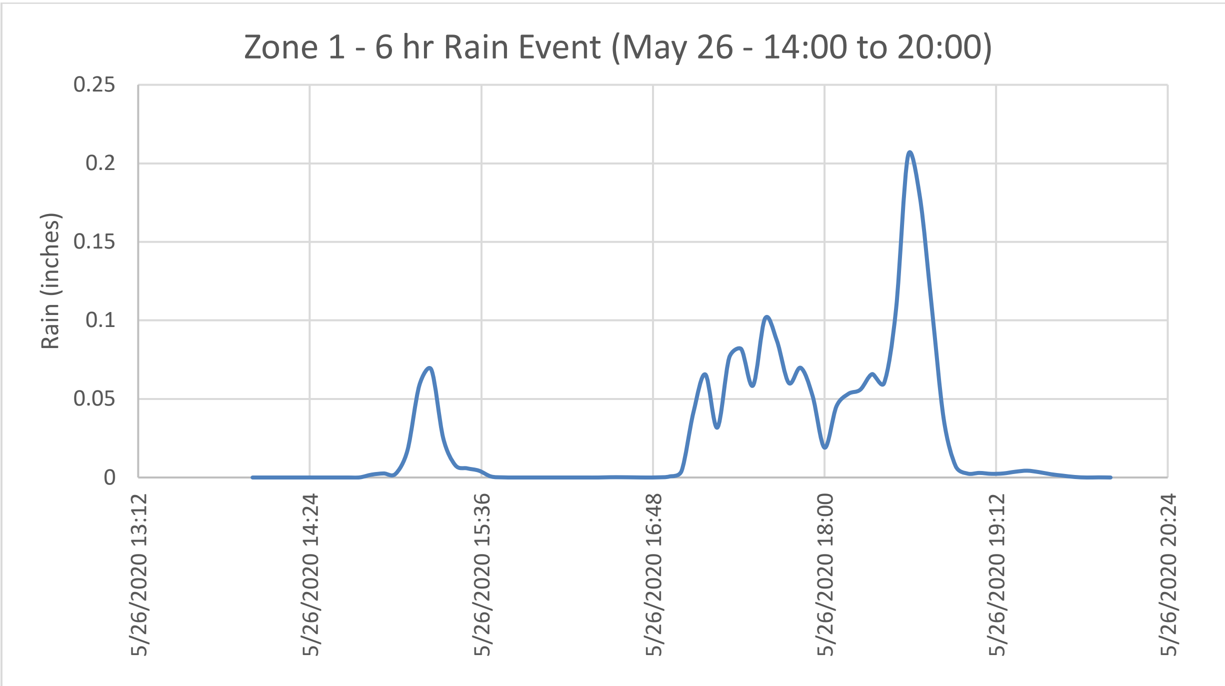


Figure 4-16 – Rain Zone 1 Hydrograph

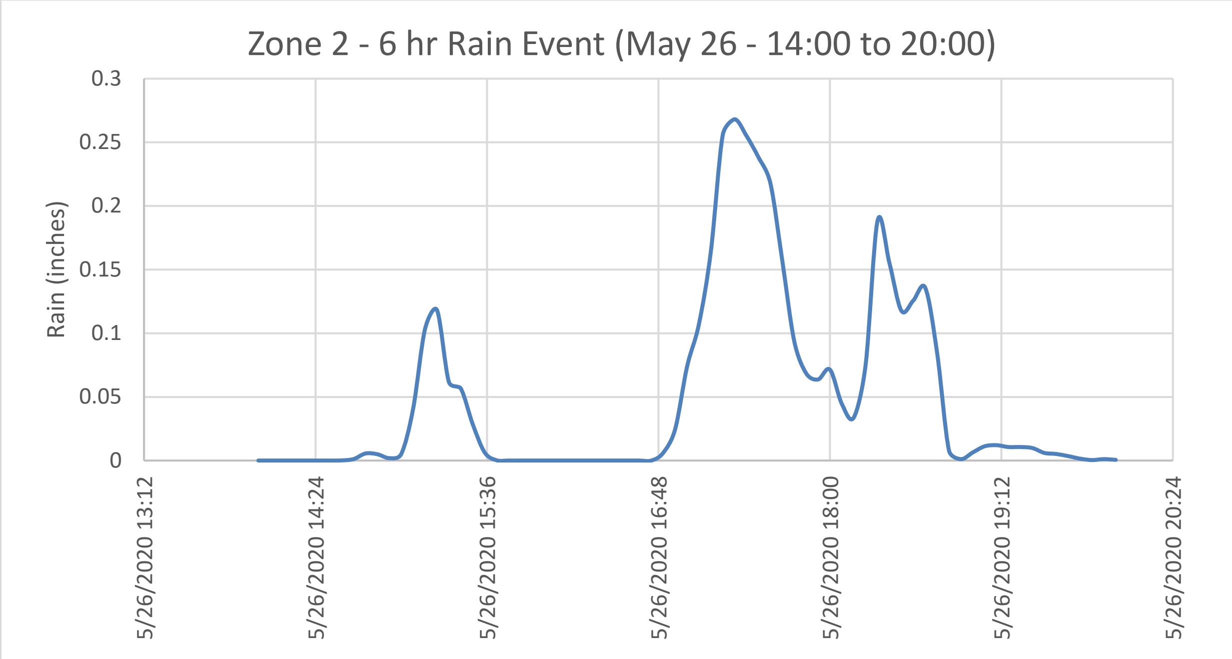


Figure 4-17 – Rain Zone 2 Hydrograph

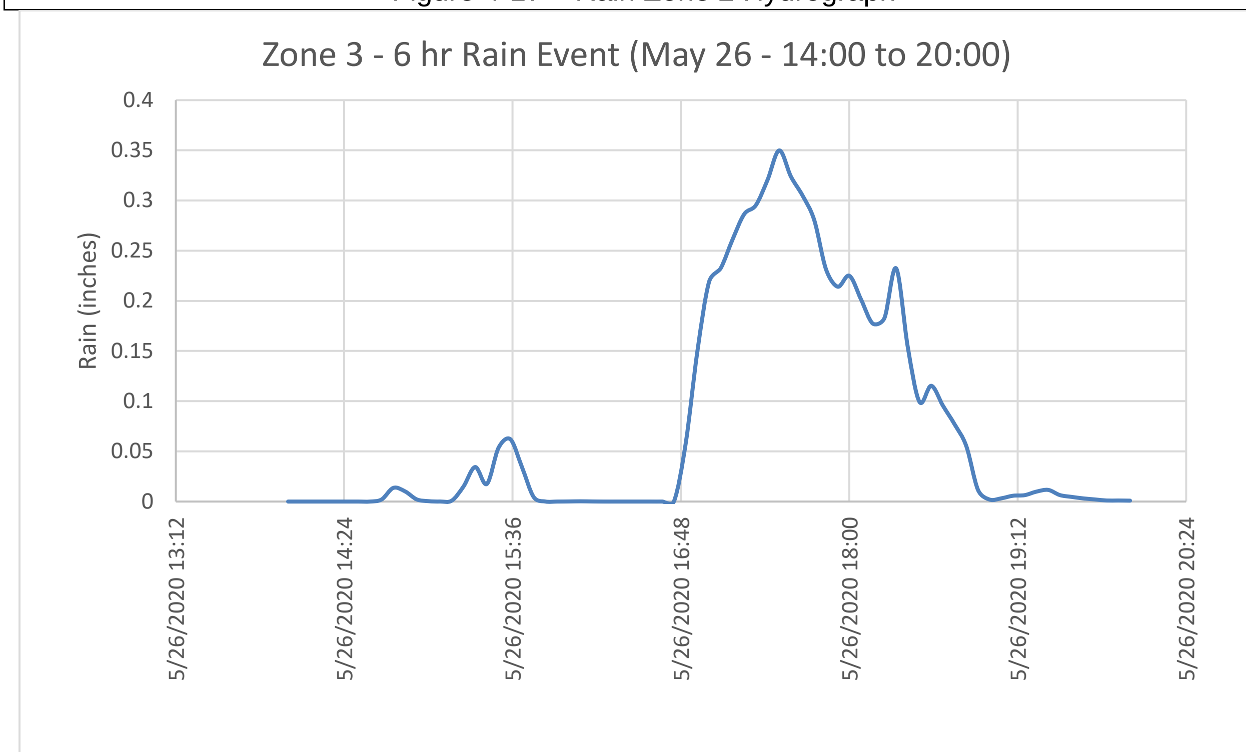


Figure 4-18 – Rain Zone 3 Hydrograph

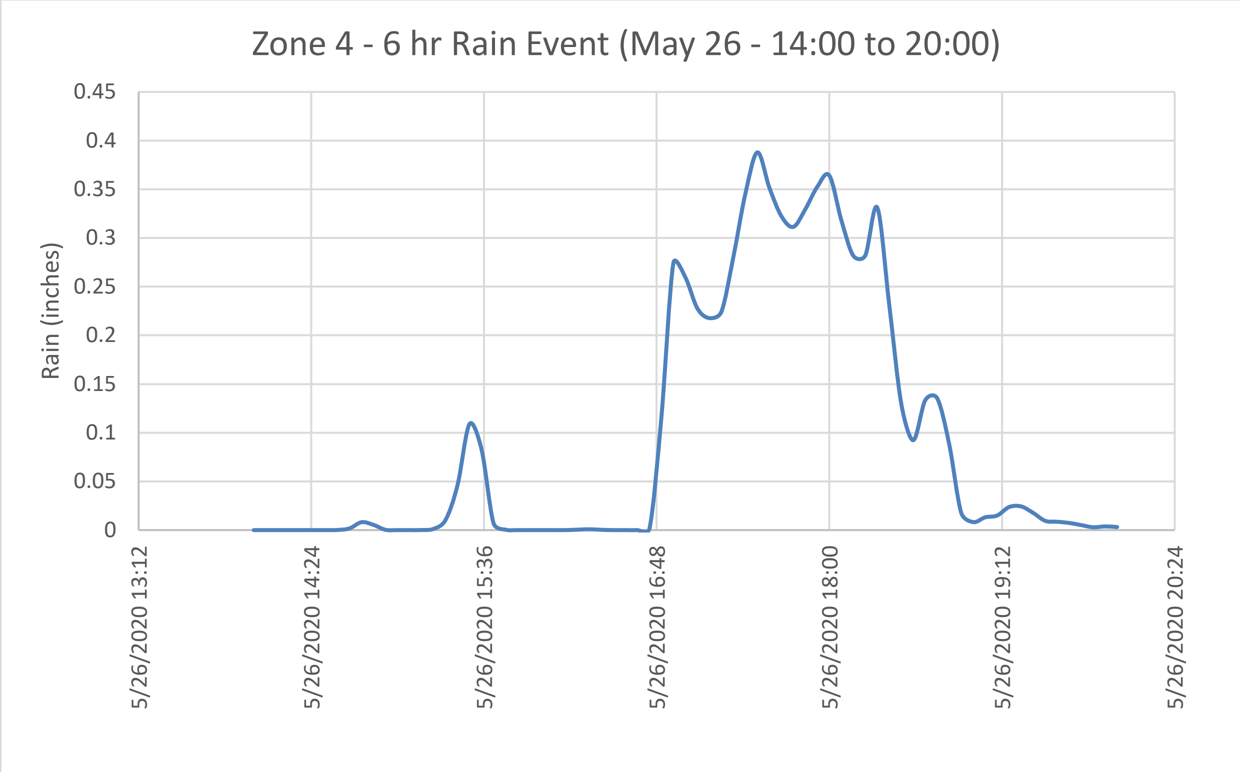


Figure 4-19 – Rain Zone 4 Hydrograph

The results of the hydrograph analyses are shown in **Table 4-8**.

Table 4-8 – Rainvieux Results

RAINVIEUX				
	Zone 1	**Zone 2**	**Zone 3**	**Zone 4**
Total (inches)	1.895	3.55	5.46	6.825
Max (inches)	0.205	0.27	0.35	0.388
Average (inches)	0.026	0.049	0.075	0.093
NOAA	<1-year Return Frequency	1- and 2-year Return Frequency	5-year Return Frequency	10- and 25-year Return Frequency

4.8.4 Boundary Conditions

In order to adequately model the City's storm sewers and canals, a time series at several identified boundary condition points within the perimeter of the City was provided by the County. **Figure 4-14** shows the boundary conditions provided by the County.

The BD1, BD4, and BD6 canal time stage hydrographs were provided by the County, and BD3, BD5, and BD7 boundary canal time stage hydrographs were interpolated and extrapolated based on the stage differential between the stages provided by the County. The interpolation and extrapolation of the boundary conditions were done as follows:

- BD3 = (+/-) BD1
- BD4 = BD4
- BD5 = (+/-) BD6
- BD6 = BD6
- BD7 = (+/-) BD6

Additionally, boundaries were extrapolated to match the higher canal stages due to the heavy rainfall throughout the County. Stages provided by the City were at 4.7 ft-NAVD88. The boundary condition from the County applied for the 0- to 6-hour time-frame from the selected validation event. The time-stage graph for each boundary condition is shown in **Appendix F**.

4.9 Validation Simulation

The validation simulation period was set to run for 6 hours, on May 26, 2020, from 2 pm to 8 pm. The assumptions made to specify the initial and boundary conditions are described in **Sections 4.8.2 and 4.8.4**, respectively. The validation models use the Ranvieux rainfall processed from the stations described in **Section 4.8.3**. Rainfall zone maps were defined to spatially distribute the varying rainfall amounts within each model area.

ICPRv4 has the capability of exporting raster files of 2D model results at any time period. Maximum elevation and ground elevation raster files were exported from ICPRv4. The ground elevation raster was then subtracted from the maximum elevation raster to create a depth of flooding raster. The depth of flooding raster for the validation event is included in **Appendix G.**

The validation flood map was presented to the City on July 14, 2020, for the City to compare the flood depths and extent of flooding predicted by the model to the observed flooding and know flooding complaints. Based on the City's review and comparison, the validation model inundation flood maps for the May 2020 rainfall event generated flooding consistent with flooding complaints and observed flooding.

4.10 Summary of Results

There is a consensus that the model compares well with the observed flooding areas and documented flooding complaints. Therefore, it is perceived that this model is a valid representation of the City's drainage conditions and can be carried forward to assess the flood protection level of service within the City and to evaluate the required stormwater management improvements needed to address flooding within the City and to address future sea level and groundwater rise projections.

4.11 Existing Conditions Design Storm Event Simulations

The Validated ICPRv4 model was used to simulate the following design storm events:

- 5-Year, 24-Hour
- 10-Year, 24-Hour
- 25-Year, 72-Hour
- 100-Year, 72-Hour
- 250-Year, 72-Hour
- 500-Year, 72-Hour
- 1,000-Year, 72-Hour

Prior to simulating the design storm events, the soil zones, rainfall zones, boundary conditions, and initial conditions had to be revised to match the design event conditions. The following sub-sections define the approach used to modify these model parameters.

4.12 Soil Zones

4.12.1 Initial Conditions/Design Highwater (DHW)

The average October groundwater elevation in feet relative to the National Geodetic Vertical Datum of 1929 (NGVD29) for the City was obtained from the County. **Figure 4-20** shows these average groundwater table contour lines. Based on these contours, a DHW of 4.0 ft-NGVD was selected for use within the City's limits (i.e., model domain). In turn, this value was converted from NGVD29 to NAVD88 by subtracting 1.5 feet. Consequently, the initial condition used for the design storm event simulations was set to 2.5 ft-NAVD88.

Table 4-9 provides a summary of elevations for each soil zone based on the above-mentioned DHW.

Table 4-9 – Summary of Elevation per Soil Zone

SOIL ZONE	ELEVATION (FT-NAVD88)
1	< 2.50
2	2.50 – 3.50
3	3.50 – 4.50
4	4.50 – 5.50
5	> 5.50

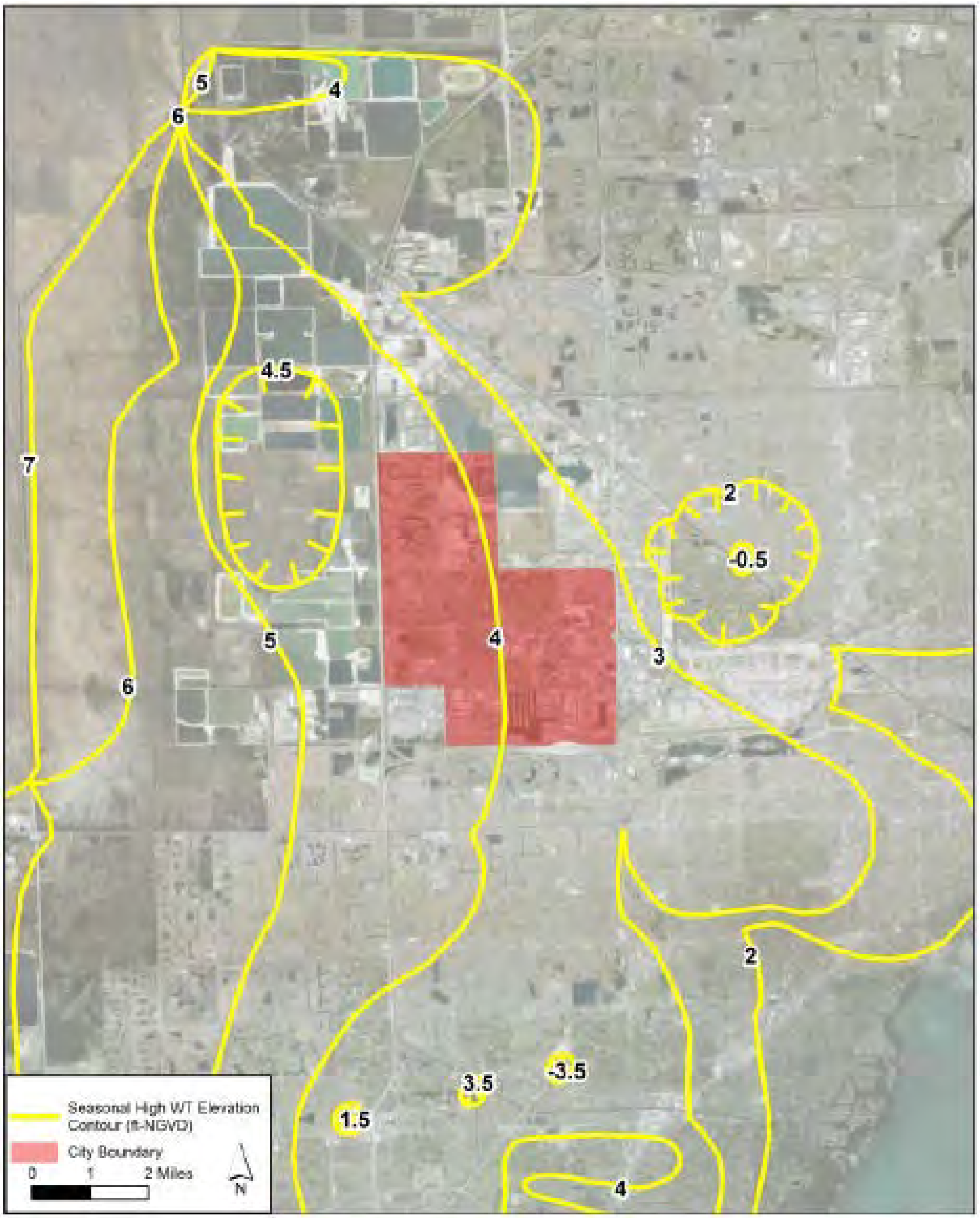


Figure 4-20 – Average October Groundwater Elevation

4.12.2 Rainfall Zones

Rainfall Depths for the design rainfall events were derived from the SFWMD isohyetal design rainfall contour maps and NOAA Atlas 14 precipitation values for the City of Doral. The peak rainfall depths for each design storm were applied throughout the entire model domain due in part to the limited distribution (i.e., variance) in rainfall depth throughout the City. **Table 4-10** summarizes the rainfall depth by design storm event.

Table 4-10 – Rainfall Depth by Design Storm Event

DESIGN STORM EVENT	RAINFALL (INCHES)
5-Year, 24-Hour	7.0
10-Year, 24-Hour	8.5
25-Year, 72-Hour	13.5
100-Year, 72-Hour	18.0
250-Year, 72-Hour	22.0
500-Year, 72-Hour	24.0
1,000-Year, 72-Hour	27.0

4.12.3 Boundary Conditions

In order to adequately model the drainage systems and canals within the City of Doral, a time series at several identified boundary condition points within the perimeter of the City were obtained from the County. **Figure 4-14** shows the boundary conditions provided by the County.

The BD1, BD4, and BD6 canal time stage hydrographs were provided by the County, and BD3, BD5, and BD7 boundary canal time stage hydrographs were extrapolated based on the stage differential between the stages provided by the County. The extrapolation of the boundary conditions was done as follows:

- BD3 = (+/-) BD1
- BD4 = BD4
- BD5 = (+/-) BD6
- BD6 = BD6
- BD7 = (+/-) BD6

The time series was started at the time the County simulated elevation reached 2.5 ft-NAVD88 (the DHW elevation) and then extended for 24 or 72 hours, depending on the design storm event duration. However, for the 250-, 500-, and 1000-year design storm events, this approach did not capture the peak stages simulated by the County. **Figure 4-21** shows this condition for the BD4 boundary condition as a sample. The time period selected for the boundary conditions had to be shifted, as shown in **Figure 4-21**, in order to capture the peak. Boundary conditions for the design storm events are included in **Appendix H**.

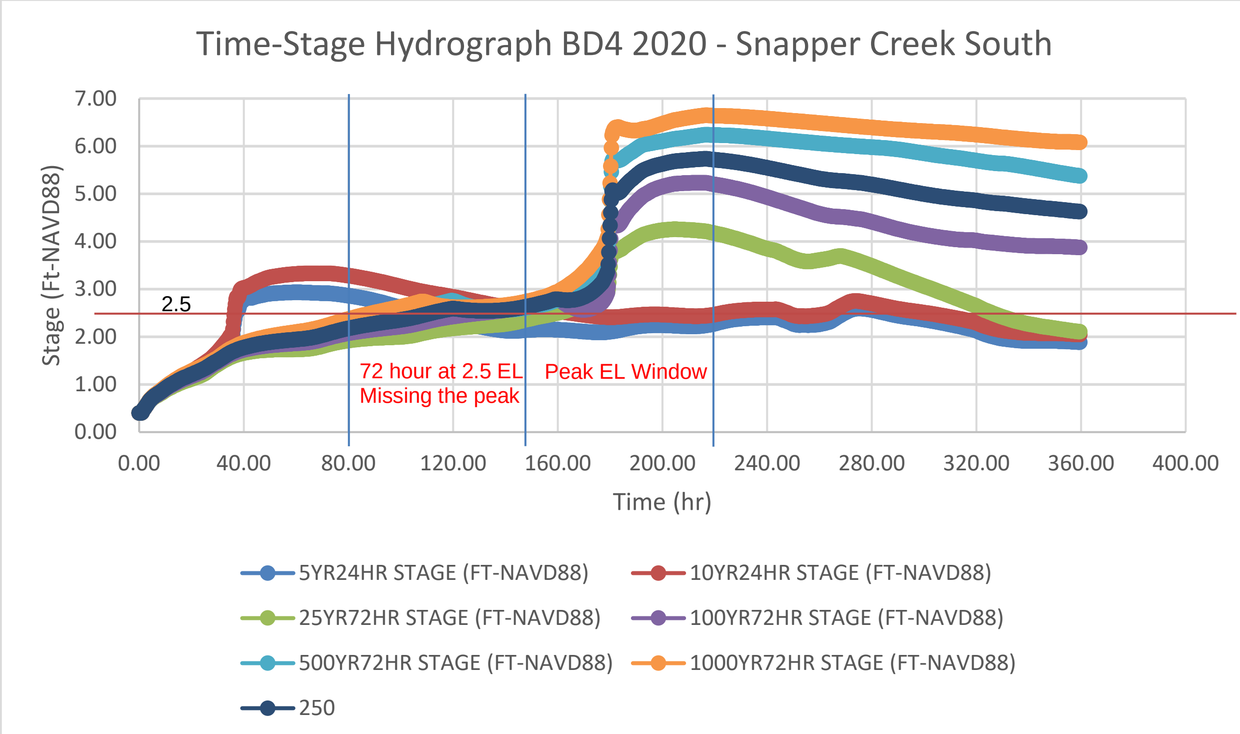


Figure 4-21 – Time-Stage Hydrograph for BD4

4.13 Design Storm Event Simulations

The validated ICPRv4 model documented in **Section 4.6** was used to simulate the level of flooding throughout the City using the initial conditions, design rainfall, and boundary conditions documented in **Section 4.1**. One set of flood maps was developed:

- Inundation Flood Maps: depth of flooding above the natural ground elevation

Appendix I includes the Inundation Flood Maps maps for each design storm event.

5.0 2014 SWMP SUB-BASIN RANKING APPROACH

5.1 2014 SWMP Flood Problem Area Ranking Procedure

The 2014 SWMP sub-basin ranking procedures were derived by modifying the ranking approach developed by the Miami Dade County Department of Regulatory and Economic Resources (RER) as part of their Stormwater Master Plan Development. The ranking of flooding problem areas was related to the defined floodplain level of service (FPLOS) as follows:

1. All structures (commercial, residential, and public) should be flood-free during the 100-year storm event.
2. Principal arterial roads, including major evacuation routes, should be passable during the 100-year storm event.
3. Minor arterial roads (up to 4-lanes) should be passable during the 10-year storm event.
4. Collector and local residential streets should be passable during the 5-year storm event, as per the current Miami-Dade County Drainage Policy.
5. The total area experiencing flooding during the 100 storm event in 10-acre units.

The severity of flooding within each sub-basin is determined through the calculation of a flooding problem severity score (FPSS), which is a function of five "severity indicators" that are directly related to the FPLOS criteria described previously. These severity indicators are defined and summarized below. Each of these indicators also has an assigned "weighing factor" (WF), which is related to the relative importance of the flooding severity indicator.

Sub-basin Flooding Severity Indicators

1. **NS:** Number of structures flooded by the 100-year flood, which can include commercial, residential, and public buildings. All structures and/or buildings are considered equivalent, regardless of their size or value. **(WF = 4)**
2. **MER:** Miles of principal arterial roads, including major evacuation routes, which are impassable during the 100-year flood. Principal arterial roads are considered impassable if the depth of flooding exceeds 8 inches above the crown of the road during the 100-year design event. **(WF = 4)**
3. **MMAS:** Miles of minor arterial roads impassable during the 10-year flood. Minor arterial road is considered impassable if the depth of flooding exceeds the crown of the road during the 10-year design event. **(WF = 2)**
4. **MCLRS:** Miles of collector and local residential streets impassable during a 5-year flood. Collector and local residential streets are considered impassable if the depth of flooding exceeds the crown of the road during the 5-year design storm event. **(WF = 1)**
5. **DEM:** Total area experiencing flooding during the 100-year storm event in 10-acre units. **(WF = 1)**

The severity indicators are rated by an exceedance (E) value of severity score listed in the table below.

Depth of Flooding Above the FPLOS	E
Less than or equal to 6 inches	1
Greater than 6 inches and less than or equal to 12 inches	2
Greater than 12 inches	3

Therefore, for the 2014 SWMP update, the FPSS was calculated as follows:

Given the definitions for the flooding severity indicators (NS, MER, MER10, MCLRS, and DEM), WF, and E, the FPSS for each sub-basin is calculated using the following formula, where $E_{(i)}$ through $E_{(v)}$ relates to the degree of exceedance for each of the applicable severity indicators.

$$\mathbf{FPSS = [4 \times E_{(i)} \times NS] + [4 \times E_{(ii)} \times MER] + [4 \times E_{(iii)} \times MMAS] + [2 \times E_{(iv)} \times MCLRS] + [1 \times E_{(v)} \times DEM]}$$

The FPSS was weighted by the total area of the sub-basin in order to give equal weight to all sub-basins. The unweighted FPSS was divided by the total area of the sub-basin in acres. Once the weighted severity score was calculated per sub-basin, the sub-basin with the highest FPSS is given a ranking value of 1. Subsequent FPSS scores are then given ranking values of 2 through X. Sub-basins with equivalent FPSS are given the same ranking value. This approach will yield the basins with the highest flooding problems based on a quantifiable and mathematical basis.

5.2 City of Doral Sub-Basin Ranking and Level of Service Procedure

The procedure developed as part of the 2014 SWMP update was further refined in coordination with the City. The revised procedure used in ranking and prioritizing sub-basins as part of this SWMP update is summarized in the following sections.

5.3 2019 SWMP Flood Problem Area Ranking Procedure

Similar to the 2014 SWMP update procedure, the ranking of flooding problem areas is also related to the defined FPLOS. The level of service indicators used as part of this SWMP update include:

1. All structures (commercial, residential, and public) should be flood-free during the 100-year storm event.
2. Principal arterial roads, including major evacuation routes, should be passable during the 100-year storm event.
3. Collector and local residential streets should be passable during the 5-year storm event.
4. Collector roads should have minimal flooding in low-lying areas during the 10-year storm event.

In keeping with the 2014 SWMP update, the severity of flooding within each sub-basin is determined through the calculation of a FPSS, which is a function of the four "severity indicators" described in this section that are directly related to the FPLOS criteria described previously. These severity indicators are defined and summarized below. Each of these indicators also has an assigned WF, which is related to the relative importance of the flooding severity indicator. The weighing factor was further refined from the 2014 SWMP update.

Sub-basin Flooding Severity Indicators

5. **NS:** Number of structures flooded by the 100-year flood, which can include commercial, residential, and public buildings. All structures and/or buildings are considered equivalent, regardless of their size or value. **(WF = 6)**
6. **MER:** Miles of principal arterial roads, including major evacuation routes, which are impassable during the 100-year flood. A principal arterial road is considered impassable if the depth of flooding exceeds 8 inches above the crown of the road during the 100-year design event. **(WF = 5)**
7. **MER10:** Miles of principal arterial roads, including major evacuation routes, which showing flooding during the 10-year event. **(WF = 4)**
8. **MCLRS:** Miles of collector and local residential streets impassable during a 5-year flood. Collector and local residential streets are considered impassable if the depth of flooding exceeds the crown of the road during the 5-year design storm event. **(WF = 3)**

Also, in keeping with the 2014 SWMP procedures, the severity indicators are rated by an exceedance (E) value pursuant to the following severity score listed in the table below for all values.

Depth of Flooding Above the FPLOS	E
Less than or equal to 6 inches	1
Greater than 6 inches and less than or equal to 12 inches	2
Greater than 12 inches	3

Given the definitions for the flooding severity indicators (NS, MER, MER10, and MCLRS), WF, and E, the FPSS for each sub-basin is calculated using the following formula, where $E_{(i)}$ through $E_{(v)}$ relates to the degree of exceedance for each of the applicable severity indicators.

$$\mathbf{FPSS} = [4 \times E_{(i)} \times NS] + [4 \times E_{(ii)} \times MER] + [4 \times E_{(iii)} \times MER10] + [2 \times E_{(iv)} \times MCLRS]$$

The FPSS is also weighted by the total area of the sub-basin in order to give equal weight to all sub-basins. The unweighted FPSS is divided by the total area of the sub-basin in acres. Both weighted and unweighted FPSS are presented in the final results.

Once the weighted severity score is calculated per sub-basin, the sub-basin with the highest FPSS is given a ranking value of 1. Subsequent FPSS scores are then given ranking values of 2 through X. Sub-basins with equivalent FPSS are given the same ranking value. This approach will yield the basins with the highest flooding problems based on a quantifiable and mathematical basis.

5.4 Sub-Basin Delineation Update and Excluded Sub-Basins

The 2014 SWMP update refined the sub-basin delineations from the 2006 SWMP update to account for new development and new City roads. These sub-basins are shown in **Figure 5-1**. The sub-basins were separated between private sub-basin and City sub-basins. The private sub-basins were identified for sub-basins having predominantly private roads. The delineation between the defined private sub-basins and City sub-basins are also shown in **Figure 5-1**.

To account for the improvements completed since 2014, the sub-basins used in the 2014 SWMP update were re-delineated or refined to account for the City's updates to the roadway infrastructure. In addition, some sub-basins were further sub-divided to exclude private areas with the corresponding buildings served by private roads. As an example, Sub-basins J-1 and J-2 in the 2014 SWMP update (**Figure 5-2**) were re-delineated in order to exclude the private areas and the buildings served by private roads. Therefore three new sub-basis were created (NW 52 ST W, NW 52 ST E, and NW 102AVE). **Figure 5-3** shows the refined sub-basin delineation to be used as part of this SWMP update. **Table 5-1 – New Sub-Basin Delineation** describes the sub-basins that were included in the new delineation and that were considered for the severity evaluation.

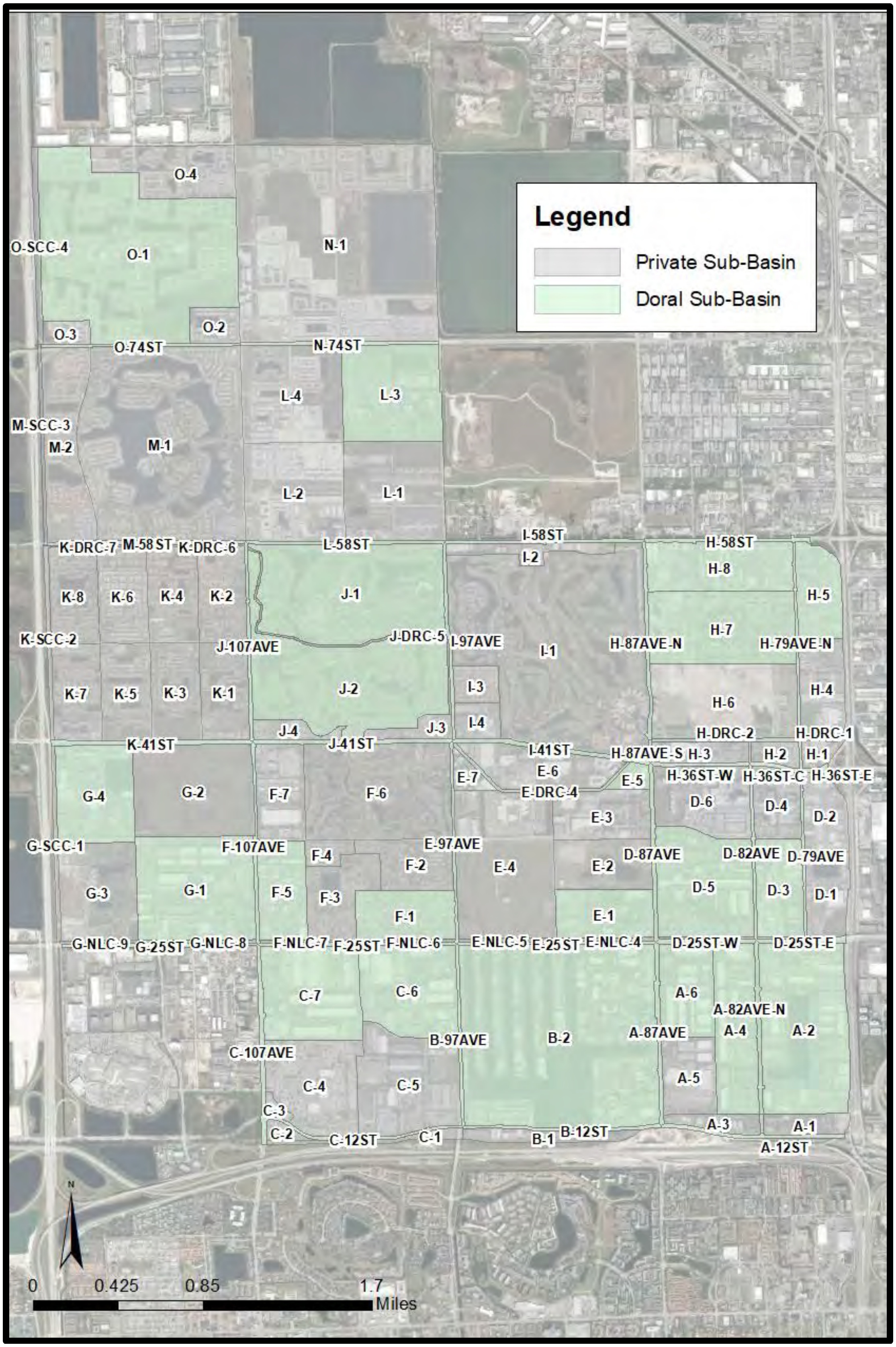


Figure 5-1– 2014 SWMP Sub-Basins

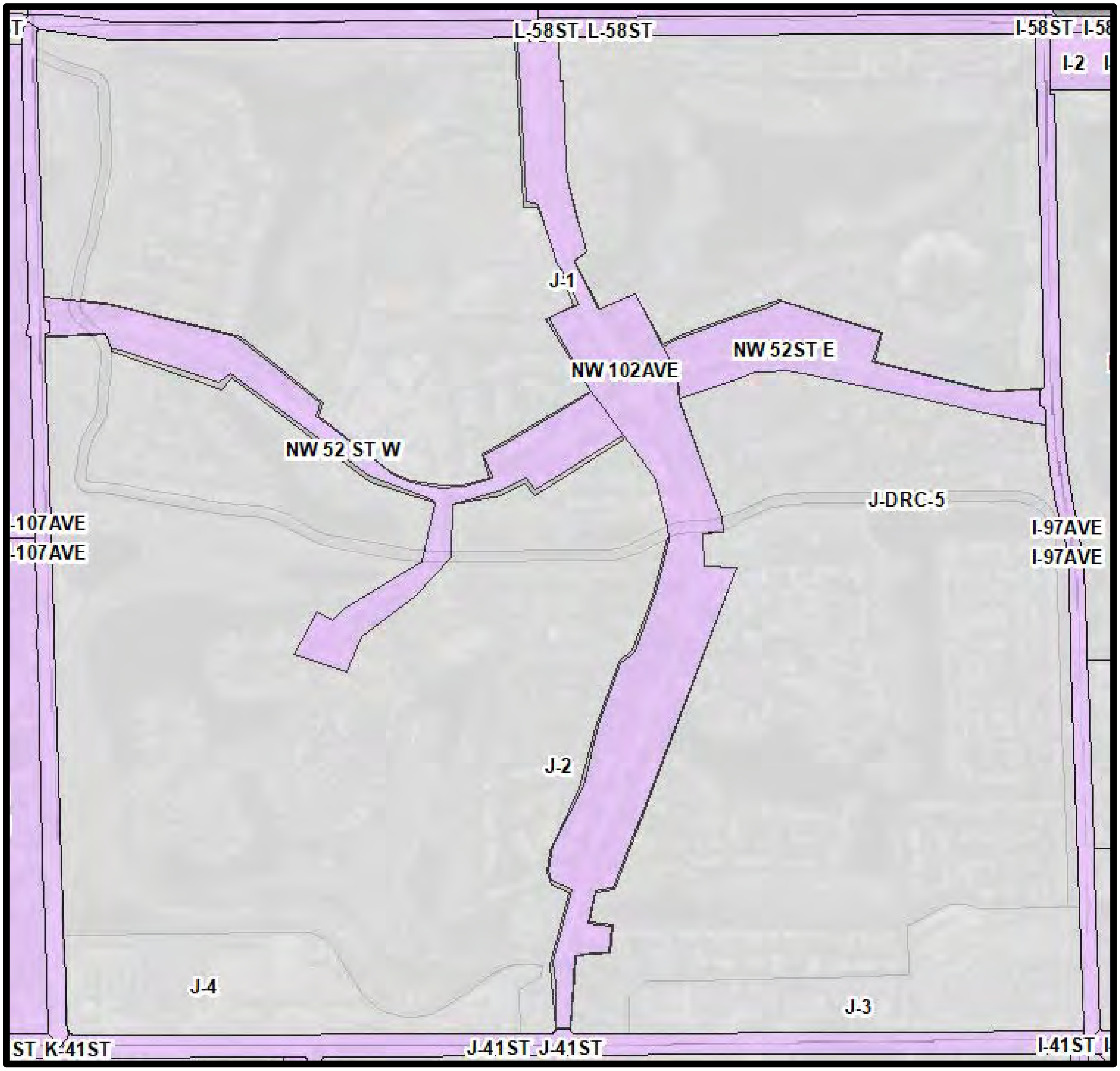


Figure 5-2 – Sub-Basin Re-delineation Example

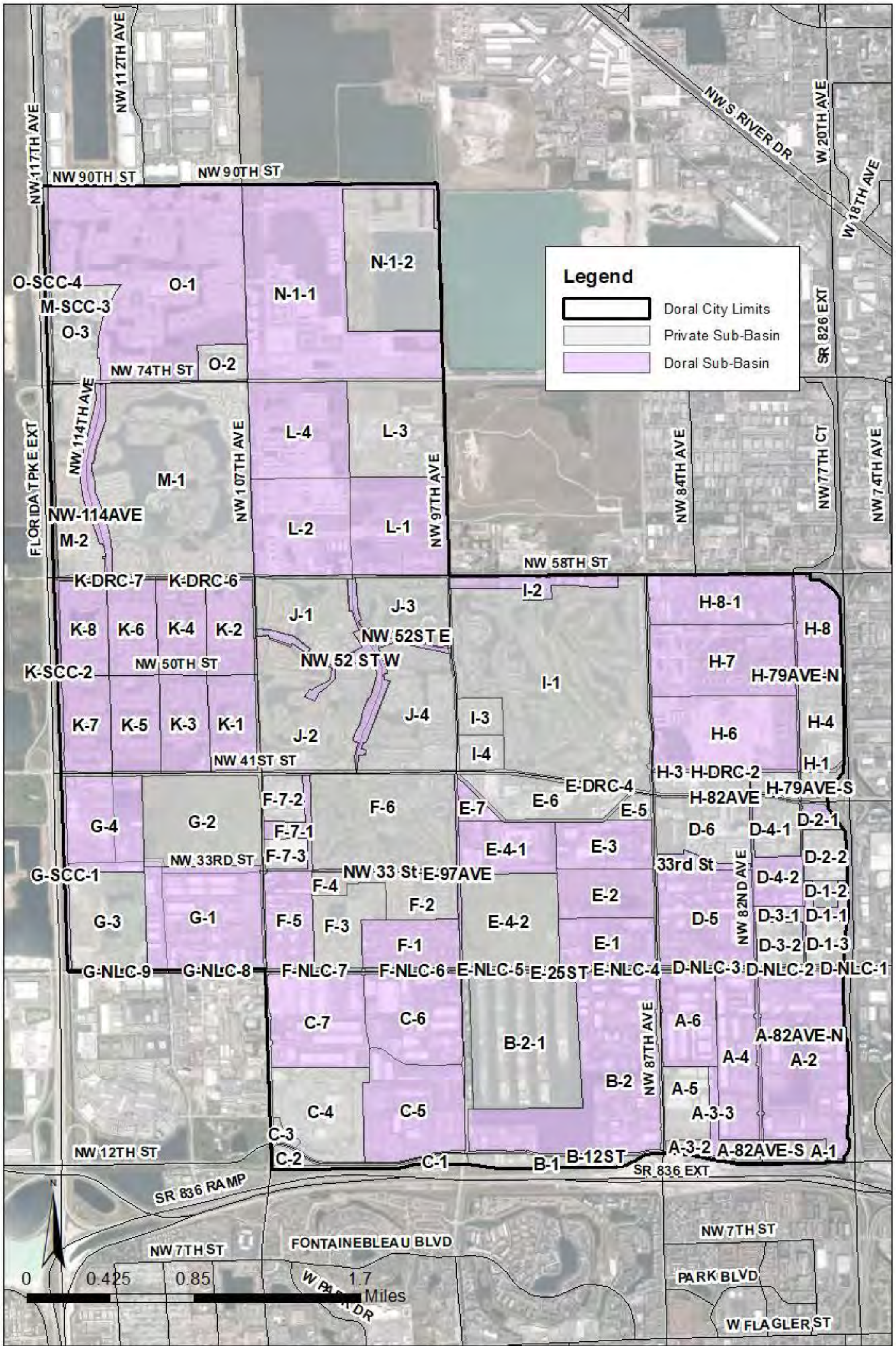


Figure 5-3– Refined Sub-Basins Delineations

Table 5-1 – New Sub-Basin Delineation

2014 SUB-BASIN	AREA (ACRES)	NEW SUB-BASIN 1	AREA 1 (ACRES)	NEW SUB-BASIN 2	AREA 2 (ACRES)	NEW SUB-BASIN 3	AREA 3 (ACRES)
A-5 **A-3**	55.08 24.02	**A-3-3**	14.11	**A-3-2 (private)**	8.38	**A-3-1**	12.83
D-1	57.66	**D-1-1**	17.97	**D-1-2**	10.77	**D-1-3**	28.92
D-2	50.85	**D-2-1**	14.07	**D-2-2**	36.77		
D-3	74.23	**D-3-1**	12.68	**D-3-2**	33.04		
D-3 **D-4**	74.23 53.68	**D-4-2**	37.71	**D-4-1**	44.49		
E-4	234.28	**E-4-1**	84.10	**E-4-2**	148.98		
F-7	75.64	**F-7-1**	22.32	**F-7-2**	31.62	**F-7-3**	21.70
I-1 **I-2**	555.18 33.48	**I-2**	34.52				
N-1	632.13	**N-1-1**	411.28	**N-1-2**	218.55		
J-1	279.28	**NW 102AVE**	34.18	**J-1**	107.67	**J-3**	87.39
F-2 **F-4**	65.71 18.46	**NW 33 St**	8.36				
J-1	279.28	**NW 52 ST W**	16.69	**NW 52ST E**	10.45		
M-1 **M-2**	491.70 132.01	**NW-114AVE**	37.79	**M-1**	470.16	**M-2**	115.69
J-2	283.11	**NW 102AVE**	34.18	**J-2**	197.97	**J-4**	160.34

The City of Doral contains large areas that are considered private and do not fall within the City's responsibility when it comes to maintenance or providing for flood protection. These areas mostly include areas such as private developments where not only the structures, lakes, and open/common areas are privately owned, but the roadways and underlying stormwater management infrastructure are also privately owned and managed. The City is not responsible for maintaining or constructing improvements to address issues within these areas. The sub-basins presented in **Table 5-2** have been identified by the City as being completely private and are outside of the responsibility of the City. As such, for the purposes of this study, these areas were excluded in the final ranking, and future projects will not be proposed for these areas.

Table 5-2 – Sub-basins Excluded from Ranking Procedure (Private Sub-basins)

BASIN	AREA (ACRES)	BASIN	AREA (ACRES)
A-1	21.63852	**F-7-2**	31.62019
A-3-1	12.83365	**F-NLC-6**	4.119292
A-3-2	8.376109	**F-NLC-7**	3.994528
A-5	55.08147	**G-2**	177.6774
B-1	32.88282	**G-3**	122.1858
B-2-1	242.4046	**G-NLC-8**	4.99416
C-1	16.6137	**G-NLC-9**	5.072193
C-2	9.163929	**H-1**	14.4731
C-3	6.439785	**H-2**	17.8199
C-4	128.064	**H-3**	32.57174
D-1-3	28.91749	**H-4**	69.1466
D-1-2	10.76675	**H-DRC-1**	2.353139
D-2-2	36.77462	**I-1**	554.1284
D-3-2	33.03644	**I-3**	27.09754
D-4-1	44.48662	**I-4**	26.21085
D-6	96.76606	**J-1**	107.6724
D-NLC-1	0.789723	**J-2**	197.9682
D-NLC-2	1.542207	**J-3**	87.3874
D-NLC-3	3.311284	**J-4**	160.3418
E-4-2	148.9794	**K-DRC-6**	2.710843
E-5	13.45911	**K-DRC-7**	2.316803
E-6	85.54419	**L-3**	152.5198
E-DRC-4	10.64707	**M-1**	470.1549
E-NLC-4	5.536045	**M-2**	115.6906
E-NLC-5	5.61802	**M-SCC-3**	80.61373
F-2	59.94454	**N-1-2**	218.5523
F-3	76.11175	**O-2**	28.73339
F-4	15.85914	**O-3**	79.90538
F-6	226.9613	**O-SCC-4**	18.10968
F-7-3	21.697		

5.5 Sub-Basin & Level of Service Summary of Results

5.5.1 Quantifying Methodology for Sub-basin Flooding Severity Indicators

The various flood severity indicators of the FPSS equation outlined in **Section 5.3** were quantified using standard GIS tools to facilitate the analysis of the resulting model data versus the digital elevation model (DEM) developed as part of this SWMP. The DEM created for this SWMP is a raster-based bare earth topographic elevation model in the North American Vertical Datum of 1988 (NAVD88) derived from the Miami-Dade County provided TIN, which was developed using Light Detection And Ranging (LiDAR) topographic data points provided by DRER. This TIN was converted into a raster-based DEM with cell dimensions of 10-ft by 10-ft in GIS using ESRI's Spatial Analyst. This cell size provided sufficient resolution to represent the overall topographic characteristics of the City, while still remaining manageable in the GIS environment. Individual roadways are visible, and general topographic trends can be seen for all areas within the City - see **Figure 5-4** for the sample area. **Appendix J** includes a topographic map for the entire City.

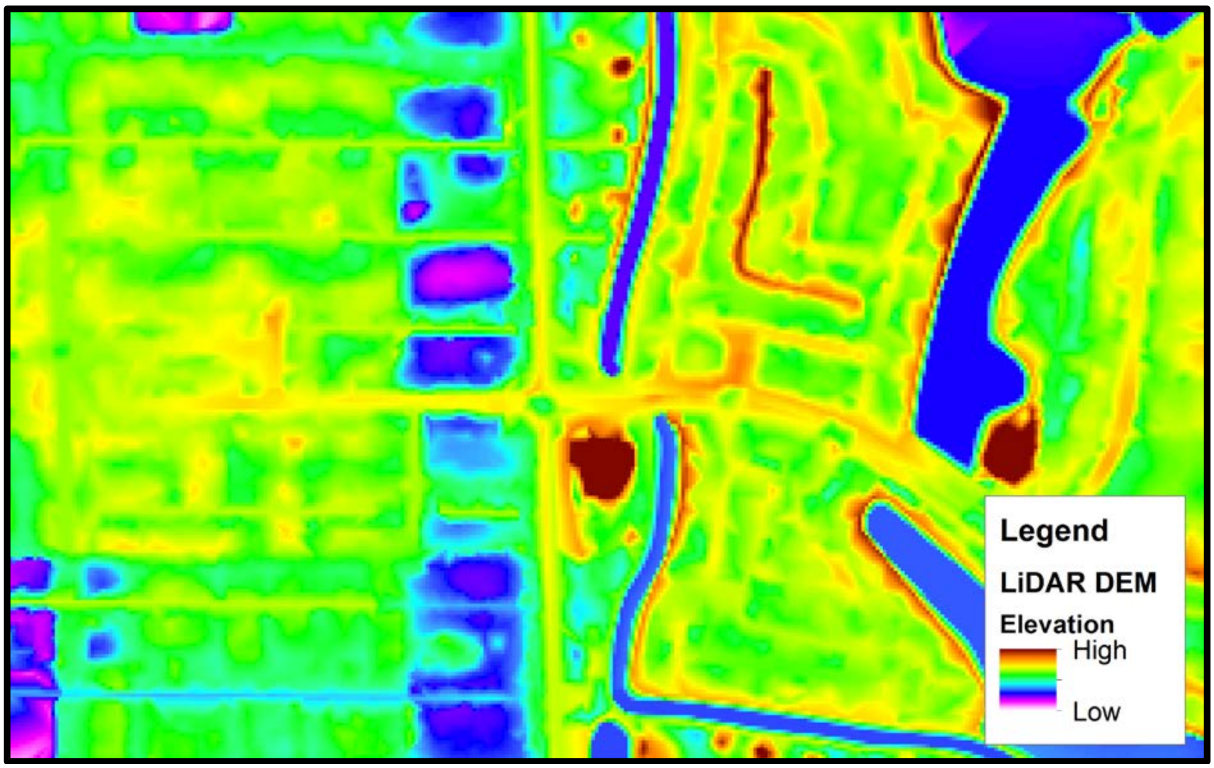


Figure 5-4 – LiDAR-based Raster DEM

The polyline roadway network from The City of Doral was utilized to determine the severity indicator values associated with the roadway network - the MER, MER10, and MCLRS indicators. The GIS roadway coverage represented the approximated centerline of each roadway throughout the City. Each road had a number classification for the type of road, with values of zero through three (0-3) being principal arterials or highways and values four through nine (4-9) being collectors or local roads. This number classification allowed each segment of the roadway to be classified under either the MER/MER10 or MCLRS severity indicator.

Figure 5-5 – Roadways lines to points

This roadway network was then projected to the raster-based DEM in order to give each line elevation data along the line. When the projection is performed, multiple vertices are created in each line at points closest to the center of each raster cell. These polylines can then be broken up into individual segments, each with a beginning and endpoint, a specific X, Y, and Z value at both ends, and a segment length. In order for each line segment to be counted once, either the beginning or endpoint can only be used to represent a given line segment - in this case, the beginning point was used – **see Figure 5-5**. Each segment was broken into individual segments approximately 10-ft in length, and each segment was represented by a point with the actual calculated length as an attribute.

Next, the number of structures flooded, or NS, was calculated using the existing property appraiser coverage acquired from Miami-Dade County. It was observed during a cursory review of the property appraiser coverage that a number of properties were listed with a zero value in the square footage of the building and a zero value for the year built. This was often the case for open lots with no buildings. In order to omit these properties in the NS count, all properties showing a zero for the year built and a zero for the building square footage were eliminated from the coverage, and the remaining properties were used for the NS count. Inconsistencies remained within the coverage, but any efforts to correct the count further would necessitate a lengthy review of each polygon and was not a feasible solution for this SWMP. In addition, the number of structures were corrected in the sub-basins, with a large number of structures covered by private roads. Therefore, the number of private structures were subtracted, as shown in **Figure 5-6**.

Figure 5-6 – Number of structures

The County does not maintain a database of finished floor elevations for properties located within their respective limits. The City, however, has some GIS data with some finished floor elevations throughout the City. Where finish floor elevations were available, the known elevation was used for those buildings. For buildings where the finished floor elevation was not known, the finished floor elevations had to be estimated utilizing a methodology similar to the approach used by Miami-Dade County in the various stormwater management master plans. This approach estimated the finished floor elevation of a lot based on the closest adjacent crown of road elevation plus eight (8) inches. For this SWMP, this was done in GIS by performing a spatial join of the property points and the roadway points - see **Figure 5-5** for a sample area showing the location of roadway points relative to property points. This resulted in the property points being assigned the attribute data, such as elevation from the closest roadway point to it.

The raster from each storm event was also converted into a point coverage to help quantify the area which was inundated under the modeled storm events. Each raster cell was given a point at the center of the cell, with the point containing the cell's topographic elevation. These points were then joined spatially in GIS with the sub-basin coverage. The attribute tables from these various coverages were analyzed in GIS in order to process the information gathered within the tables and arrive at a proper count of the various elements making up the FPSS. Each table contained data such as sub-basin name, point elevation, and other pertinent data necessary for the proper grouping and summarizing of the entities they represented.

5.6 Flood Protection Level of Service and Sub-basin Ranking Results

The flood severity result data was collected under two scenarios and three storm events: the 5-year, 24-hour; 10-year-24-hour; and the 100-year, 72-hour events. Flood plain data for each event was prepared in raster format in order to show the location and severity of the flood conditions developed under this analysis. Flooding was represented in three colors corresponding to the severity indicators (E) assigned to specific flood conditions. These conditions were:

- Green - flooding is greater than zero and less than or equal to 6-inches
- Yellow - flooding is greater than 6-inches and less than or equal to 12-inches
- Red - flooding is greater than 12-inches

Figure 5-7 shows a sample area of the flood plain mapping developed for this SWMP with some transparency added to the raster cells. **Appendix K** provides a map showing the sub-basin delineation for the sub-basins within the City, and **Appendix L** contains maps showing the location and severity of flooding for the design storm events modeled.

Figure 5-7 – Sample of Flood Plain Mapping Results

The FPSS results for the City are presented in **Appendix M,** showing each sub-basin severity score by severity indicator, the ranking of the sub-basin within that severity indicator, and the overall composite ranking of the sub-basins for the City of Doral. **Table 5-3** presents a condensed version of **Appendix M**.

Table 5-3 – FPSS Baseline Model Scenario Ranking

SUB-BASIN	SUB-BASIN AREA (ACRES)	FPSS	RANK	WEIGHTED FPSS	RANK
H-7	172.13	11205.34	1	65.10	1
F-1	78.08	3533.54	2	45.25	2
NW 102AVE	34.18	1336.13	6	39.09	3
NW 33 St	8.36	265.84	48	31.80	4
D-3-1	54.96	394.38	24	31.10	5
D-4-2	79.99	1061.32	12	28.14	6
D-1-1	17.97	463.83	20	25.81	7
H-8	67.88	1599.57	4	23.56	8
NW 52 ST W	16.69	285.20	28	17.09	9

SUB-BASIN	SUB-BASIN AREA (ACRES)	FPSS	RANK	WEIGHTED FPSS	RANK
F-5	76.91	1203.25	7	15.64	10
NW-114AVE	37.79	441.48	22	11.68	11
H-8-1	116.44	1157.82	9	9.94	12
G-4	121.64	1085.08	11	8.92	13
G-1	199.44	1543.48	5	7.74	14
D-5	167.89	1203.10	8	7.17	15
E-1	76.37	466.89	19	6.11	16
D-2-1	14.07	85.32	34	6.06	17
E-7	16.00	91.02	33	5.69	18
C-5	159.98	869.90	14	5.44	19
O-1	347.34	2647.38	3	5.10	20
C-7	149.19	727.31	15	4.88	21
L-1	96.48	657.85	16	4.11	22
B-2	317.01	1156.53	10	3.65	23
A-3-3	14.11	49.77	40	3.53	24
E-4-1	84.10	295.54	27	3.51	25
F-7-1	22.32	75.23	35	3.37	26
H-6	120.37	572.80	17	3.27	27
L-2	43.88	452.24	21	2.86	28
E-3	76.69	213.44	30	2.78	29
L-4	34.21	425.96	23	2.68	30
C-6	138.00	351.94	25	2.55	31
N-1-1	154.62	960.99	13	2.34	32
A-2	245.46	524.82	18	2.14	33
I-2	34.52	72.21	36	2.09	34
A-4	111.07	223.28	29	2.01	35
E-25ST	9.50	10.50	46	1.11	36
A-6	85.69	94.41	32	1.10	37
NW 52ST E	10.45	349.27	26	33.42	38
K-1	22.95	67.30	37	0.90	39
K-7	21.06	67.07	38	0.89	40
K-8	19.94	62.17	39	0.82	41
H-79AVE-N	8.59	4.91	64	0.57	42
H-82AVE	0.67	0.34	84	0.50	43
K-2	16.81	30.34	41	0.41	44
H-79AVE-S	1.30	0.52	82	0.40	45
A-82AVE-N	11.29	3.33	72	0.29	46
A-82AVE-S	1.17	0.32	85	0.27	47
K-SCC-2	12.67	3.12	74	0.25	48
G-SCC-1	12.28	1.62	81	0.13	49
K-6	25.85	8.23	51	0.11	50

SUB-BASIN	SUB-BASIN AREA (ACRES)	FPSS	RANK	WEIGHTED FPSS	RANK
E-2	78.61	6.77	55	0.09	51
K-5	24.77	2.35	76	0.03	52
K-4	22.49	2.30	77	0.03	53
K-3	22.39	2.04	78	0.03	54
H-DRC-2	8.01	0.05	86	0.01	55

Additionally, **Appendix N** presents the ranking results in maps color-coded by their respective FPSS rank.

6.0 SEA LEVEL AND GROUNDWATER RISK ASSESSMENT

To assess the future flood protection LOS throughout the City based on the observed and predicted climate change impacts, the following resilience factors were evaluated and accounted for as part of this SWMP update:

- sea-level rise,
- groundwater rise, and
- rainfall amount increases.

These factors were not accounted for in the prior SWMP updates.

6.1 Sea-level Rise

The Southeast Florida Regional Climate Change Compact (the Compact) is a partnership between Broward, Miami-Dade, Monroe, and Palm Beach Counties, to unify a diversity of sea-level rise projections to create a single, regionally unified projection, ensuring consistency in adaptation planning and policy, and infrastructure siting and design in the Southeast Florida four-county region. These projections represent a consensus from a technical Work Group consisting of members from the academic community, and federal agencies, with support from local government staff, and incorporate the most up-to-date, peer-reviewed literature, and climate modeling data. In 2019, the Compact published the latest Unified Sea Level Rise Projections for Southeast Florida for various planning horizons. The Unified Sea Level Rise Projections contains three global curves adapted for regional application, as shown in **Figure 6-1**.

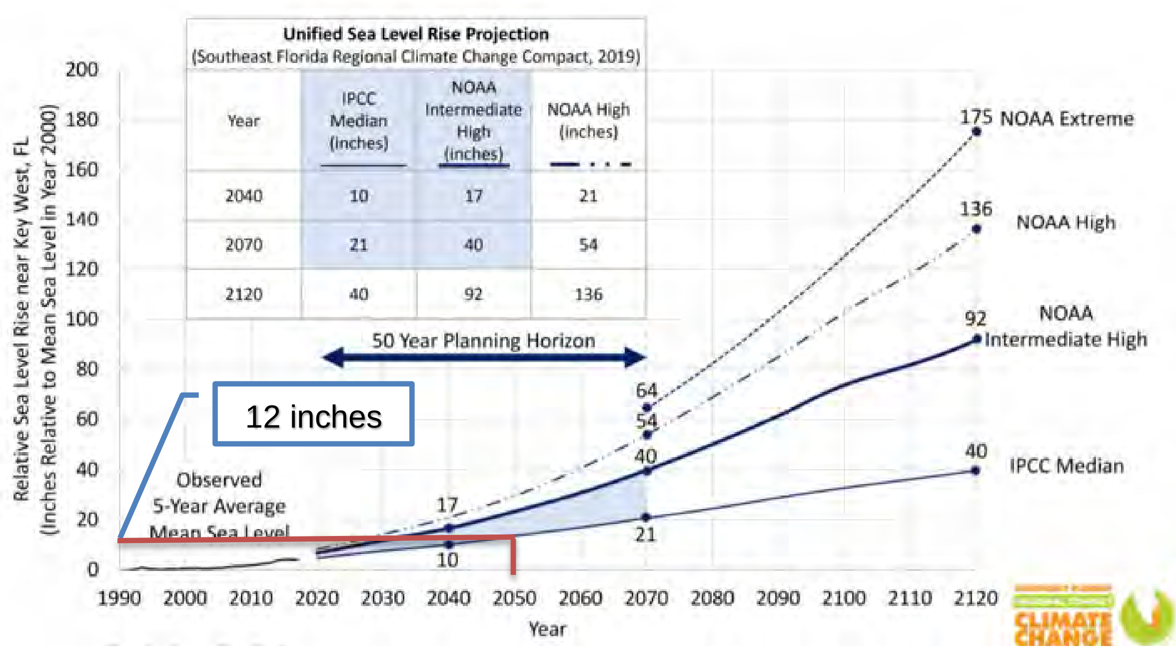


Figure 6-1 – Unified Sea Level Rise Projections for Southeast Florida (2019)

The study can be downloaded from https://southeastfloridaclimatecompact.org/wp-content/uploads/2020/04/Sea-Level-Rise-Projection-Guidance-Report_FINAL_02212020.pdf

In coordination with the City, it was agreed that the planning horizon for this study should be the year 2050. This determination is consistent with the previous *City of Doral Stormwater Vulnerability Assessment Study* adopted in February 2020. The vulnerability assessment study focused on evaluating the potential impacts on the City's primary stormwater infrastructure due to the predicted groundwater rise within the City, based on the 2050 projected sea-level rise (SLR). It was also agreed that the 2050 planning horizon IPCC low-end value should be used to account for future sea-level rise impacts as part of this SWMP update. This value equals 12 inches, as depicted in **Figure 6-1**.

6.2 Groundwater Rise

The study performed by Miami-Dade Water and Sewer, in conjunction with the USGS (*Hydrologic Conditions in Urban Miami-Dade County, Florida, and the Effect of Groundwater Pumpage and Increase Sea Level on Canal Leakage and Regional Groundwater Flow, 2016*) estimated groundwater rise conditions in Miami-Dade County. **Figure 6-2** shows the image from the USGS report of the change in water table elevations from one foot of sea-level rise from the projected sea-level rise in 2045. The figure can be used to estimate the amount of groundwater rise in the City for future sea-level rise conditions.

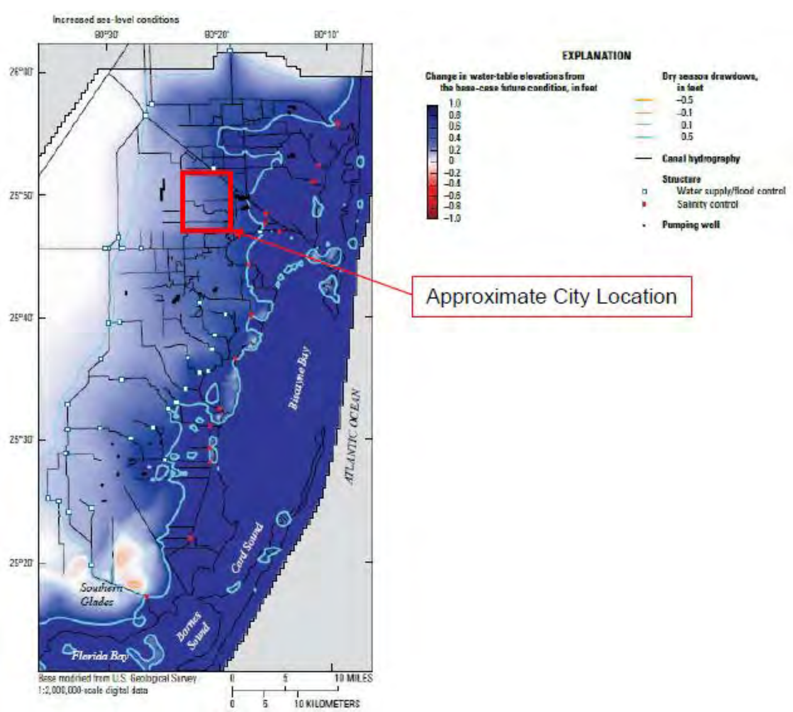


Figure 6-2 – Hydrologic and Effects of Pumpage and Sea Level on Canal Leakage and Groundwater Regional Flow

The *City of Doral Stormwater Vulnerability Assessment Study* adopted in February 2020 also evaluated the projected groundwater rise that is anticipated for the City for the 2050 planning horizon. The vulnerability assessment focused on evaluating the potential impacts on the City's primary stormwater infrastructure due to the predicted groundwater rise within the City, based on the 2050 projected sea-level rise within Miami-Dade County. **Figure 6-2** define groundwater rise in the region concerning one (1) foot of sea-level rise. **Figure 6-3** shows the contours of groundwater rise estimated for one foot of sea-level rise based on the 2015 USACE high curve projections. Therefore, the Vulnerability Assessment Study concluded that 0.17 feet were to be the defined groundwater rise within the City for the predicted 2050 sea-level rise conditions, which correlates to 1.17 feet (14 inches) of sea-level rise that will occur by 2050 based on the 2015 USACE High Curve projections.

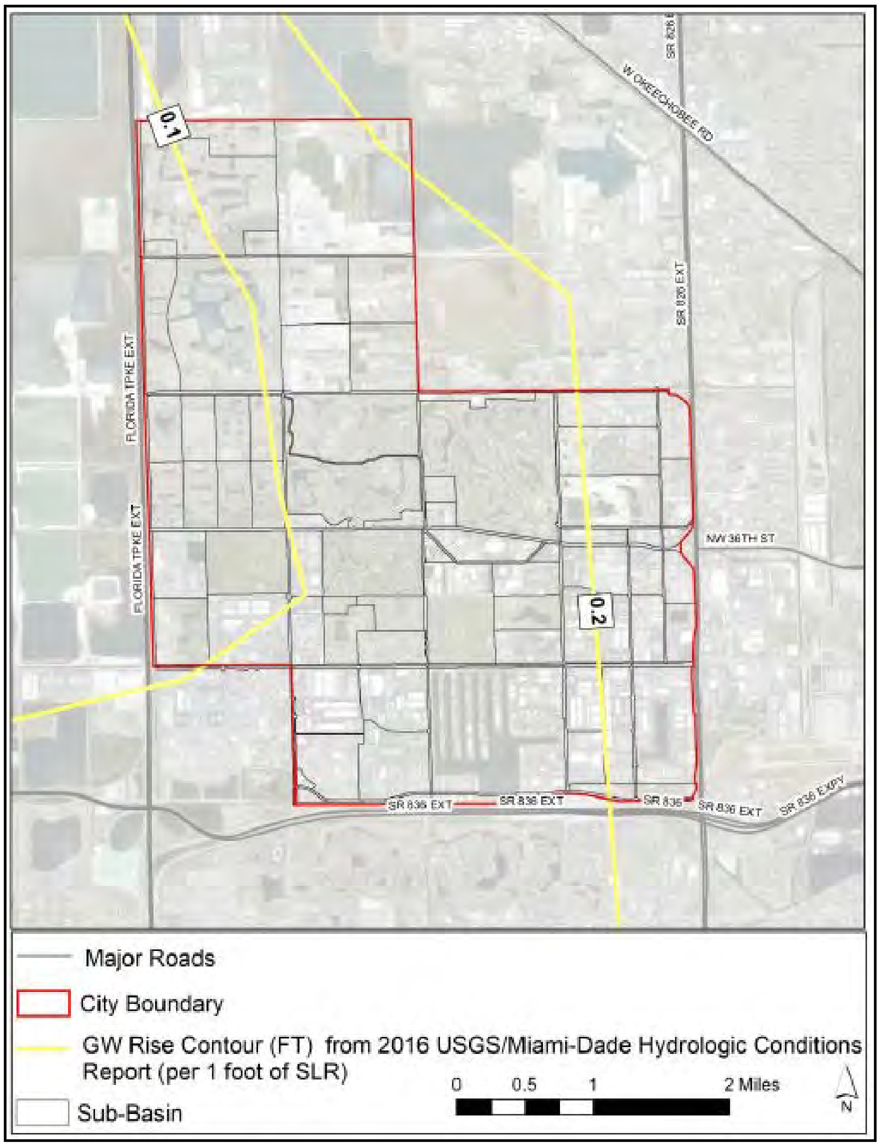


Figure 6-3 – October Average Groundwater Rise Contours with One Foot of Sea Level Rise

The initial groundwater elevation, or the design high water (DHW), in the Existing Condition Model (TM No. 2, Section 3) is the average October Groundwater elevation provided by the County contour shapefile. The initial stage elevation was raised from 2.5 ft-NAVD88 in the Existing Conditions model to 2.75 ft-NAVD88. According to the information presented and in coordination with the City, it was determined that a groundwater elevation of 2.75 ft-NAVD88 should be implemented for the entire City for the 2050 planning horizon. This increase of 0.25 ft correlates with the lower end of the 2019 projections for the low range and groundwater increase projections summarized in the *City of Doral Stormwater Vulnerability Assessment Study* adopted in February 2020.

6.3 Rainfall Amount Increase

In May 2015, a report was produced for the Miami-Dade Water and Sewer Department titled *Final Rainfall Intensity, Duration, and Frequency Projections Based on Climate Change for Miami-Dade County* that outlines the increase rainfall depths experienced in recent years when compared to the South Florida Water Management District (SFWMD) isohyetal maps based on observations at nine daily stations throughout Miami-Dade County. For this analysis, the rainfall depths for the 2050 design storm events were incrementally increased by 25 percent each to account for the rising trend in rainfall depth.

Currently, Miami-Dade Water and Sewer Department is implementing an increase of 10 to 15 percent in rainfall, depending on the planning horizon selected. After discussions with the City, it was concluded that a rainfall increase of 5 percent should be used for the entire City due to uncertainty in data indicating that rainfall intensities are increasing. **Table 6-1** describes the rainfall depths for each design storm event for the existing conditions model, as well as for the Low-Range 2050 Planning Horizon model.

Table 6-1 – Existing and Projected Rainfall Depths

	5-YEAR	10-YEAR	25-YEAR	100-YEAR	250-YEAR	500-YEAR	1000-YEAR
Existing (inches)	7	8.5	13.5	18	22	24	27
Projected (inches)	7.35	8.93	14.18	18.9	23.1	25.2	28.35

6.4 Hydrologic/hydraulic model resiliency Revisions to assess future LOS

The existing conditions ICPRv4 hydrologic/hydraulic model developed and validated as part of Task 3 was revised to incorporate the resiliency factors described in **Section 2**. The parameters requiring adjustments to account for the sea-level rise, groundwater rise, and rainfall increase include:

1. Boundary Conditions
2. Rainfall Depths
3. Groundwater Initial Condition
4. Soil Parameters
5. Curve Numbers

For the 2050 planning horizon, boundary conditions were raised, soil storage was decreased, rainfall depths increased, and initial groundwater conditions increased. Updated flood maps for the City of Doral were generated, and the sub-basin ranking was updated to reflect the sea level rise and groundwater projected future impacts.

The following sections and sub-sections describe the updated data and projections used to develop flood maps for the various design storm events.

6.5 Boundary Conditions

Peak stage model results were provided by the County for 2060 and 2100 projections for the nodes used in the Existing Condition Model or Technical Memorandum No. 2 – Existing Condition Hydrologic and Hydraulic Model (H&H) Update (TM2). **Table 6-2** shows a comparison of the peak stages provide by the County between the modeled 2020 and the projected 2060 sea-level rise stages, and **Table 6-3** shows a comparison of the peak stages provide by the County between the modeled 2020 and the projected 2100 sea-level rise stages. The highlighted red values on **Table 6-2** and **Table 6-3** corresponds to the boundary conditions that were provided by the County. All other values of the remaining boundary conditions were interpolated to establish these values. Reviewing the peak stages for most of the boundary nodes shows that stages are lower or barely increase for the projected 2060 and 2100 modeled projections compared to the 2020 values. For example, BD1, the 100-year stage = 4.27 ft-NAVD88 for the Year 2020. When compared to the Year 2060 and 2100, the stages are = 4.24 and 4.19 ft-NAVD88, respectively, which does not correlate with the new projected values for the sea-level rise from the South Florida Regional Climate Change Compact.

Table 6-2 – Modeled Boundary Peak Stages provided by County Comparing 2020 and 2060 Projection

PEAK STAGE BOUNDARY CONDITIONS 2020 VS 2060 (FT-NAVD88)												
BND	2020						2060					
	5YR 24HR	10YR 24HR	25YR 72HR	100YR 72HR	500YR 72HR	1000YR 72HR	5YR 24HR	10YR 24HR	25YR 72HR	100YR 72HR	500YR 72HR	1000YR 72HR
BD1	**3.83**	**3.84**	**4.01**	**4.27**	**5.29**	**5.78**	**3.17**	**3.49**	**3.99**	**4.24**	**5.29**	**5.78**
BD2	3.83	3.84	**4.01**	**4.32**	5.29	5.78	3.17	3.49	3.99	4.20	5.29	5.78
BD3	3.82	3.83	**4.02**	**4.37**	5.30	5.81	3.14	3.48	4.01	4.35	5.30	5.81
BD4	**3.70**	**3.73**	**4.18**	**5.15**	**6.24**	**6.65**	**3.01**	**3.39**	**4.30**	**5.26**	**6.24**	**6.66**
BD5	3.54	3.56	**4.14**	**5.56**	6.92	7.34	3.07	3.14	4.04	5.70	6.90	7.35
BD6	**3.54**	**3.56**	**4.33**	**5.82**	**7.10**	**7.41**	**3.07**	**3.15**	**4.37**	**6.18**	**7.10**	**7.42**
BD7	3.41	3.61	**4.22**	**5.77**	6.57	6.95	3.04	3.14	3.94	5.80	6.60	6.99
BD8	3.43	3.65	**4.94**	**5.94**	6.79	7.15	2.99	3.05	4.45	6.01	6.81	7.17
BD9	3.43	3.89	**5.15**	**5.94**	6.79	7.15	2.99	3.05	4.45	6.01	6.81	7.17

Table 6-3 – Modeled Boundary Peak Stages provided by County Comparing 2020 and 2100 Projection

PEAK STAGE BOUNDARY CONDITIONS 2020 VS 2100 (FT-NAVD88)												
BND	2020						2100					
	5YR 24HR	10YR 24HR	25YR 72HR	100YR 72HR	500YR 72HR	1000YR 72HR	5YR 24HR	10YR 24HR	25YR 72HR	100YR 72HR	500YR 72HR	1000YR 72HR
BD1	**3.83**	**3.84**	**4.01**	**4.27**	**5.29**	**5.78**	**3.44**	**3.53**	**4.01**	**4.19**	**5.33**	**5.80**
BD2	3.83	3.84	**4.01**	**4.32**	5.29	5.78	3.44	3.53	4.01	4.18	5.33	5.80
BD3	3.82	3.83	**4.02**	**4.37**	5.30	5.81	3.42	3.51	4.05	4.29	5.36	5.84
BD4	**3.70**	**3.73**	**4.18**	**5.15**	**6.24**	**6.65**	**3.27**	**3.35**	**4.50**	**5.31**	**6.28**	**6.67**
BD5	3.54	3.56	**4.14**	**5.56**	6.92	7.34	3.58	3.59	4.37	5.81	6.99	7.39
BD6	**3.54**	**3.56**	**4.33**	**5.82**	**7.10**	**7.41**	**3.56**	**3.57**	**4.66**	**6.25**	**7.15**	**7.45**
BD7	3.41	3.61	**4.22**	**5.77**	6.57	6.95	5.33	5.42	5.66	6.29	6.95	7.26
BD8	3.43	3.65	**4.94**	**5.94**	6.79	7.15	5.10	5.11	5.61	6.32	7.02	7.35
BD9	3.43	3.89	**5.15**	**5.94**	6.79	7.15	4.26	4.63	5.61	6.32	7.02	7.35

In discussion with the City, it was agreed that the 12 inches of sea-level rise increase for the 2050 planning horizon would be added to the boundary stages provided by the County and used in the Existing Condition Model or Technical Memorandum No. 2 – Existing Condition Hydrologic and Hydraulic Model (H&H) Update. The boundary condition initial elevation was set at 2.75 ft-NAVD88, as described in **Section 6.7**. The revised boundary stages are provided in **Appendix O**.

6.6 Soil Zone Parameters

Due to the projected increase of the groundwater elevation or the groundwater initial conditions, the soil storage is lower in the sea-level rise scenarios. As in TM2 (Section 2.2.4), soil zones were defined according to the depth to seasonal high groundwater elevation from existing ground versus water storage capacity relationship specified in the South Florida Water Management District (SFWMD) Environmental Resource Permit (ERP) Applicant's Handbook Volume II for coastal compacted soils, based on Soil Conservation Service (SCS) estimates.

The soil zones identified for the simulations were defined for the study area as follows:

1. Zone 1 - Depths below 1 ft-NAVD88
2. Zone 2 - Depths between 1 and 2 ft-NAVD88
3. Zone 3 - Depths between 2 and 3 ft-NAVD88
4. Zone 4 - Depths between 3 and 4 ft-NAVD88
5. Zone 5 - Depths above 5 ft-NAVD88

The soil zone for the 2050 projected sea-level rise model was edited, and the Design High Water (DHW) implemented on the model as described in **Section 6.2**. **Table 6-4** provides a summary of elevations for each soil zone based on the above-mentioned DHW.

Table 6-4 – Summary of Elevation per Soil Zone

SOIL ZONE	ELEVATION (FT-NAVD88)
1	< 2.75
2	2.75 – 3.75
3	3.75 – 4.75
4	4.75 – 5.75
5	> 5.75

6.6.1 Curve Numbers

The calculated Curve Number (CN) values were updated based on the depth to the DHW elevation for the projected 2050 sea-level rise planning horizon. The updated ICPRv4 uses the spatial coverages of the land cover zones and the soil zones during the 2D overland flow runoff calculations, as described in TM3 (Section 2.2.3, 2.2.4, 2.2.5). **Table 6-5** summarizes the CN calculations per land use.

Table 6-5 – CN Calculation per Zone per Land Use

LAND USE	CN ZONE 1	CN ZONE 2	CN ZONE 3	CN ZONE 4	CN ZONE 5
Agriculture	96	90	75	60	55
Cemeteries	96	91	76	63	58
Communications, Utilities, Terminals, Plants	99	98	94	88	86
Expressway Right of Way Open Areas	96	90	76	62	56
Industrial	99	98	94	90	88
Industrial Extraction	97	92	80	68	63
Institutional	98	95	87	78	74
Low-Density Multi-Family	98	96	89	81	78
Multi-Family, Migrant Camps	99	97	91	83	80
Office	99	97	92	86	83
Parks (Including Preserves & Conservation)	96	90	75	61	56
Shopping Centers, Commercial, Stadiums, Tracks	99	98	94	90	88
Single-Family	98	96	89	81	78
Streets/Roads, Expressways, Ramps	100	99	98	97	96
Streets/Roads/Canals R/W	99	97	91	84	80

Townhouses	99	97	91	84	81
Transient-Residential (Hotels/Motels)	98	96	88	80	76
Two-Family (Duplexes)	99	97	91	83	80
Vacant Unprotected	96	90	75	61	55
Vacant, Government Owned	96	90	75	61	55
Water	100	100	100	100	100

6.7 Summary of results

The validated ICPRv4 model documented in TM2 Section 3 was used to simulate the level of flooding throughout the City for the projected 2050 sea-level rise condition. For the 2050 planning horizon, boundary conditions were raised, soil storage was decreased, rainfall depths increased, and initial groundwater conditions increased. One set of flood maps was developed:

- Inundation Flood Maps: depth of flooding above the natural ground elevation

Appendix P includes the Inundation Flood Maps maps for each design storm event.

6.8 Sub-basin Re-Ranking Based on Resiliency Considerations

The ranking procedure and level of service procedure documented in Technical Memorandum (TM3) - Identification and Ranking of Problem Sub-Basin (Section 2.0 and 3.0) were implemented to assess the sea-level, groundwater rise, and rainfall depth increase impacts for a 2050 planning horizon.

6.9 Flood Protection Level of Service and Sub-basin Ranking Results

Flood plain data for each event was prepared in raster format in order to show the location and severity of the flood conditions developed under this analysis. Flooding was represented in three colors corresponding to the severity indicators (E) assigned to specific flood conditions. These conditions were:

- Green - flooding is greater than zero and less than or equal to 6-inches
- Yellow - flooding is greater than 6-inches and less than or equal to 12-inches
- Red - flooding is greater than 12-inches

Figure 6-1 shows a sample area of the flood plain mapping developed for this SWMP with some transparency added to the raster cells. **Appendix Q** contains maps showing the location and severity of flooding for the design storm events modeled under sea-level rise conditions for the 5-, 10-, and 100-year.

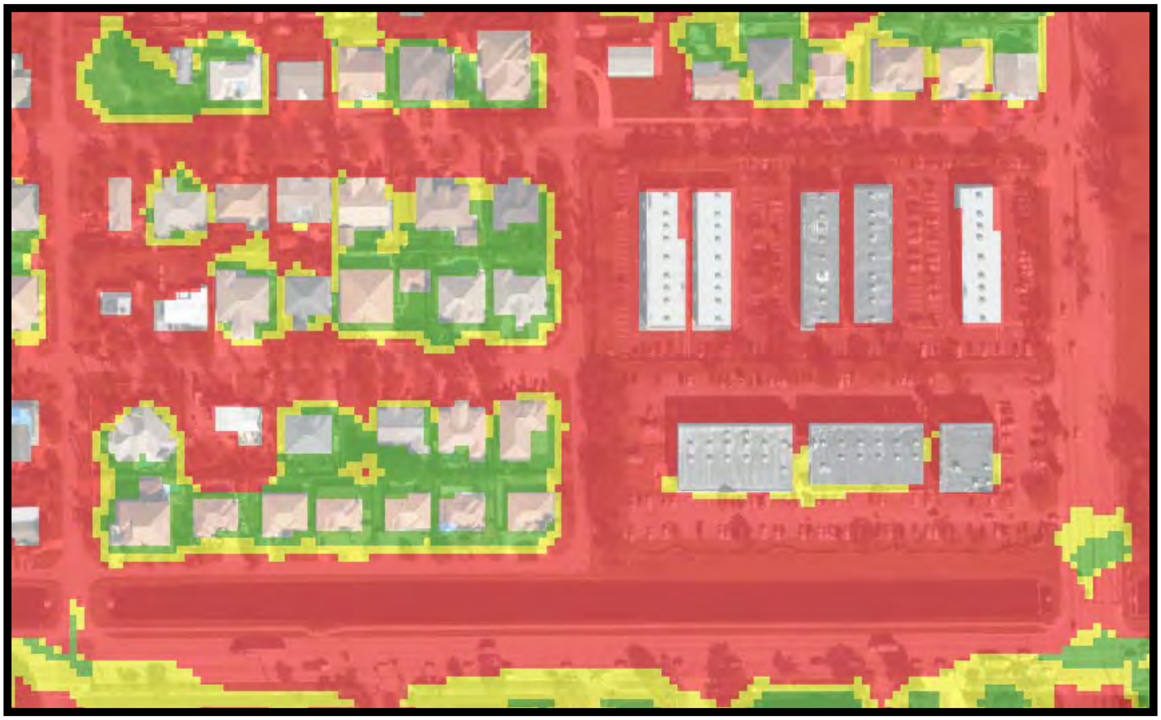


Figure 6-1 – Sample of Flood Plain Mapping Results

The FPSS results under Sea Level Rise (SLR) conditions for the City are presented in **Appendix R** showing each sub-basin severity score by severity indicator, the ranking of the sub-basin within that severity indicator, and the overall composite ranking of the sub-basins for the City of Doral along with the sub-basin raking map.

Table 6-6 presents a condensed version of **Appendix R**.

Table 6-6 – FPSS SLR Model Scenario Ranking

SUB-BASIN	SUB-BASIN AREA (ACRES)	FPSS	RANK	NEW WEIGHTED FPSS	RANK SLR	% INCREASE FROM EXISTING	EXISTING RANK
H-7	172.13	33581.49	1	195.098	1	200%	1
NW 52ST E	10.45	787.26	22	75.328	2	125%	
NW 102AVE	34.18	2386.05	6	69.805	3	79%	3
F-1	78.08	4062.46	4	52.028	4	15%	2
D-4-2	45.53	1824.34	10	40.072	5	72%	6
NW 52 ST W	16.69	561.25	24	33.628	6	97%	9
D-1-1	17.97	536.27	25	29.838	7	16%	7
H-8	67.88	2020.74	9	29.770	8	26%	8

SUB-BASIN	SUB-BASIN AREA (ACRES)	FPSS	RANK	NEW WEIGHTED FPSS	RANK SLR	% INCREASE FROM EXISTING	EXISTING RANK
F-5	76.91	2224.82	8	28.926	9	85%	10
NW-114AVE	37.79	1077.38	17	28.511	10	144%	11
N-1-1	154.62	4318.03	3	27.927	11	349%	33
L-4	34.21	890.61	20	26.034	12	109%	31
K-8	19.94	470.43	28	23.587	13	657%	51
L-2	43.88	1011.57	18	23.052	14	124%	29
O-1	347.34	7846.05	2	22.589	15	196%	21
D-3-1	20.50	401.53	30	19.591	16	2%	5
L-1	96.48	1416.97	14	14.687	17	115%	23
K-7	21.06	306.80	33	14.570	18	357%	49
H-8-1	116.44	1688.18	12	14.498	19	46%	12
G-1	199.44	2287.32	7	11.469	20	48%	14
G-4	121.64	1320.96	16	10.860	21	22%	13
D-5	167.89	1811.58	11	10.790	22	51%	15
E-7	16.00	163.04	37	10.188	23	79%	19
E-1	76.37	713.30	23	9.340	24	53%	16
C-7	149.19	1375.76	15	9.222	25	89%	22
C-5	159.98	1458.79	13	9.119	26	68%	20
K-1	22.95	193.40	35	8.428	27	187%	47
H-6	120.37	1000.65	19	8.313	28	75%	28
B-2	317.01	2405.03	5	7.587	29	108%	24
A-3-3	14.11	103.76	39	7.352	30	108%	25
D-2-1	14.07	93.11	40	6.617	31	9%	17
E-3	76.69	501.72	27	6.542	32	135%	30
E-4-1	84.10	445.73	29	5.300	33	51%	26
K-2	16.81	84.64	41	5.035	34	179%	70
F-7-1	22.32	112.07	38	5.020	35	49%	27
I-2	34.52	168.27	36	4.874	36	133%	35
C-6	138.00	509.38	26	3.691	37	45%	32
A-2	245.46	816.35	21	3.326	38	56%	34
A-4	111.07	314.66	32	2.833	39	41%	36
A-6	85.69	196.85	34	2.297	40	109%	42
NW 33 St	8.36	16.01	48	1.915	41	78%	43
E-25ST	9.50	14.80	50	1.558	42	41%	41
K-6	25.85	20.50	42	0.793	43	149%	81
H-79AVE-N	8.59	5.48	71	0.638	44	12%	59
G-SCC-1	12.28	6.52	66	0.531	45	303%	80
H-82AVE	0.67	0.33	84	0.500	46	-1%	64

SUB-BASIN	SUB-BASIN AREA (ACRES)	FPSS	RANK	NEW WEIGHTED FPSS	RANK SLR	% INCREASE FROM EXISTING	EXISTING RANK
H-79AVE-S	1.30	0.49	83	0.374	47	-6%	71
A-82AVE-N	11.29	3.40	75	0.301	48	2%	75
K-SCC-2	12.67	3.09	76	0.244	49	-1%	79
E-2	78.61	12.71	55	0.162	50	88%	82
A-82AVE-S	1.17	0.18	85	0.155	51	-43%	78
K-5	24.77	2.41	78	0.097	52	3%	83
K-4	22.49	2.18	79	0.097	53	-5%	84
K-3	22.39	2.11	80	0.094	54	4%	85
H-DRC-2	8.01	0.05	86	0.007	55	0%	86

The Design Storm Inundation Flood Maps for the 5-year, 10-year, 25-year, 10-year, 250-year, 500-year, and 1000-year events are presented in **Appendix R.**

The City requested a combined map, which was revised and re-ranked by the City, according to their knowledge of the City, which is shown in **Figure 1-5**. The Revised Combined-Ranking was re-scored according to the City new basin delineations, as summarized in **Table 1-2.**

7.0 STORMWATER IMPROVEMENT PROJECT FORMULATION AND CONCEPTUAL DESIGN AND CAPITAL IMPROVEMENT PLAN

7.1 Stormwater Control Measure Descriptions

Stormwater management systems must adhere to strict water quality and quantity criteria set forth by various local, state, and federal agencies with jurisdiction within the state of Florida. All new or improved stormwater management systems must adhere to these criteria before permitting and be constructed as permitted. As such, all projects which were developed for the City will require full coordination with regulatory agencies and adherence to all local, state, and federal laws. As with any regulatory requirements, changes do occur over time, and all criteria must be verified with the applicable agency before the commencement of the design phase of a project.

The typical stormwater management systems used within the City of Doral include positive drainage systems with connections to surface water bodies and exfiltration trenches. Injection wells are not feasible for this area due to the location of the City of Doral relative to the saltwater intrusion zone. These systems and their performance within the parameters of the analyses performed for this Storm Water Management Plan (SWMP) are detailed further in this section.

7.2 Water Quality Regulatory Requirements

In the City of Doral, and dependent upon project/site-specific circumstances, the South Florida Water Management District (SFWMD) and Miami Dade County Department of Regulatory and Economic Resources (RER) will have jurisdiction over stormwater quality criteria. The following subsections outline the current requirements set forth by these entities. All systems to be permitted must be designed to meet these requirements most stringent criteria and are specific to each project.

7.2.1 Miami-Dade County RER

Miami-Dade County RER requires that all projects meet the State of Florida water quality standards set forth in the Florida Administrative Code (F.A.C.) Chapter 17-302. To assure that this criterion is met, 100 percent of the first one inch of runoff from the furthest hydrologic point must be retained on site. The methodology for calculating this volume is outlined in RER's Policy for Design of Drainage Structures, dated December 1980, using the following equations, **Equation 7.2-1** through **Equation 7.2-2**.

$$V = 60CiAT_t$$

Equation 7.2-3

Where V = Required stormwater quality volume, cubic feet
C = Runoff Coefficient; 0.3 for pervious areas, 0.9 for impervious areas, or weighted average for areas with mixed type.

A = Total tributary area, acre
T_t = Time to generate one inch of runoff plus the time of concentration, minutes, from **Equation 2.1-2**
i = Rainfall intensity, inches per hour, from **Equation 2.1-4**

$$T_t = T_{1''} + T_c$$

Equation 7.2-4

Where T_c = Time of concentration, minutes
$T_{1''}$ = Time to generate one inch of runoff, minutes, from **Equation 2.1-3**

$$T_{1''} = \frac{2940\ F^{-0.11}}{308.5\ C - 60.5(0.5895 + F^{-0.67})}$$

Equation 7.2-5

Where F = Storm frequency, years

$$i = \frac{308.5}{48.6F^{-0.11} + T_t(0.5895 + F^{-0.67})}$$

Equation 7.2-6

Additionally, RER requires that the required stormwater quality volume (V) from **Equation 7.2-7** is infiltrated into the groundwater table in a period of less than 24 hours and the use of bleeder mechanisms is not allowed.

7.2.2 South Florida Water Management District

The SFWMD requires that all projects meet State of Florida water quality standards set forth in the Florida Administrative Code (F.A.C.) Chapter 62-302. To assure that these criteria are met, projects must meet the following volumetric retention/detention requirements, as described in the SFWMD Environmental Resource Permit Applicant's Handbook Volume II:

1. For wet detention systems:
   - i A wet detention system is a system where the control elevation is less than one foot above the seasonal high groundwater elevation and does not bleed-down more than one-half inch of detention volume in 24 hours.
   - ii The greater of the following volumes must be detained on site:
     - The first one inch of runoff times the total project area
     - 2.5 inches of total runoff from the impervious area
2. Dry detention systems must provide 75 percent of the required wet detention volume. Dry detention systems maintain the control elevation at least one foot above the seasonal high groundwater elevation.
3. Retention systems must provide at least 50 percent of the wet detention volume.

4. For projects with impervious areas accounting for more than 50 percent of the total project area, discharge to receiving water bodies must be made through baffles, skimmers, and/or other mechanisms suitable for preventing oil and grease from discharging to or from the retention/detention areas.

Although a determination for detention systems is described within the SFWMD criteria, Miami-Dade County RER does not allow for the use of detention systems, either wet or dry, for the purposes of meeting the water quality criteria. Exfiltration trenches with the perforated pipe located at or above the seasonal high groundwater elevation are considered dry retention systems. Since dry retention ponds and exfiltration trenches are both deemed to be retention systems, the retention reduction credit outlined under item #3 applies to all systems within the City of Doral.

7.3 Water Quantity Regulatory and Permitting Requirements

The following subsections outline the most stringent stormwater quantity requirements applicable to any City of Doral projects. Also, depending on project-specific circumstances, the SFWMD, RER, and FDOT may have jurisdiction over specific stormwater quantity criteria.

7.3.1 City of Doral

The City of Doral does not have explicit stormwater criteria but does require that all new projects adhere to applicable regulatory design and permitting criteria from applicable agencies having jurisdiction within the City.

7.3.2 Miami-Dade County RER

For projects that discharge to Miami-Dade County canals, the specific allowable discharge criteria for that canal must be met. Designers must coordinate with Miami-Dade County RER to obtain the applicable discharge criteria of the specific receiving Miami-Dade County canal or water body. Through the required permitting, a Class II or Class III permit may be required.

7.3.3 South Florida Water Management District

The SFWMD requires that off-site discharge rates be limited to rates not causing adverse impacts to existing off-site properties, and:

1. historic discharge rates,
2. rates determined in previous SFWMD permit action, or
3. basin allowable discharge rates.

For projects discharging to a SFWMD canal basin, the SFWMD ERP Applicant's Handbook Volume II outlines basin allowable discharge rates. The City of Doral receiving water bodies are within the C-4 Canal Basin and C-6 Canal Basin. These basins do not have historic or allowable discharge criteria. **Table 7-1** includes the allowable discharge criteria as per SFWMD Environmental Resource Permit Applicant's Handbook Volume II.

Table 7-1 – SFWMD Allowable Discharge Rate Formulas for Basins with Restricted Discharge

CANAL	ALLOWABLE DISCHARGE RATE FORMULA	DESIGN FREQUENCY
C-4	Essentially unlimited inflow by gravity connections east of S.W. 87th Avenue	200 year +
C-6	Essentially unlimited inflow by gravity connections east of FEC Railroad	200 year +

For project areas with no historical discharge rate and discharge to an area with an unlimited discharge rate, the SFWMD requires that pre-development flows during a 25-year, 72-hour rainfall event are not increased during post-development conditions.

7.3.4 Florida Department of Transportation

FDOT requires that proposed drainage systems meet the offsite discharge requirements outlined in F.A.C. Chapter 14-86. The following items are applicable regarding the FDOT criteria for the transfer of stormwater to the FDOT right of way as a result of manmade changes to adjacent properties:

- The offsite discharge criteria are based on a critical storm frequency analysis, including storm events with 2- to 100-year frequencies and 1-hour to 10-day durations for closed basins, and 3-day durations for basins with positive outlets.
- Any discharging pipe establishing or constituting a drainage connection to the FDOT's right of way is limited in size based on the pre-improvement discharge rate, downstream conveyance limitations, downstream tailwater influences, and design capacity restrictions imposed by other governmental entities.
- The peak discharge rates and total volumes allowed by applicable local regulations are not exceeded.
- The improvements shall not increase stormwater discharge rates above the pre-development conditions.
- The quality of water conveyed by the connection meets all applicable water quality standards.

7.4 Stormwater Management Systems

The following subsections summarize the most common and feasible stormwater control measures available to the City of Doral to reduce the peak flood stages. These items were evaluated for implementation into the sub-basins based on the existing stormwater management systems in place, the sub-basins topographic elevations, the stormwater system relative location to receiving water bodies/canals, and the available open areas. Additionally, the stormwater system capacity to remove volumes of stormwater runoff from a sub-basin was described in this subsection. The effectiveness of the stormwater system implementation within a sub-basin will be further evaluated in **Section 7.7.**

7.4.1 Positive Drainage with Outfalls

Positive drainage systems are stormwater management systems that discharge stormwater runoff directly into open water bodies such as canals, lakes, and rivers. This type of stormwater management system does not provide any form of pre-treatment before discharge and is the least accepted practice in Miami-Dade County.

Several positive drainage systems exist within the City's limits, and it is most likely that the majority of these systems were constructed before the advent of modern stormwater discharge regulations. These systems can remain in place if no additional impervious areas or increases in post-development discharges are experienced through a reparation or rehabilitation of an existing system compared to the original functioning system.

Suppose the capacity or contributing areas associated with a stormwater management system are increased. In that case, these systems are then required to meet all of the applicable quantity and quality criteria previously described in **Section 7.2** and **7.3**. These criteria are often met by converting these direct discharge only systems into systems that exfiltrate or infiltrate stormwater runoff into the groundwater table – most commonly through the use of exfiltration trenches, dry ponds, or green swale. A positive drainage system's effectiveness is controlled by the size, length, and associated capacity of the pipes and structures making up the system and the stages within the system and that of the receiving water body.

7.4.2 Exfiltration Trenches

A drainage system utilizing exfiltration trenches is the most common system used in South Florida to meet stormwater quantity and quality retention requirements. Exfiltration trenches have a relatively low construction cost and are among the least land-intensive stormwater drainage systems available. Their effectiveness is heavily dependent on acceptable soil hydraulic conductivity, groundwater table elevations, and available topographic elevations. The pipes associated with exfiltration trench systems can also provide additional interconnectivity within an area, as does a solid pipe system.

An exfiltration trench system consists of at least one catch basin or inlet that leads to a perforated or slotted pipe lying in a bed of aggregate filter media, such as pea rock. They can be placed below paved surfaces or at the bottom of retention areas and offer a method of conveying stormwater runoff to the groundwater table in areas where impervious areas have been significantly increased. **Figure 7-1** shows a typical longitudinal profile and cross-section of an exfiltration trench.

These systems typically include a weir or control structure that retains a certain amount of stormwater runoff and surcharges the perforated pipe and trench to induce exfiltration into the surrounding native soil. Self-contained systems do not require a weir or control structure since the lowest inlet elevation acts as the target surge elevation or control elevation of the system.

Exfiltration trenches are deemed viable when soil hydraulic conductivity is greater than 1×10^{-5} cubic feet per second (cfs), per square foot (ft^2) per foot (ft) of hydraulic head.

When good soil hydraulic conductivity is present, exfiltration trenches are viable when the average wet season groundwater elevation (average October elevation in Miami-Dade County) is at least one to two feet below the control elevation of the drainage system.

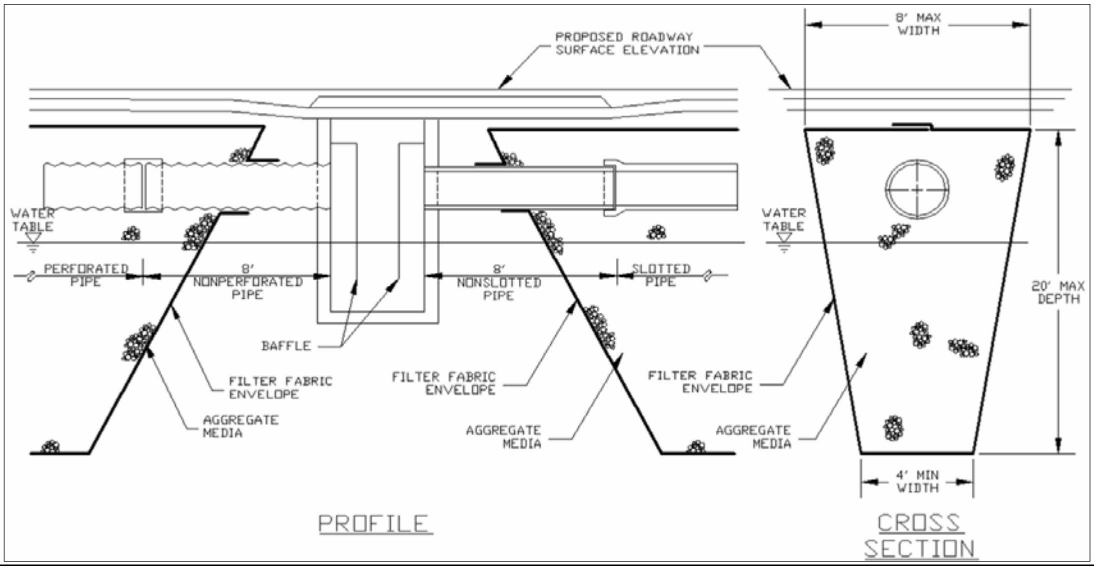


Figure 7-1 – Typical Exfiltration Trench Sections

For exfiltration trenches, when the design high water elevation is within the aggregate media and the control elevation is above the exfiltration trench aggregate media as depicted in **Figure 7-2** and as will be typical for the City of Doral systems, the following equations are typically used to quantify exfiltration capacity for a system.

For 10-ft deep exfiltration trench,

$$E_t = 2\,K_{10}\,[\,d_u(d_p - d_u/2) + d_s d_p\,]$$ **Equation 7.4-1**

For 15-ft deep exfiltration trench,

$$E_t = 2\,K_{10}\,[\,d_u(d_p - d_u/2) + d_s d_p\,] + 2K_{15} d_p d_2$$ **Equation 7.4-2**

Where E_t = Total exfiltration rate, in cfs/linear ft (LF) of trench
d_u = depth of the unsaturated zone, in ft
d_s = depth of the saturated zone, in ft
d_p = hydraulic head on exfiltration trench, in ft

d_2 = depth of 10-15 foot stratum, typically 5-ft
K_{10} = Hydraulic conductivity, 0- to 10-foot stratum, in cfs/ ft^2 x ft of head
K_{15} = Hydraulic conductivity, 10- to 15-foot stratum, in cfs/ ft^2 x ft of head

Additionally, it should be noted that the slots of slotted exfiltration trench pipes limit the exfiltration capacity of the exfiltration trench system and, because of this, it is recommended that the exfiltration rate should be limited to 0.1 cfs per foot of trench regardless of the perforations in the pipe or the soil hydraulic conductivity.

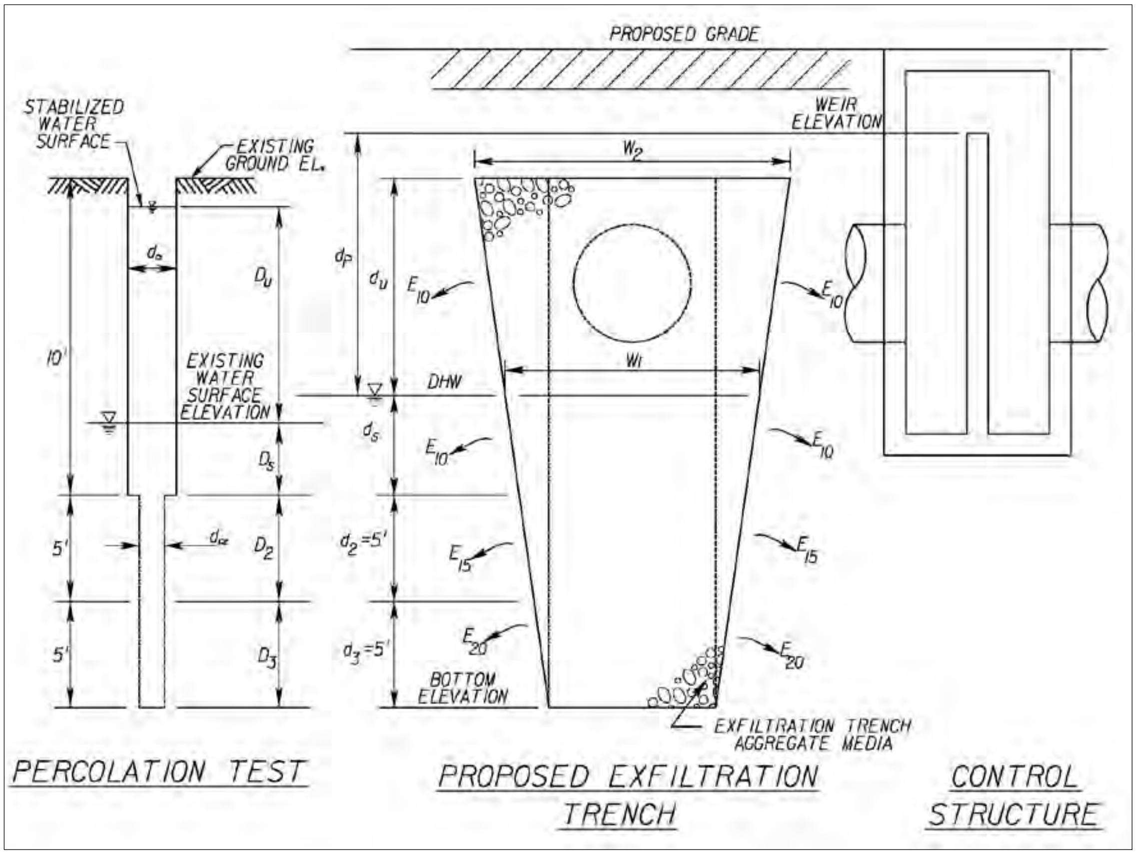


Figure 7-2 – Schematic of the percolation test parameters compared to the proposed exfiltration trench and control structure. Condition where DHW is within the trench aggregate media and the control elevation is above the trench aggregate media.

7.4.3 Dry Retention Ponds and Off-line Storage Areas

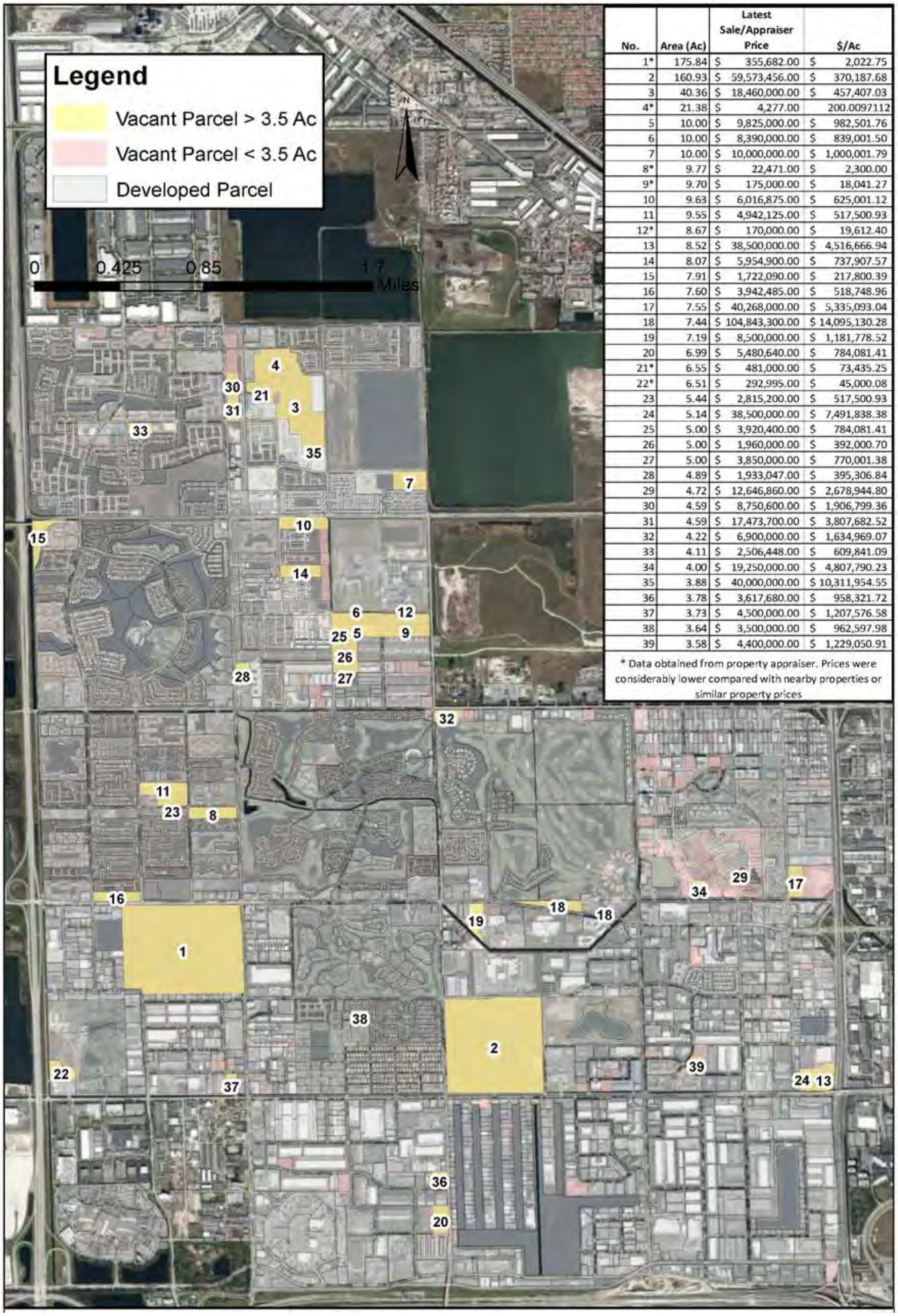
Dry retention ponds and off-line storage areas with topographic elevations lower than the surrounding areas and are often interconnected with stormwater collection systems within the surrounding areas. These retention ponds are required to have a bottom elevation one (1) foot above the seasonal high groundwater elevation, allowing the retention ponds to remain dry during times of no rain. The seasonal high groundwater elevation for the City of Doral for a 2050 sea-level rise scenario to be used in future design projects is 2.75 ft-NAVD88, as outlined in Technical Memorandum (TM) 4.

Dry retention pods and off-line storage areas are also designed to collect and store stormwater runoff to meet both water quantity and quality requirements for a system/area. They can also be constructed in combination with exfiltration trenches, which help reduce drawdown times for the stored water, returning the pond to dry conditions (less than 72-hours). These ponds can also be developed from recreational areas such as parks that provide an additional benefit to the community in the form of green areas for City residents to use.

Dry retention ponds and off-line storage areas will require the acquisition and maintenance of large tracts of land and are often not readily available or feasible in urbanized areas such as most sub-basins within the City of Doral. Because of the demand and cost of land in the City of Doral, acquiring the parcels may be cost-prohibitive. These tracks of lands will also be taken private parcels of land off the City's tax rolls, reducing tax revenue to the City.

These storage areas are viable when the topographic elevations are several feet above the seasonal high groundwater elevation within a given area and can significantly reduce stages with a large enough retention basin. A retention pond's capacity is based on the horizontal dimensions of the pond, the depth between the bottom of the retention basin, and the highest point at which no discharge to adjacent areas is achieved. These types of storage areas within a drainage system require that stormwater runoff be conveyed to them. Gravity systems are typically used to convey stormwater runoff to retention basins. However, when the storage area is far from the flood areas that require mitigation, a stormwater pump station will be required to convey the flood volume to these storage areas.

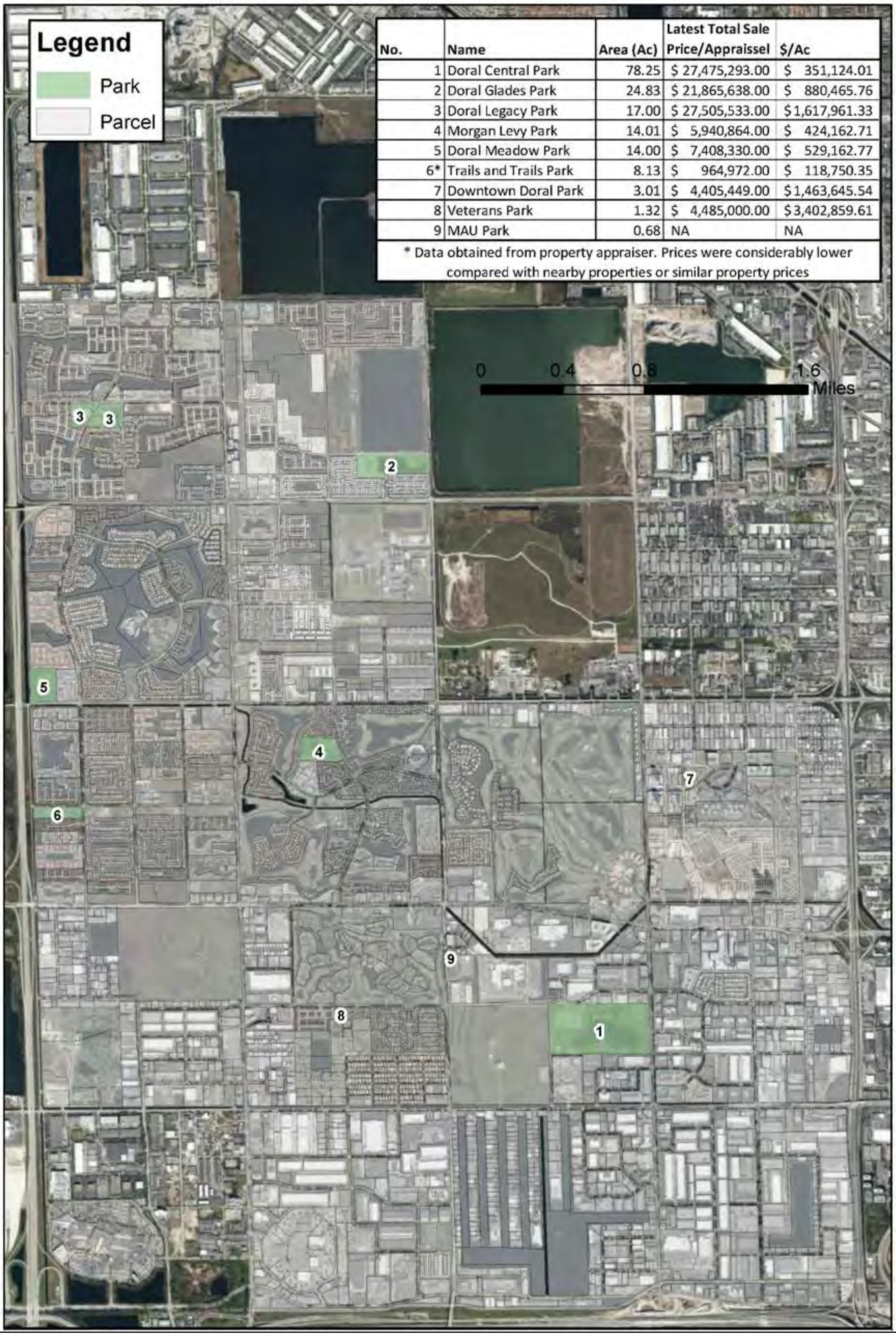
Several areas and open parcels were identified throughout the City to potentially be used for dry retention ponds and off-line storage areas. The available open parcels within the City and City-owned parks that could potentially be used for dry retention ponds and off-line storage areas are depicted in **Figure 7-3** and **Figure 7-4 – Parks Map**, respectively. Given the limited availability and cost of land within the City's flood-prone areas, these types of stormwater management systems would be costly and determined not to be viable compared to exfiltration trench systems. However, these areas could be evaluated in the future, if and when it becomes cost-effective to purchase these land parcels for flood mitigation.



No.	Area (Ac)	Latest Sale/Appraiser Price	$/Ac
1*	175.84	$ 355,682.00	$ 2,022.75
2	160.93	$ 59,573,456.00	$ 370,187.68
3	40.36	$ 18,460,000.00	$ 457,407.03
4*	21.38	$ 4,277.00	200.0097112
5	10.00	$ 9,825,000.00	$ 982,501.76
6	10.00	$ 8,390,000.00	$ 839,001.50
7	10.00	$ 10,000,000.00	$ 1,000,001.79
8*	9.77	$ 22,471.00	$ 2,300.00
9*	9.70	$ 175,000.00	$ 18,041.27
10	9.63	$ 6,016,875.00	$ 625,001.12
11	9.55	$ 4,942,125.00	$ 517,500.93
12*	8.67	$ 170,000.00	$ 19,612.40
13	8.52	$ 38,500,000.00	$ 4,516,666.94
14	8.07	$ 5,954,900.00	$ 737,907.57
15	7.91	$ 1,722,090.00	$ 217,800.39
16	7.60	$ 3,942,485.00	$ 518,748.96
17	7.55	$ 40,268,000.00	$ 5,335,093.04
18	7.44	$ 104,843,300.00	$ 14,095,130.28
19	7.19	$ 8,500,000.00	$ 1,181,778.52
20	6.99	$ 5,480,640.00	$ 784,081.41
21*	6.55	$ 481,000.00	$ 73,435.25
22*	6.51	$ 292,995.00	$ 45,000.08
23	5.44	$ 2,815,200.00	$ 517,500.93
24	5.14	$ 38,500,000.00	$ 7,491,838.38
25	5.00	$ 3,920,400.00	$ 784,081.41
26	5.00	$ 1,960,000.00	$ 392,000.70
27	5.00	$ 3,850,000.00	$ 770,001.38
28	4.89	$ 1,933,047.00	$ 395,306.84
29	4.72	$ 12,646,860.00	$ 2,678,944.80
30	4.59	$ 8,750,600.00	$ 1,906,799.36
31	4.59	$ 17,473,700.00	$ 3,807,682.52
32	4.22	$ 6,900,000.00	$ 1,634,969.07
33	4.11	$ 2,506,448.00	$ 609,841.09
34	4.00	$ 19,250,000.00	$ 4,807,790.23
35	3.88	$ 40,000,000.00	$ 10,311,954.55
36	3.78	$ 3,617,680.00	$ 958,321.72
37	3.73	$ 4,500,000.00	$ 1,207,576.58
38	3.64	$ 3,500,000.00	$ 962,597.98
39	3.58	$ 4,400,000.00	$ 1,229,050.91

* Data obtained from property appraiser. Prices were considerably lower compared with nearby properties or similar property prices

Figure 7-3 – Vacant Land Map



No.	Name	Area (Ac)	Latest Total Sale Price/Appraissel	$/Ac
1	Doral Central Park	78.25	$ 27,475,293.00	$ 351,124.01
2	Doral Glades Park	24.83	$ 21,865,638.00	$ 880,465.76
3	Doral Legacy Park	17.00	$ 27,505,533.00	$1,617,961.33
4	Morgan Levy Park	14.01	$ 5,940,864.00	$ 424,162.71
5	Doral Meadow Park	14.00	$ 7,408,330.00	$ 529,162.77
6*	Trails and Trails Park	8.13	$ 964,972.00	$ 118,750.35
7	Downtown Doral Park	3.01	$ 4,405,449.00	$1,463,645.54
8	Veterans Park	1.32	$ 4,485,000.00	$3,402,859.61
9	MAU Park	0.68	NA	NA

* Data obtained from property appraiser. Prices were considerably lower compared with nearby properties or similar property prices

Figure 7-4 – Parks Map

7.4.4 Pump Stations

Pump stations are used for expediting flows to a receiving water body or retention area. Although stormwater pump stations are expensive to install, operate, and maintain, their use is often required in areas where no other practical gravity alternative is available. **Figure 7-5** Shows a typical plan view of a stormwater pump station.

Numerous factors play a role in determining the potential rate/volume for which a pump station should commodate. They include limits on rate/volume of receiving water body, conveyance capacity of contributing systems, and size constraints for the pump station wet well. These factors can limit a pump station system's overall effectiveness when being implemented in a given area.

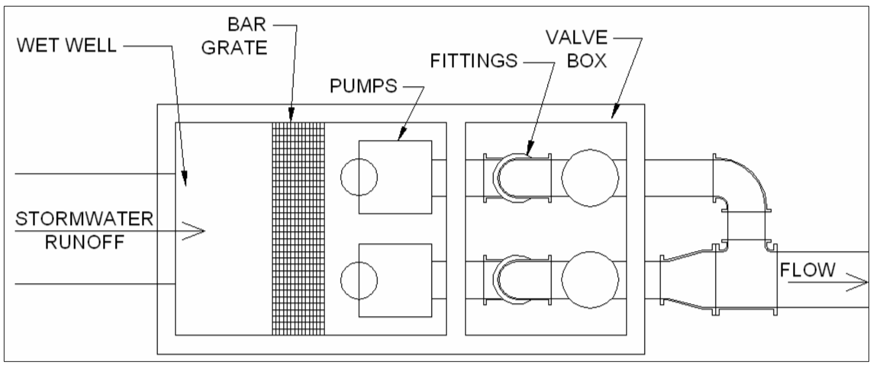


Figure 7-5 – Typical StormwatFigure 7-5er Pump Station Plan View

Stormwater management systems utilizing pump stations are more expensive to implement than most other stormwater management system options due to the mechanical and electrical components making up the pump station (i.e., pumps, valves, and control panels). Pump stations also require regular maintenance by trained staff and may require occasional overhauling or possible replacement after extended periods.

Throughout the last 15 years, the City has almost maximized the use of exfiltration trenches through the City. There is currently a limited amount of areas that can accommodate additional exfiltration trenches. Furthermore, as outlined in the City of Doral Stormwater Vulnerability Assessment study dated January 2020, exfiltration trenches will continue losing capacity due to the projected groundwater rise due to projected Climate Change data. Stormwater Vulnerability Assessment Study projects an overall City average reduction of 8.2% in exfiltration capacity by 2050, based on the projection of 0.25 inches in groundwater rise during that time frame.

To mitigate the limited amount of additional areas where exfiltration trenched can be added and projected reduction in exfiltration capacity, stormwater pump stations should be evaluated for areas discharging to adjacent canals. However, based on a coordination meeting with RER on October 26, 2020, RER stated that the canals within and adjacent to the City are at capacity. RER is currently evaluating if there is any additional capacity available in these canals, but allowing pump station discharges to these canals is highly unlikely. RER stated that they are evaluating potential issues with the Northline Canal capacity that may be caused by the recently constructed viaduct culvert and downstream control structures. Also, Miami-Dade County is currently in the design phase for a roadway improvement project to NW 25th Street from NW 87th Avenue to NW 117th Avenue and will need to verify if this project will create additional adverse capacity impacts to the Northline Canal. RER stated that their capacity analysis would take a year or longer. The meeting minutes are provided in **Appendix S**.

Based on the discussion at this meeting, RER requested the City evaluate one pump station for the Vanderbilt area (limited by NW 25th Street at the south boundary, NW 28th Terr at the north, NW 102nd Ave west, and NW 97th Avenue at the east boundary) and provide the County with the peak flows and additional volumes that would be discharged to the Northline Canal. The County would then evaluate if the canal will be able to accommodate these flows and volumes as part of their future study. Therefore, as part of this master plan update, the feasibility of adding a pump station to the Vanderbilt neighborhood (Sub-basin F-1) to reduce flooding in this neighborhood to the maximum extent possible. **Figure 7-6** shows the location of the proposed pump station for the Vanderbilt neighborhood.

Figure 7-6 – Vanderbilt Neighborhood Proposed Pump Station

7.5 Low Impact Development (LID) Best Management Practices

In November 2016, the City of Doral developed and adopted a Low Impact Development Master Plan. The purpose of the LID Master Plan was to assist the City in maximizing the implementation of the LID Integrated Management Practices. These practices will minimize impacts from anticipated new development and/or redevelopment projects. The

Master Plan also provided guidance for LID site planning, hydrologic analysis, and erosion and sediment control practices, as well as incentives for participation.

The Low Impact Development Stormwater Master Plan recommends using the following LID Best Management Practices (BMPs) when feasible to implement on a project. The primary nonstructural LID BMPs recommend in the Master Plan include:

- Restoration and preservation of pre-development topography and soil profile
- Preservation and use of native and local vegetation
- Open space design and conservation
- Minimization of total impervious areas
- Reduction of DCIA

And the structural LID BMPs recommended in the Master Plan include:

- Bioretention Basins or Rain Gardens
- Tree Box Filters or Infiltration Planters
- Vegetated Swales
- Filter Strips or Vegetated Buffers
- Infiltration Trench
- Exfiltration Trench or French Drains
- Green Roofs/Rain Barrels or Cisterns
- Permeable Pavement
- Detention Ponds
- Parking Chambers

As stated in the Low Impact Development Stormwater Master Plan, these BMPs mainly mitigate low rainfall events and improve the quality of stormwater discharges. Therefore, these BMPs were not evaluated as part of the regional hydrologic/hydraulic assessment performed as part of this Stormwater Master Plan. During the design phase of the conceptual design projects, opportunities should be evaluated to implement as many of the LID BMPs outlined in the Low Impact Development Stormwater Master Plan.

7.6 Raising Roads and Flood Proofing

When there are no other available alternatives to mitigate roadway or building flooding, raising roads and floodproofing may be the only viable options.

7.6.1 Raising Roads

When roadway flooding cannot be mitigated via the stormwater management systems outlined above, one alternative is to raise the roads. However, this alternative sometimes becomes cost-prohibitive, but it should be considered and evaluated for roadway widening projects or for new road construction. For new roadway projects, the flood elevations outlined in this stormwater master plan for the 2050 sea level and groundwater rise conditions should be used in establishing the minimum roadway elevation. One critical element for roadway widening projects is to evaluate that the roadway rasing does not impact access harmonization of adjacent properties.

7.6.2 Floodproofing

For older buildings constructed below the latest FEMA flood elevation, it is not feasible to raise buildings' finish floor elevations to the FEMA flood elevations. For these buildings, floodproofing techniques can be applied. Floodproofing applications follow all the latest flood codes and regulations enforced by the NFIP, FEMA, and local ordinances. Viable floodproofing techniques include wet floodproofing and dry floodproofing with passive and active components.

Wet floodproofing allows floodwater to freely flow through an enclosure such as a crawlspace or a garage utilizing flood vents. **Figure 7-7** shows an example of spaces suitable for wet floodproofing and vents. The flood vents relieve hydrostatic pressure on foundation walls during a flood event. The flood vents must allow for free inflow and outflow of water in both directions, ensuring that water levels rise and fall at the same rate as floodwaters outside the house. Wet floodproofing is not practical for areas that are to be used as living spaces.

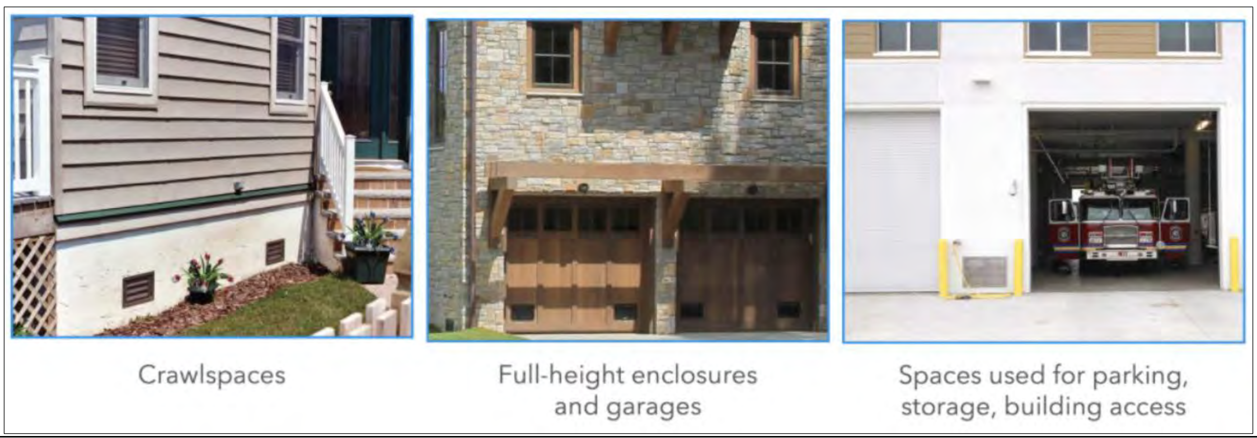


Figure 7-7 – Wet Floodproofing from Smart Vent

In contrast, dry floodproofing prevents the entry of floodwater into the building and provides the flexibility to keep the property open for a longer time, providing the fastest recovery time. These include

- Door flood barriers,
- Door and window flood barriers
- Point of use flood barriers
- Flood logs
- Flood plank system
- Standard perimeter flood barriers
- Collapsible perimeter flood barriers
- Passive flood barriers, and
- Flood pumps.

Figure 7-8 shows examples of dry floodproofing active, passive flood barriers, shields, and windows.

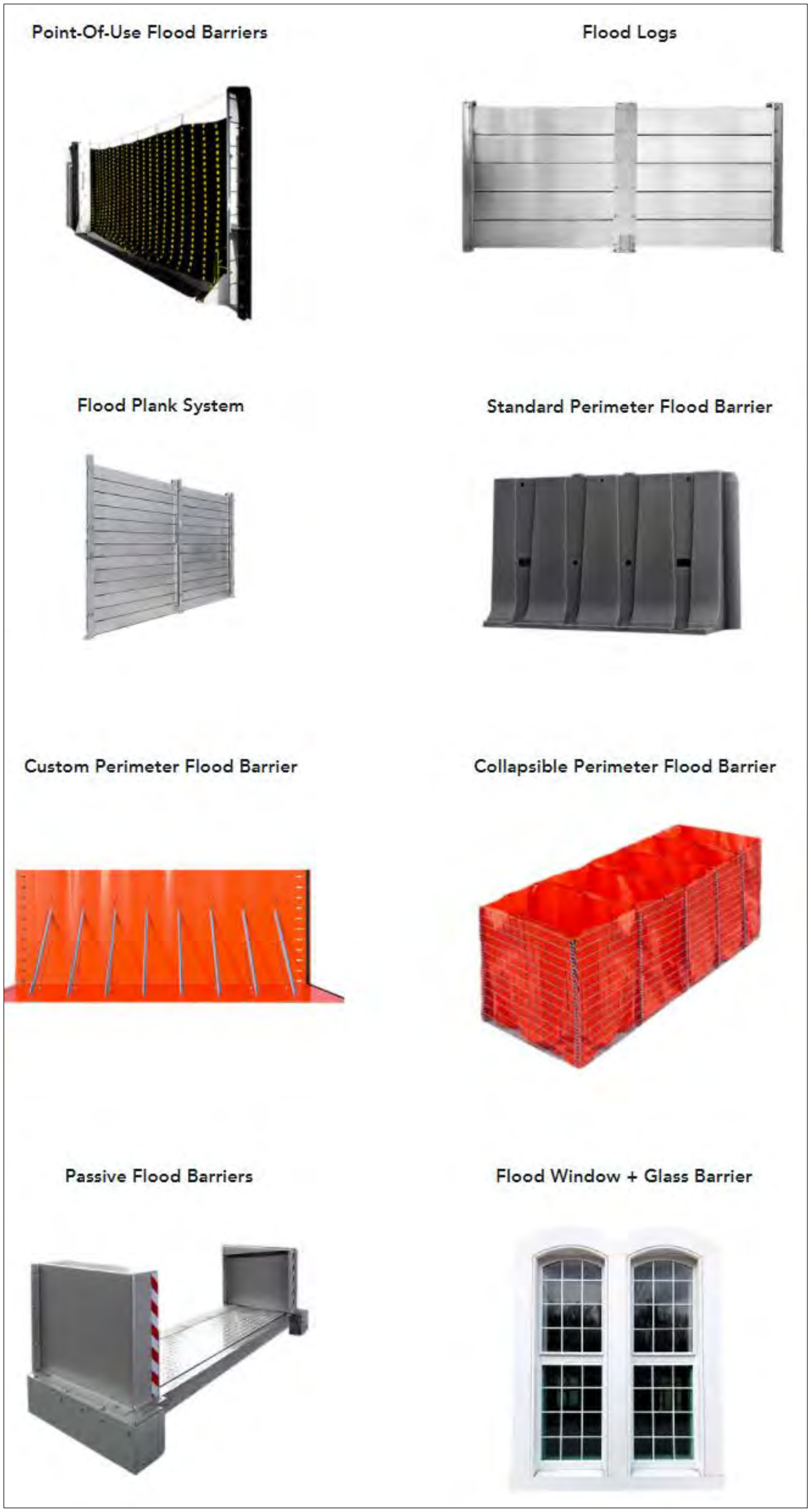


Figure 7-8 – Dry Floodproofing from Smart Vent

7.7 Proposed Stormwater Improvement Projects

In discussions with City staff, it was determined that the most viable stormwater management system that will be evaluated would be exfiltration trench systems due to their relatively low construction cost, low maintenance requirements, and effectiveness in satisfying stormwater quality and quantity requirements. Where feasible, drainage systems will be interconnected to provide redundancy and distribute available exfiltration capacity throughout the drainage systems.

This study also includes assessing the positive outfall system project currently being designed and permitted through RER (Sub-basin H-8) at the northeast end of the City. This outfall discharges to the NW 58th Street Canal according to **Figure 7-9** shows Basin H-8 and approved proposed outfall location.

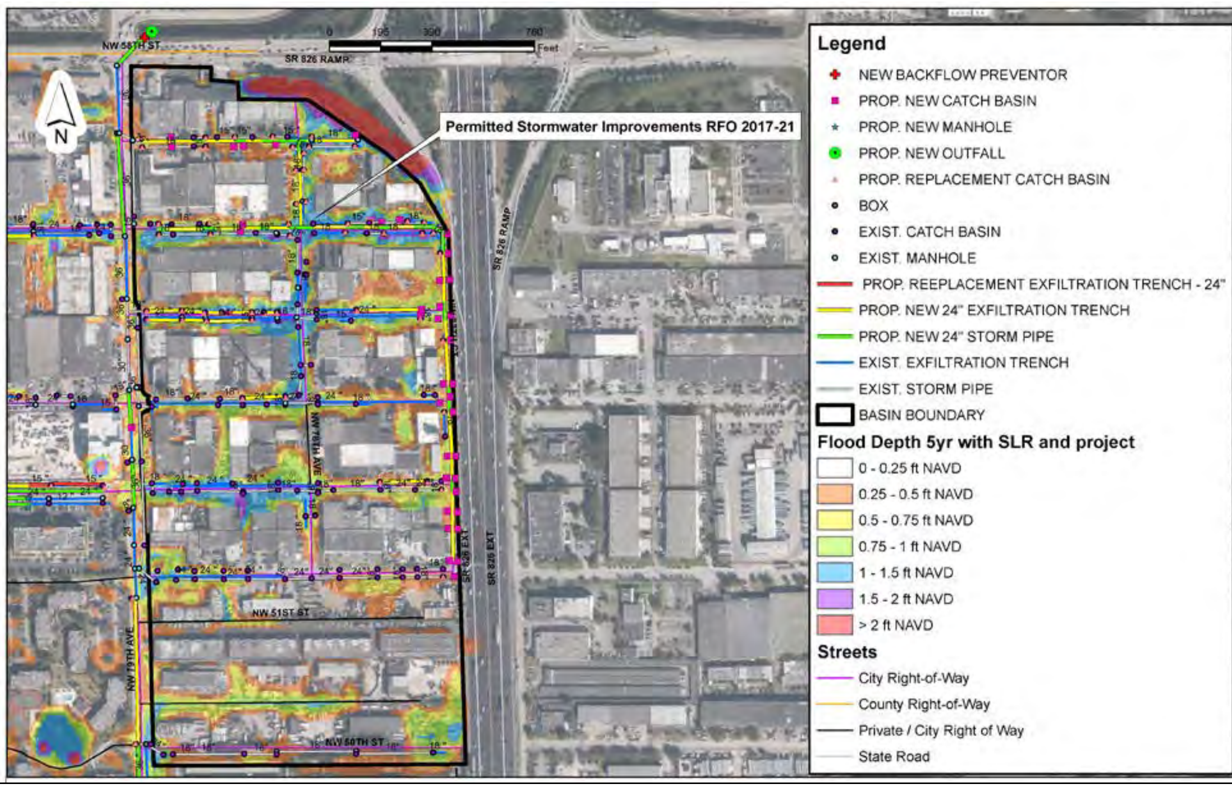


Figure 7-9 – Basin H-8 Proposed Outfall Location

Additionally, a stormwater pump station will be evaluated for the Vanderbilt neighborhood (Sub-basin F-1) due to the limited availability for additional exfiltration trenches and the elevated flood levels in that Basin. The following subsections detail the methodology used in determining the proposed stormwater management systems.

7.7.1 Evaluation Process

The top 20 City Sub-Basins identified in Technical Memorandum #3 (TM3) experiencing the most significant flood issues within the City of Doral were evaluated for potential future stormwater improvement projects. Schematic GIS shapefiles of the existing stormwater management systems were available for review for this assessment. The shapefiles available showing the location of stormwater infrastructure in the City did not contain detailed information regarding the age, size/diameters, or facility type. As such, in areas where flooding was identified as prevalent, it was assumed that the systems had reached the end of their useful life, which would be typical for exfiltration trench systems older than 15 years.

For the purposes of this evaluation, the following items were considered to be typical of the existing systems:

- Existing site conditions are comprised mainly of residential and commercial roads.
- The existing drainage systems are primarily composed of P-5, P-6, and grate inlets and manholes.
- Existing pipes consist mostly of 12-36" pipes.
- Exfiltration trenches are mainly composed of 18-24" diameter perforated pipes to a depth of 10-ft.
- Systems adjacent to canals or lakes will have overflows discharging to those water bodies with systems controlled by weirs.
- The majority of the exfiltration trench systems are over 10 years of age.
- Although the City is proactive in its maintenance program, inlets are subject to being clogged with debris resulting in reductions in capacity.
- Grass swale areas have been modified in numerous locations. Some grass swales have been paved over to provide additional access to homes/businesses without City or County approval. Some grass swales have been compacted due to vehicle traffic.

In addition to the typical makeup of the existing systems, there are also several locations where no stormwater infrastructure is present. In these areas, street flooding is an issue during most rainfall events. Additionally, several of the homes within the priority sub-basins, particularly the older models, have finished floor elevations below the standards used today. The top 20 City sub-basins ranked in order of priority are shown in **Table 7-2**. **Table 7-2** also includes the FPSS computed as part of TM 3.

Table 7-2 – Proposed Stormwater Improvement Projects for the top 20 Ranked City Sub-Basins

SUB-BASIN	SLR BASIN RANK (CITY MODIFIED)	SLR WEIGHTED FPSS
H-8	1	25.17
F-1 No PS	2	51.95
H-7	3	194.96
H-8-1	4	14.39
D-3-1	5	21.97
D-4-2	6	38.19
NW 33 St	7	1.92
D-1-1	8	29.84

SUB-BASIN	SLR BASIN RANK (CITY MODIFIED)	SLR WEIGHTED FPSS
NW 33 ST W	9	20.50
F-5	10	28.46
NW 52 ST W	11	56.83
NW 114 AVE	12	26.76
G-4	13	10.56
G-1	14	11.38
H-79AVE-N	15	0.64
H-79AVE-S	16	0.38
D-2-1	17	6.61
E-7	18	9.81
C-5	19	9.08
O-1	20	15.11

*Interconnection with other sub-basins – Project implementation order is not known at the time. Sub-basins that connect to another sub-basin should have a stub in place so they can connect when the other project is implemented.

These areas are known areas of flood concern based on public feedback from City residents/business owners and areas documented by City staff as areas where flooding is prevalent. **Figure 7-10** shows the top 20 City Sub-Basin sub-basins identified in **Table 7-2**.

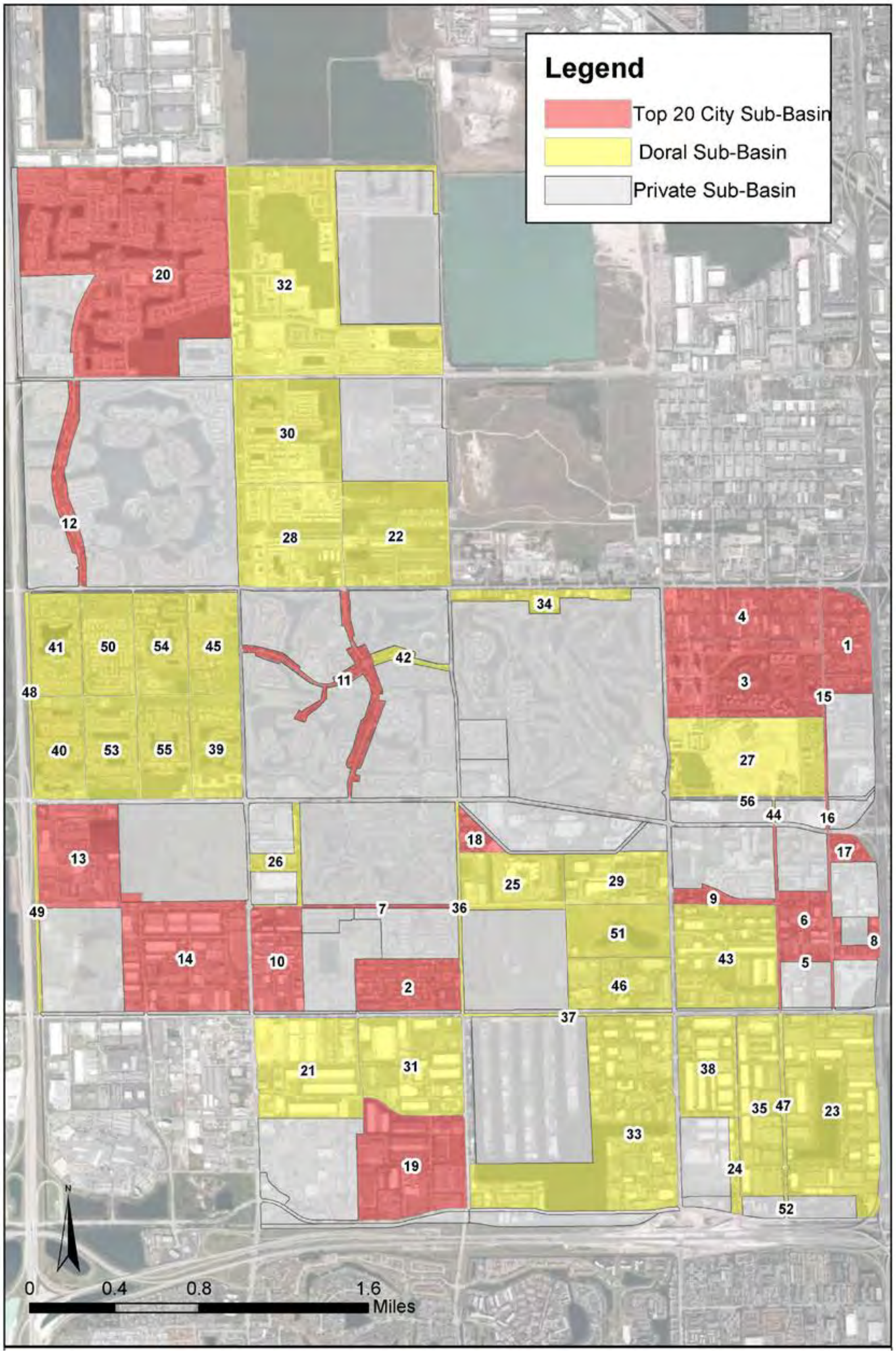


Figure 7-10 – Top 20 City Sub-Basin Ranking

7.7.2 Proposed Stormwater Improvement Projects

For the City of Doral, it was determined that the most viable stormwater improvement projects would be exfiltration trench systems due to their relatively low construction cost, low maintenance requirements, and effectiveness in satisfying stormwater quality and quantity requirements. Additionally, a design storm event return frequency of less than 10-years is used for designing stormwater management systems, with most municipalities utilizing a 5-year return frequency. Some roadway ponding is also allowed because the majority of the local municipality-maintained roads are not high-speed highways and are usually considered above ground storage areas within sub-basins that are available during periods of excessive rainfall. Exfiltration trench systems help offset the additional impervious areas that prohibit surface percolation, which is a major cause of flooding and mitigates excess flooding.

The following items were considered for the purposes of evaluating the effectiveness of the exfiltration trench systems proposed:

- The Hydraulic Conductivity (k-Factor) for various locations throughout the City was based on available percolation test data provided by the City for various locations throughout the City. These tests were performed through a number of different projects and studies throughout the City and were included in the City of Doral Stormwater Vulnerability Assessment January 2020 Report. **Figure 7-11** shows the percolation test values and locations.

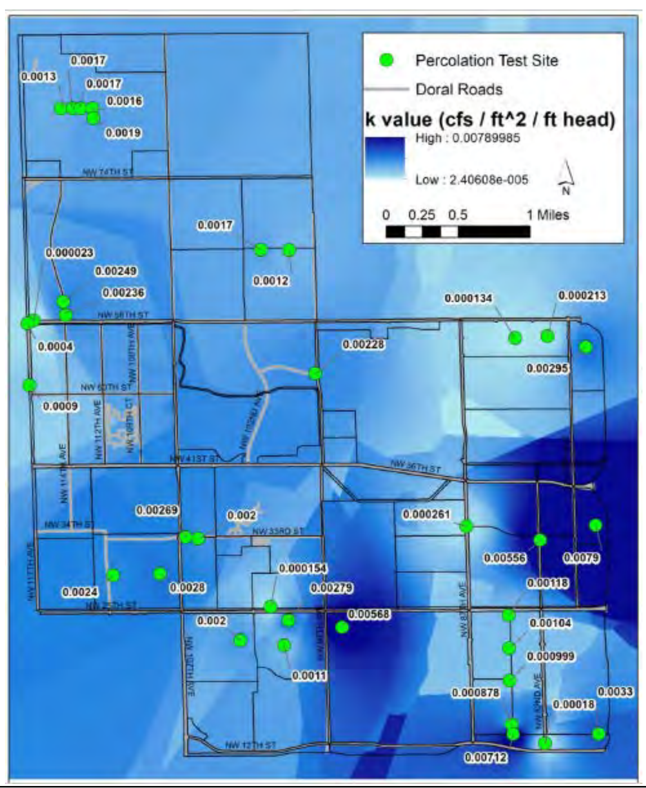


Figure 7-11 – Percolation Test Values and Locations

- The control elevations used for this analysis are based on the average rim elevation of drainage inlets located at the average lowest points in the sub-basins in the City. This elevation varied between 4.30 and 4.50 ft-NAVD88.
- The initial groundwater elevation, or the design high water (DHW), in the Existing Condition Mode (TM No. 2, Section 3) is the average October Groundwater elevation provided by the County contour shapefile. The initial stage elevation was raised from 2.5 ft-NAVD88 in the Existing Conditions model to 2.75 ft-NAVD88. According to the information presented and in coordination with the City, it was determined that a groundwater elevation of 2.75 ft-NAVD88 should be implemented for the entire City for the 2050 planning horizon. This increase of 0.15 ft correlates with the lower end of the 2019 projections for the low range and groundwater increase projections summarized in the City of Doral Stormwater Vulnerability Assessment Study completed in October 2019.
- Design parameters for the exfiltration trenches were selected as follows:
    - The top of the exfiltration trench rock media should be located at least 1 foot below finish grade.
    - The top of the pipe should be located 1 foot below the top of the exfiltration trench rock media.

In most cases, infrastructure was proposed to provide additional connectivity within the systems, rehabilitate the systems by replacing old and potentially inferior/damaged drainage systems presently in place, and provide systems in areas with limited or no stormwater management systems. See **Appendix T** for the proposed stormwater management project schematics for the top 20 ranked City Sub-Basin.

Schematic Maps for each of the 20 City priority basins listed previously were provided, indicating the location of existing catch basins and storm pipes, proposed catch basins/inlets, 18-inch pipes, manholes, and 24-inch exfiltration trenches, as well as the locations of percolation tests, basin boundaries, and priority areas within the basins. Utility conflicts were not assessed, although this should be addressed in the design phase as with all subsurface work that is performed. **Appendix U** includes the flood maps of the top 20 high-priority City Sub-Basins with projects for the 5-year design storm events.

As previously discussed, a stormwater pump station was evaluated for the Vanderbilt Neighborhood. This neighborhood is fully developed, and exfiltration trenches are maximized in most of the neighborhood roads. The addition of the pump did not provide much benefit due to the existing exfiltration trenches and low elevations. Two option were evaluated and modeled:

- Option 1: 2 pumps of 20,000 GPM for a total of 90 CFS
- Option 2: 2 pump of 60,000 GPM for a total of 134 CFS

The pump provides a reduction in the duration of the flooding but not the flooding itself. Therefore the cost will not justify the benefit. Additionally, after meeting with the County on September 26, 2020 (See meeting minutes **Appendix S**), RER stated that it is presumed that the Nothline Canal is at the maximum capacity, and RER is in the process of evaluating if there is any excess capacity after the NW 25th Street project is designed.

Based on this information, the addition of the pump and discharge to the canal would be difficult to get permitted.

7.7.3 Analysis of the Proposed Stormwater Improvement Projects

The effectiveness of the proposed stormwater management system improvements described in this section were evaluated per sub-basin based on the rainfall extraction methodology provided by the proposed exfiltration system. The extraction methodology used for this SWMP assumed that exfiltration trenches in a given system have the ability to exfiltrate or extract up to 3.28 inches of the total rainfall depth produced by a design rainfall event over the area contributing to the exfiltration trench. This is an accepted practice by RER and the SFWMD.

For this methodology, rain areas were developed for the top 20 ranked City sub-basins, and 3.28 inches were extracted from the total rainfall depth for each rain area when there is sufficient room to include the required length of the exfiltration trench. If the required length of the exfiltration trench was not feasible, the actual rainfall extraction was computed based on the actual length of the exfiltration trench that could be constructed in the sub-basin. **Table 7-3** provides a summary of the top 20 City sub-basins and rainfall extraction for each.

Table 7-3 – Rainfall Extraction for the Top 20 City Sub-Basin

SUB-BASIN RANK	SUB-BASIN NAME	EXTRACTION RAINFALL DEPTH (INCHES)
1	H-8	3.28
2	F-1 with PS	0.51
2	F-1 No PS	0.51
3	H-7	3.28
4	H-8-1	3.28
5	D-3-1	3.28
6	D-4-2	3.28
7	NW 33 ST	3.28
8	D-1-1	3.28
9	NW 33 ST W	3.28
10	F-5	3.28
11	NW 52 ST W	3.28
12	NW 114 AVE	3.28
13	G-4	3.28
14	G-1	3.28
15	H-79AVE-N	3.28
16	H-79AVE-S	3.28
17	D-2-1	3.28
18	E-7	3.28
19	C-5	3.28
20	O-1	3.28

For this analysis, each sub-basin's proposed exfiltration trench systems were correlated with the nearest percolation test available from those available from the City. Exfiltration trench lengths were calculated for each sub-basin. **Table 7-4** provides a summary of exfiltration lengths per sub-basin. **Appendix V** includes the exfiltration trench lengths calculations.

Table 7-4 – Exfiltration Length Calculated and Provided

SUB-BASIN RANK	SUB-BASIN NAME	EXFILTRATION LENGTH CALCULATED (FEET)	EXFILTRATION LENGTH PROVIDED (FEET)
1	H-8	1,300	1,467
2	F-1 with PS	40,310	4,460
2	F-1 No PS	40,310	4,460
3	H-7	5,340	5,626
4	H-8-1	5,965	6,084
5	D-3-1	340	358
6	D-4-2	640	671
7	NW 33 ST	305	305
8	D-1-1	122	129
9	NW 33 ST W	140	145
10	F-5	1,755	1,917
11	NW 52 ST W	2,420	2,521
12	NW 114 AVE	1,450	1,499
13	G-4	3,460	3,545
14	G-1	4,450	4,832
15	H-79AVE-N	350	559
16	H-79AVE-S	32	55
17	D-2-1	165	167
18	E-7	670	719
19	C-5	3,185	3,333
20	O-1	24,274	24,389

These improvements are for the stormwater improvement projects being proposed within each sub-basin as a whole (without prioritization). **Appendix U** includes the floodmap for each top 20 City sub-basin with the proposed projects.

7.7.4 Opinion of Probable Construction Cost

As outlined in **Section 7.7**, the proposed projects consist of typically implemented stormwater infrastructure components. Each project was assessed to mitigate the projected flooding with a 30-year sea level and groundwater rise (Year 2050). The 5-year, 1-day design storm event was used to model flooding within the roadways to determine how much flooding is mitigated, based on the flooding in that given location with the proposed stormwater management systems. The 100-year, 3-day storm was modeled and utilized to remove homes and buildings from the 100-year flood plain to the maximum extent possible. **Appendix V** depicts the proposed conceptual designs for each of the problem areas.

Planning-level cost estimates were developed for each project based on the Florida Department of Transportation (FDOT) cost databases, costs from recent projects constructed within the City, and BCC's construction cost databases. These unit costs are included in **Table 7-5**. In addition to the average unit cost of the proposed improvements, the incidental expenditures, including maintenance of traffic, mobilization, permitting contingency, design, and construction administration were also calculated. These costs are included in **Table 7-6**.

Table 7-5 – Average Unit Cost for Proposed Capital Improvement Projects

DESCRIPTION	UNITS	AVERAGE UNIT COST
ROADWAY PAY ITEMS		
CLEARING AND GRUBBING	AC	$ 52,260.38
MILLING EXISTING ASPHALT (1" AVG. DEPTH)	SY	$ 5.00
TYPE S-I ASPHALTIC CONCRETE (1") (110 LBS/SY)	TN	$ 200.00
CONCRETE SIDEWALK / DRIVEWAY (6" THICK)	SY	$ 52.65
PERFORMANCE TURF (SOD)	SY	$ 3.67
DRAINAGE ITEMS		
INLETS, DT BOT TYPE D, <10'	EA	$ 10,000.00
MANHOLE <10'	EA	$ 6,000.00
BACKFLOW PREVENTOR	EA	$ 45,000.00
PIPE CULVERT, OPTIONAL MATERIAL, ROUND, 18" SD	LF	$ 101.25
PIPE CULVERT, OPTIONAL MATERIAL, ROUND, 24" SD	LF	$ 81.50
EXFILTRATION TRENCH, OPTIONAL MATERIAL, ROUND, 24" SD	LF	$ 143.50
DESILTING PIPE, 0-24"	LF	$ 8.08
2-20,000 gpm pump station/CDS/Panel	EA	$ 4,000,000.00
***AC=Acre, SY= Square Yards, TN=Tons , EA=Each, LF=Linear Feet**		

Table 7-6 – Capital Cost Factors

CAPITAL COST FACTORS AS A PERCENTAGE OF TOTAL MATERIAL COST			
Maintenance Of Traffic	Mobilization	Permitting	Contingency
10%	10%	2%	25%

It should be noted that the planning-level cost estimates developed for this stormwater master plan update are intended as an adaptive planning tool for sea-level rise and to help guide the City in prioritizing the location where stormwater improvement projects would immediately address current and observed areas of known flooding cost-effectively. Costs were identified for placing stormwater management systems within the City's right-of-way for the top 20 City ranked sub-basins. **Appendix W** includes a detailed planning-level cost estimate for each of the top 20 City ranked basins within the City. A summary of the planning-level cost estimates for each of the City's top 20 sub-basin is provided in **Table 7-7**. Please refer to **Figure 7-10** for the location of the top 20 City high-priority sub-basins.

Table 7-7 – Capital Improvement Project Planning-Level Cost Estimate

BASIN RANKING - CITY MODIFIED	RANKING	APPROX. TOTAL COST PROJECT
H-8	1	$ 645,402.70
F-1 with PS	2	$ 8,225,582.00
F-1 No PS	2	$ 2,345,582.00
H-7	3	$ 2,781,300.98
H-8-1	4	$ 2,347,477.31
D-3-1	5	$ 421,231.74
D-4-2	6	$ 937,994.33
NW 33 ST	7	$ 823,837.44
D-1-1	8	$ 165,360.97
NW 33 ST W	9	$ 301,645.14
F-5	10	$ 826,550.60
NW 52 ST W	11	$ 1,488,362.73
NW 114 AVE	12	$ 1,107,908.26
G-4	13	$ 2,095,009.55
G-1	14	$ 3,692,714.23
H-79AVE-N	15	$ 417,610.88
H-79AVE-S	16	$ 253,849.67
D-2-1	17	$ 204,138.38
E-7	18	$ 515,181.63
C-5	19	$ 1,570,433.93
O-1	20	$ 12,011,203.06
TOTAL no Pump Station (PS)		$ 34,952,795.52

These costs should be further refined during the final design and permitting phases of the capital improvement plan implementation process.

7.7.5 Capital Improvement Project Ranking and Prioritization

In both *Technical Memorandum No. 2 – Existing Conditions Level of Service* and *Technical Memorandum No. 3 – Projected Sea Leve Rise Impacts,* the Flood Protection Severity Score (FPSS) was computed as a basis for determining the level of service and ranking problem areas based on the severity of flooding. The FPSS was also computed with the proposed stormwater management systems for each problem area. **Table 7-8** depicts FPSS for current conditions, 30-year sea level and groundwater rise without stormwater management improvements, and the 30-year sea level groundwater rise FPSS with proposed stormwater improvement projects. This table also includes the reduction of FPSS with the proposed stormwater improvement projects. The reduction was then weighted based on the size of the sub-basin.

Table 7-8 – FPSS for Current and Future Conditions

SUB-BASIN	SLR BASIN RANK (CITY MODIFIED)	SLR WEIGHTED FPSS	NEW WEIGHTED FPSS WITH IMPROVEMENT PROJECTS	% CHANGE FROM SLR	APPROX. TOTAL COST PROJECT	COST PER % REDUCTION FPSS	COST RANKING*
H-8	1	25.17	25.12	0.21%	$ 645,403	$ 1,346	7
F-1 No PS	2	51.95	51.79	0.32%	$ 2,345,582	$ 7,451	11
H-7	3	194.96	161.11	17.37%	$ 2,781,301	$ 482,976	18
H-8-1	4	14.39	13.80	4.14%	$ 2,347,477	$ 97,117	16
D-3-1	5	21.97	21.96	0.09%	$ 421,232	$ 375	6
D-4-2	6	38.19	38.18	0.03%	$ 937,994	$ 248	5
NW 33 St	7	1.92	1.91	0.50%	$ 823,837	$ 4,093	9
D-1-1	8	29.84	29.83	0.03%	$ 165,361	$ 43	2
NW 33 ST W	9	20.50	20.50	0.01%	$ 301,645	$ 20	1
F-5	10	28.46	28.14	1.13%	$ 826,551	$ 9,316	12
NW 52 ST W	11	56.83	55.41	2.49%	$ 1,488,363	$ 37,115	13
NW 114 AVE	12	26.76	25.65	4.15%	$ 1,107,908	$ 46,015	14
G-4	13	10.56	10.20	3.49%	$ 2,095,010	$ 73,135	15
G-1	14	11.38	9.73	14.46%	$ 3,692,714	$ 533,885	19
H-79AVE-N	15	0.64	0.48	25.49%	$ 417,611	$ 106,432	17

SUB-BASIN	SLR BASIN RANK (CITY MODIFIED)	SLR WEIGHTED FPSS	NEW WEIGHTED FPSS WITH IMPROVEMENT PROJECTS	% CHANGE FROM SLR	APPROX. TOTAL COST PROJECT	COST PER % REDUCTION FPSS	COST RANKING*
H-79AVE-S	16	0.38	0.37	1.22%	$ 253,850	$ 3,099	8
D-2-1	17	6.61	6.61	0.04%	$ 204,138	$ 77	4
E-7	18	9.81	9.81	0.01%	$ 515,182	$ 56	3
C-5	19	9.08	9.04	0.47%	$ 1,570,434	$ 7,340	10
O-1	20	15.11	14.38	4.83%	$ 12,011,203	$ 580,612	20
TOTAL					**$ 34,952,796**		
F-1 with PS	2	51.95	51.71	0.46%	$ 8,225,582	$ 38,064	
*** Cost Ranking in Ascending order of the cost per % reduction of FPSS**							

To prioritize projects, the capital improvements for each area of concern were ranked based on the cost per FPSS area-weighted reduction, as depicted in **Table 7-8**. In other words, the Areas of concern are ranked in order from the least expensive to most expensive construction cost to improve FPSS by one point. The flood reduction benefits and FPSS for each Area of concern are described in **Section 7.7** of this report, and **Appendix X. Table 7-9** below contains the project ranking by Area of concern based on the cost to lower the FPSS by one point, normalized by the area of concern.

Table 7-9 – FPSS for Current and Future Conditions

RANK	PROBLEM AREA	BASIN NAME	COST PER % REDUCTION FPSS
1	9	NW 33 ST W	$ 20.28
2	8	D-1-1	$ 42.66
3	18	E-7	$ 55.90
4	17	D-2-1	$ 76.99
5	6	D-4-2	$ 248.40
6	5	D-3-1	$ 374.84
7	1	H-8	$ 1,346.06
8	16	H-79AVE-S	$ 3,098.85
9	7	NW 33 St	$ 4,092.63
10	19	C-5	$ 7,339.95
11	2	F-1 No PS	$ 7,450.86

RANK	PROBLEM AREA	BASIN NAME	COST PER % REDUCTION FPSS
13	10	F-5	$ 9,316.15
14	11	NW 52 ST W	$ 37,115.12
15	12	NW 114 AVE	$ 46,014.88
16	13	G-4	$ 73,135.50
17	4	H-8-1	$ 97,116.88
18	15	H-79AVE-N	$ 106,432.05
19	3	H-7	$ 482,976.03
20	14	G-1	$ 533,885.50

Figure 7-12 – City of Doral Sub-Basin Ranking by Cost-Effectiveness

The project ranking will allow the City to focus on funding for capital improvement projects in order of priority and cost-effectiveness. The entire stormwater management systems could be constructed over time in order of priority as funding becomes available.

7.8 Capital Improvement Plan

With the top 20 City sub-basins prioritized and ranked by cost-effectiveness as shown in **Table 7-9** with stormwater improvement projects proposed for each of the sub-basins identified, BCC and the City further refined the implementation plan for inclusion into the 5-year Capital Improvement Plan (CIP) that fell within the estimated yearly budgetary allocations for stormwater improvement projects for the City. The City's annual budget is approximately $2 Million for stormwater improvement projects, and to maximize available funds, the City has started implementing an alternating CIP that includes one-year designing and the following year constructing the projects. In order to have some options for the CIP implementation, BCC, in coordination with the City, identified three (3) alternatives for implementing stormwater improvement projects:

- Alternative 1: the proposed annual projects for the next 5 years will be implemented based on the Cost-Effectiveness and the Maximum Annual Benefit as shown in **Table 7-10**
- Alternative 2: the proposed annual projects for the next 5 years will be implemented based on the Basin Severity Score and the Maximum Annual Budget as shown in **Table 7-11**
- Alternative 3: this is a hybrid option where the proposed annual projects for the next 5 years will be implemented based on a combination of cost-effectiveness, basin severity score, available funding, and coordination with other CIP roadway and/or utility projects, as shown in **Table 7-12**

The City can decide which approach they will follow for a specific year and approved budget to ensure the maximum benefit per project.

Table 7-10 – Alternative 1 CIP Proposed Project Order (Cost-Effectiveness)

COST-EFFECTIVENESS	COST-EFFECTIVENESS RANK	SLR BASIN RANK	SUB-BASIN NAME	ESTIMATED PROJECT COST
Year 1	1	9	NW 33 ST W	$301,645.14
	2	8	D-1-1	$165,360.97
	3	18	E-7	$515,181.63
	4	17	D-2-1	$204,138.38
	5	6	D-4-2	$937,994.33
SUBTOTAL YEAR 1				***$2,124,320.45***
Year 2	6	5	D-3-1	$421,231.74
	7	1	H-8	$645,402.70

COST-EFFECTIVENESS	COST-EFFECTIVENESS RANK	SLR BASIN RANK	SUB-BASIN NAME	ESTIMATED PROJECT COST
	8	16	H-79AVE-S	$253,849.67
	9	7	NW 33 St	$823,837.44
SUBTOTAL YEAR 2				***$2,144,321.54***
Year 3	10	19	C-5	$1,570,433.93
	17	15	H-79AVE-N	$417,610.88
SUBTOTAL YEAR 3				***$1,988,044.81***
Year 4	11	2	F-1 No PS	$2,345,582.00
SUBTOTAL YEAR 4				***$2,345,582.00***
Year 5	12	10	F-5	$826,550.60
	14	12	NW 114 AVE	$1,107,908.26
SUBTOTAL YEAR 5				***$1,934,458.86***
TOTAL				**$10,536,727.66**
Year 6 to 17				
Fiscal Year	**COST-EFFECTIVENESS RANK**	**SLR Basin Rank**	**Sub-Basin Name**	**Estimated Project Cost**
Year 6	13	11	NW 52 ST W	$1,488,362.73
	18	3	H-7, Phase II	$681,300.98
SUBTOTAL YEAR 6				***$2,169,663.71***
Year 7	15	13	G-4	$2,095,009.55
SUBTOTAL YEAR 7				***$2,095,009.55***
Year 8	16	4	H-8-1	$2,347,477.31
SUBTOTAL YEAR 8				***$2,347,477.31***
Year 9	18	3	H-7, Phase I	$2,100,000.00
SUBTOTAL YEAR 9				***$2,100,000.00***
Year 10	19	14	G-1, Phase I	$2,000,000.00
SUBTOTAL YEAR 10				***$2,000,000.00***
Year 11	19	14	G-1, Phase II	$1,692,714.23
SUBTOTAL YEAR 11				***$1,692,714.23***
Year 12 to Year 16	20	20	O-1, Phase I - to Phase V	$2,000,000.00
SUBTOTAL YEAR 12 to Year 16				***$10,000,000.00***
Year 17	20	20	O-1, Phase VI	$ 2,011,203.06
SUBTOTAL YEAR 17				***$2,011,203.06***

COST-EFFECTIVENESS	COST-EFFECTIVENESS RANK	SLR BASIN RANK	SUB-BASIN NAME	ESTIMATED PROJECT COST
TOTAL				**$24,416,067.86**

Table 7-11 – Alternative 2 CIP Proposed Project Order (Basin Ranking)

FISCAL YEAR	SLR BASIN RANK	COST RANK	SUB-BASIN NAME	ESTIMATED PROJECT COST
Year 1	1	7	H-8	$645,402.70
	5	6	D-3-1	$421,231.74
	6	5	D-4-2	$937,994.33
SUBTOTAL YEAR 1				***$2,004,628.76***
Year 2	2	11	F-1 No PS	$2,345,582.00
SUBTOTAL YEAR 2				***$2,345,582.00***
Year 3	4	16	H-8-1	$2,347,477.31
SUBTOTAL YEAR 3				***$2,347,477.31***
Year 4	7	9	NW 33 St	$823,837.44
	8	2	D-1-1	$165,360.97
	9	1	NW 33 ST W	$301,645.14
	10	12	F-5	$826,550.60
SUBTOTAL YEAR 4				***$2,117,394.15***
Year 5	12	14	NW 114 AVE	$1,107,908.26
	15	17	H-79AVE-N	$417,610.88
	16	8	H-79AVE-S	$253,849.67
	17	4	D-2-1	$204,138.38
SUBTOTAL YEAR 5				***$1,983,507.19***
TOTAL				**$10,798,589.42**
Year 6 to 17				
Fiscal Year	**SLR Basin Rank**	**Cost Rank**	**Sub-Basin Name**	**Estimated Project Cost**
Year 6	3	18	H-7, Phase I	$2,100,000.00
SUBTOTAL YEAR 6				***$2,100,000.00***
Year 7	11	13	NW 52 ST W	$1,488,362.73
	18	3	E-7	$515,181.63

FISCAL YEAR	SLR BASIN RANK	COST RANK	SUB-BASIN NAME	ESTIMATED PROJECT COST
SUBTOTAL YEAR 7				***$2,003,544.36***
Year 8	13	15	G-4	$2,095,009.55
SUBTOTAL YEAR 8				***$2,095,009.55***
Year 9	14	19	G-1, Phase I	$2,000,000.00
SUBTOTAL YEAR 9				***$2,000,000.00***
Year 10	14	19	G-1, Phase II	$1,692,714.23
SUBTOTAL YEAR 10				***$1,692,714.23***
Year 11	19	10	C-5	$1,570,433.93
	3	18	H-7, Phase II	$681,300.98
SUBTOTAL YEAR 11				***$2,251,734.91***
Year 12 to Year 16	20	20	O-1, Phase I - to Phase V	$2,000,000.00
SUBTOTAL YEAR 12 to Year 16				***$10,000,000.00***
Year 17	20	20	O-1, Phase VI	$ 2,011,203.06
SUBTOTAL YEAR 17				***$2,011,203.06***
TOTAL				**$24,154,206.11**

Table 7-12 – Alternative 3 CIP Proposed Project Order (Hybrid)

FISCAL YEAR	HYBRID RANK	COST RANK	SUB-BASIN NAME	ESTIMATED PROJECT COST
Year 1	1	7	H-8	$645,402.70
	5	6	D-3-1	$421,231.74
	9	1	NW 33 ST W	$301,645.14
	8	2	D-1-1	$165,360.97
	15	17	H-79AVE-N	$417,610.88
SUBTOTAL YEAR 1				***$1,951,251.42***
Year 2	6	5	D-4-2	$937,994.33
	7	9	NW 33 St	$823,837.44
	16	8	H-79AVE-S	$253,849.67
SUBTOTAL YEAR 2				***$2,015,681.44***
Year 3	2	11	F-1 No PS	$2,345,582.00
SUBTOTAL YEAR 3				***$2,345,582.00***
Year 4	10	12	F-5	$826,550.60
	12	14	NW 114 AVE	$1,107,908.26
	17	4	D-2-1	$204,138.38

FISCAL YEAR	HYBRID RANK	COST RANK	SUB-BASIN NAME	ESTIMATED PROJECT COST
SUBTOTAL YEAR 4				***$2,138,597.24***
Year 5	4	16	H-8-1	$2,347,477.31
SUBTOTAL YEAR 5				***$2,347,477.31***
TOTAL				**$10,798,589.42**
Year 6 to 17				
Fiscal Year	**HYBRID RANK**	**Cost Rank**	**Sub-Basin Name**	**Estimated Project Cost**
Year 6	3	18	H-7, Phase I	$2,100,000.00
SUBTOTAL YEAR 6				***$2,100,000.00***
Year 7	11	13	NW 52 ST W	$1,488,362.73
	3	18	H-7, Phase II	$681,300.98
SUBTOTAL YEAR 7				***$2,169,663.71***
Year 8	13	15	G-4	$2,095,009.55
SUBTOTAL YEAR 8				***$2,095,009.55***
Year 9	14	19	G-1, Phase I	$2,000,000.00
SUBTOTAL YEAR 9				***$2,000,000.00***
Year 10	14	19	G-1, Phase II	$1,692,714.23
SUBTOTAL YEAR 10				***$1,692,714.23***
Year 11	19	10	C-5	$1,570,433.93
	18	3	E-7	$515,181.63
SUBTOTAL YEAR 11				***$2,085,615.56***
Year 12 to Year 16	20	20	O-1, Phase I - to Phase V	$2,000,000.00
SUBTOTAL YEAR 12 to Year 16				***$10,000,000.00***
Year 17	20	20	O-1, Phase VI	$ 2,011,203.06
SUBTOTAL YEAR 17				***$2,011,203.06***
TOTAL				**$24,154,206.11**

See **Appendix Y** for a summary of each Alternative for the Capital Improvement Plan proposed project order implementation.

The rankings shown in **Table 7-10**, **Table 7-11**, and **Table 7-12** are intended to help guide the City in prioritizing the location where stormwater improvement projects would immediately address current and observed areas of known flooding. It should be noted that this ranking does not require the City to design and construct projects in this order.

This list is also not a commitment by the City to allocate or expend the estimated amounts within the 5-year period. This list and SWMP serve to guide the City in locating potential projects and correlating potential projects with simulated real-world events.

A further detailed analysis will be required to refine the information presented in this SWMP. Additionally, more projects may be added to the 5-year CIP plan if more funding is allocated to these types of projects or if these projects can be combined with other types of Capital Improvement projects.

APPENDIX A. DATA COLLECTED FROM CITY OF DORAL

City of Doral Project Data Catalog

Project Location	Project Year	File Type	Description
NW 52ND, 53RD, 54TH, & 55TH b/w NW 79TH Aver	2016	PDF	As-built Drainage Plans
NW 97TH Avenue b/w 70TH Street & 74TH Street	2016	PDF	As-built Drainage Plans
NW 82ND Avenue & NW 12TH Street	2016	PDF	As-built Drainage Plans
NW 28TH Terrace b/w 99TH Avenue & 102ND Aven	2017	PDF	As-built Drainage Plans
NW 31ST Street & NW 82ND Avenue	2017	PDF / CAD	As-built Drainage Plans
27TH Terrace & 98TH Avenue	2017	PDF / CAD	As-built Drainage Plans
27TH Street b/w 98TH Avenue & 99TH Avenue	2017	PDF / CAD	As-built Drainage Plans
26TH Street & 102ND Avenue	2017	PDF / CAD	As-built Drainage Plans
NW 102ND Avenue b/w NW 27TH Terrace & NW 28	2017	PDF	As-built Drainage Plans
NW 27TH Terrace b/w NW 100TH Avenue & NW 10	2017	PDF	As-built Drainage Plans
NW 114TH Avenue b/w NW 72ND Street & NW 74T	2017	PDF	As-built Drainage Plans
NW 77TH Terrace & NW 113TH Avenue	2017	PDF	As-built Drainage Plans
NW 82ND Terrace & NW 113TH Court	2017	PDF	As-built Drainage Plans
NW 102ND Place b/w NW 21ST Street & NW 25TH Street	2017	PDF	As-built Drainage Plans
NW 21ST Street b/w NW 102ND Place & NW 102ND Avenue	2017	PDF	As-built Drainage Plans
NW 108TH Avenue & NW 29TH Street	2017	PDF	As-built Drainage Plans
NW 21ST Street & NW 99TH Avenue	2017	PDF	As-built Drainage Plans

City of Doral Data Catalog

Title of Document or File	File Type	Description
Canal Bank Stabilization Year 1-7	PDF / CAD	Canal Cross Sections
Inlets	SHP	Catch Basin Points
Exfiltration_Trench	SHP	Exfiltration Lengths and Pipe Diameters
Slab_Trench	SHP	Slab Trench Lengths and Depths
Slab_Covered_Trench	SHP	Slab Covered Trench Points
High Resolution Aerials	TIF	Aerial of City of Doral
PD Reported Flooding	KMZ	Citizen Complaints
Percolation Test Data	PDF	Years 1-5 Capital Improvement Program
SW Cost	XLSX	Sub Basins A-4, D-3, F-1, F-5, C-6, C-7, G-1, H-5, H-8
SW Vulnerability Study	PDF	Vulnerability analyses of City's drainage system
Outfalls	PDF	Fesibility study of an outfall in Sub Basin H-5
Canal Culverts	SHP	Culvert Diameters
City Outfalls	LYR	City Outfall Points
2014 Stormwater Masterplan	PDF /SHP / XPSWMM	Previous SWMP and all related files

APPENDIX B. DATA COLLECTED FROM MIAMI-DADE COUNTY

Miami Dade County Data Catalog

Title of Document or File	Author	File Type
building_2018	Miami Dade County	ArcGIS
canals	Miami Dade County	ArcGIS
LiDAR2018	Miami Dade County	DEM
Canal Maximum Stage / Boundary Conditions	Miami Dade County	Excel
lakes	Miami Dade County	ArcGIS
landuse_2020	Miami Dade County	ArcGIS
Parcel2020	Miami Dade County	ArcGIS
majorroads	Miami Dade County	ArcGIS
soils	Miami Dade County	README
soils_sfwmd	Miami Dade County	ArcGIS
streets	Miami Dade County	ArcGIS
Stormwater Lines/Points 2015	Miami Dade County	ACAD / GIS

APPENDIX C. DATA COLLECTED FROM OTHER SOURCES

Other Sources Data Catalog

Title of Document or File	Author	File Type
251185-1-52-01_CSI_Culvert	A&P Consulting Engineers	PDF
Permit Modification Drainage Report	A&P Consulting Engineers	PDF
Permit Plans	A&P Consulting Engineers	TIFF
Proposed Engineering Report	A&P Consulting Engineers	PDF
Revised Drainage Plans	A&P Consulting Engineers	PDF
WESTproject	A&P Consulting Engineers	PDF
Urban Hydrology for Small Watersheds TR-55	NRCS	PDF
Unified Sea Level Rise Projections	Southeast Florida Regional Climate Change Contact	PDF
Hydrologic Conditions in Urban Miami-Dade County, Florida, and the Effect of Groundwater Flow, Version 1.2 July 2016	USGS	PDF
011219-15	SFWMD	PDF
100209-8	SFWMD	PDF
010103-5	SFWMD	PDF
020219-1	SFWMD	PDF
980422-13	SFWMD	PDF
00322-10	SFWMD	PDF
020513-4	SFWMD	PDF
050531-7	SFWMD	PDF
060315-25	SFWMD	PDF
070515-9	SFWMD	PDF
970220-5	SFWMD	PDF
980410-3	SFWMD	PDF
980820-5	SFWMD	PDF
010625-12	SFWMD	PDF
151020-11	SFWMD	PDF
161018-1	SFWMD	PDF
010625-12	SFWMD	PDF
151020-11	SFWMD	PDF
161018-1	SFWMD	PDF
041012-4	SFWMD	PDF
170504-18	SFWMD	PDF
130813-3	SFWMD	PDF
001023-11	SFWMD	PDF
991022-2	SFWMD	PDF
080516-12	SFWMD	PDF
100618-1	SFWMD	PDF
080514-10	SFWMD	PDF
110316-15	SFWMD	PDF
971107-7	SFWMD	PDF

Other Sources Data Catalog

Title of Document or File	Author	File Type
971219-14	SFWMD	PDF
160916-15	SFWMD	PDF
190403-10	SFWMD	PDF
171121-208	SFWMD	PDF
050207-3	SFWMD	PDF
970811-13	SFWMD	PDF
000505-4	SFWMD	PDF
120105-7	SFWMD	PDF
970625-2	SFWMD	PDF
970804-9	SFWMD	PDF
971219-15	SFWMD	PDF
9807117-6	SFWMD	PDF
030728-4	SFWMD	PDF
171207-8	SFWMD	PDF
980331-3	SFWMD	PDF
000517-4	SFWMD	PDF
001018-1	SFWMD	PDF
070409-11	SFWMD	PDF
070705-9	SFWMD	PDF
080312-4	SFWMD	PDF
120816-9	SFWMD	PDF
170526-27	SFWMD	PDF
970924-3	SFWMD	PDF
990416-9	SFWMD	PDF
000112-7	SFWMD	PDF
000216-5	SFWMD	PDF
000519-2	SFWMD	PDF
000718-11	SFWMD	PDF
000828-14	SFWMD	PDF
000828-15	SFWMD	PDF
000928-21	SFWMD	PDF
001020-3	SFWMD	PDF
001205-2	SFWMD	PDF
010205-1	SFWMD	PDF
010223-1	SFWMD	PDF
010302-1	SFWMD	PDF
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010604-19	SFWMD	PDF
010814-6	SFWMD	PDF
061120-3	SFWMD	PDF
10224-13	SFWMD	PDF
150825-4	SFWMD	PDF
960805-12	SFWMD	PDF
960903-12	SFWMD	PDF

Other Sources Data Catalog

Title of Document or File	Author	File Type
971203-3	SFWMD	PDF
971203-3	SFWMD	PDF
980807-12	SFWMD	PDF
980917-12	SFWMD	PDF
981012-2	SFWMD	PDF
981014-13	SFWMD	PDF
981022-3	SFWMD	PDF
990618-11	SFWMD	PDF
990903-16	SFWMD	PDF
991005-19	SFWMD	PDF
991011-8	SFWMD	PDF
991122-8	SFWMD	PDF
051216-5	SFWMD	PDF
021016-18	SFWMD	PDF
051021-8	SFWMD	PDF
021016-18	SFWMD	PDF
030128-17	SFWMD	PDF
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140115-9	SFWMD	PDF
140731-4	SFWMD	PDF
070329-9	SFWMD	PDF
071116-4	SFWMD	PDF
150608-8	SFWMD	PDF
171113-11	SFWMD	PDF
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140912-2	SFWMD	PDF
141027-2	SFWMD	PDF
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960815-13	SFWMD	PDF
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970731-3	SFWMD	PDF
970121-7	SFWMD	PDF
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980618-12	SFWMD	PDF
000222-10	SFWMD	PDF
100624-3	SFWMD	PDF
961122-16	SFWMD	PDF
980316-12	SFWMD	PDF
980622-8	SFWMD	PDF
981102-17	SFWMD	PDF
990601-7	SFWMD	PDF
150720-13	SFWMD	PDF
951120-7	SFWMD	PDF

Other Sources Data Catalog

Title of Document or File	Author	File Type
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980528-6	SFWMD	PDF
020403-4	SFWMD	PDF
030925-3	SFWMD	PDF
961112-6	SFWMD	PDF
961122-16	SFWMD	PDF
971104-9	SFWMD	PDF
971208-10	SFWMD	PDF
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951116-9	SFWMD	PDF
970812-1	SFWMD	PDF
971120-8	SFWMD	PDF
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970505-13	SFWMD	PDF
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000613-6	SFWMD	PDF
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040713-9	SFWMD	PDF
050629-13	SFWMD	PDF
070227-8	SFWMD	PDF
111207-7	SFWMD	PDF
130618-5	SFWMD	PDF
140509-4	SFWMD	PDF
161220-1	SFWMD	PDF

Other Sources Data Catalog

Title of Document or File	Author	File Type
181228-1081	SFWMD	PDF
950816-7	SFWMD	PDF
990507-8	SFWMD	PDF
040825-4	SFWMD	PDF
091221-5	SFWMD	PDF
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061120-19	SFWMD	PDF
090127-12	SFWMD	PDF
090511-11	SFWMD	PDF
110801-8	SFWMD	PDF
130320-10	SFWMD	PDF
140627-14	SFWMD	PDF
141107-19	SFWMD	PDF
000118-9	SFWMD	PDF
190516-5	SFWMD	PDF
051101-13	SFWMD	PDF
070530-5	SFWMD	PDF
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070816-13	SFWMD	PDF
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151223-9	SFWMD	PDF
161118-4	SFWMD	PDF
180328-7	SFWMD	PDF
051116-1	SFWMD	PDF
030808-15	SFWMD	PDF
010925-8	SFWMD	PDF
031126-10	SFWMD	PDF
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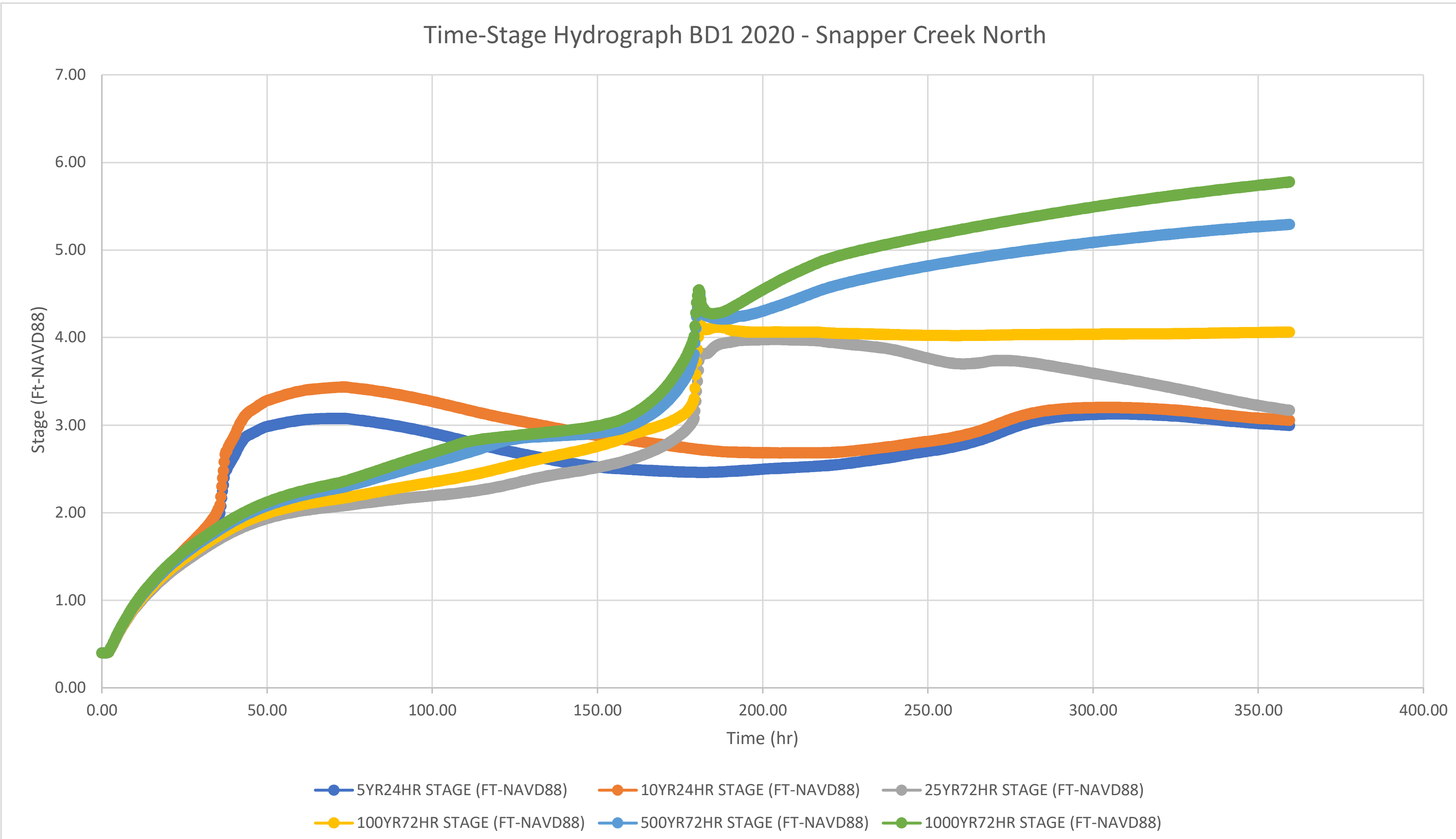
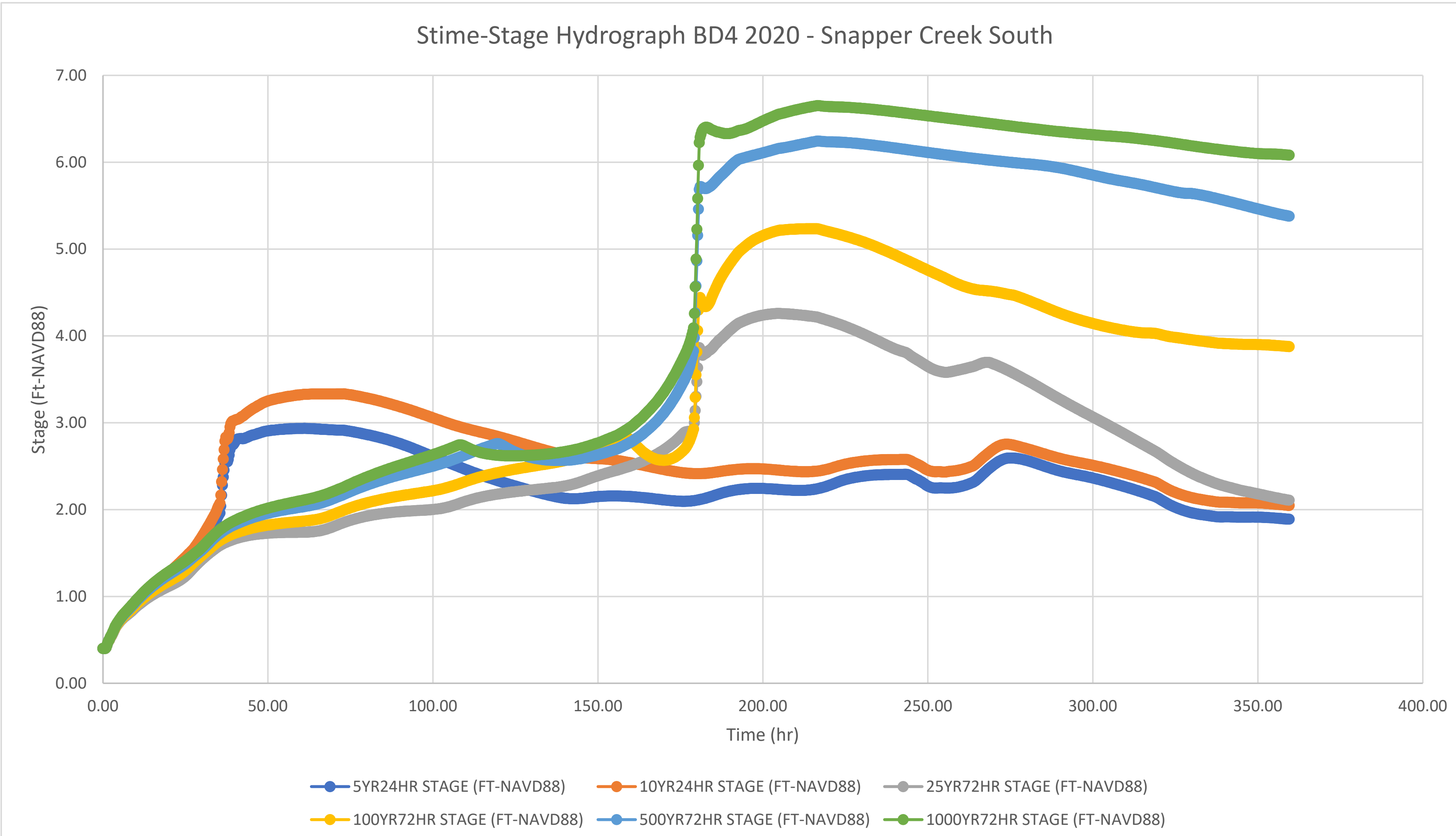
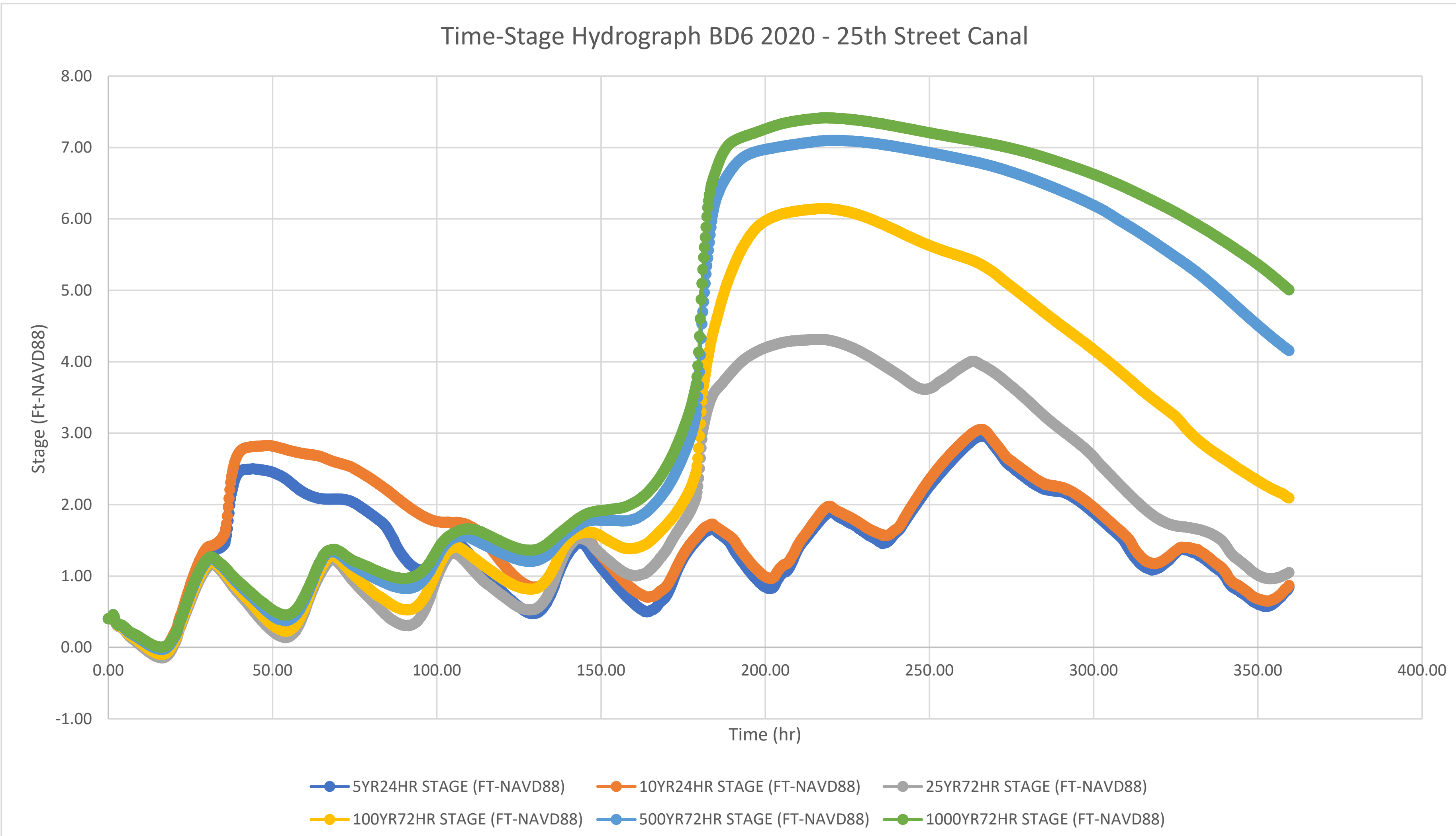
140822-12	SFWMD	PDF
160223-5	SFWMD	PDF
050919-20	SFWMD	PDF
071210-10	SFWMD	PDF
080207-18	SFWMD	PDF
050930-12	SFWMD	PDF
080331-8	SFWMD	PDF
100726-17	SFWMD	PDF

APPENDIX D. TIME-STAGE HYDROGRAPHS FOR BOUNDARY CONDITIONS BD1, BD4, BD6


Time-Stage Hydrograph BD1 2020 - Snapper Creek North
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Stage (Ft-NAVD88)
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
400.00
Time (hr)
5YR24HR STAGE (FT-NAVD88)
10YR24HR STAGE (FT-NAVD88)
25YR72HR STAGE (FT-NAVD88)
100YR72HR STAGE (FT-NAVD88)
500YR72HR STAGE (FT-NAVD88)
1000YR72HR STAGE (FT-NAVD88)

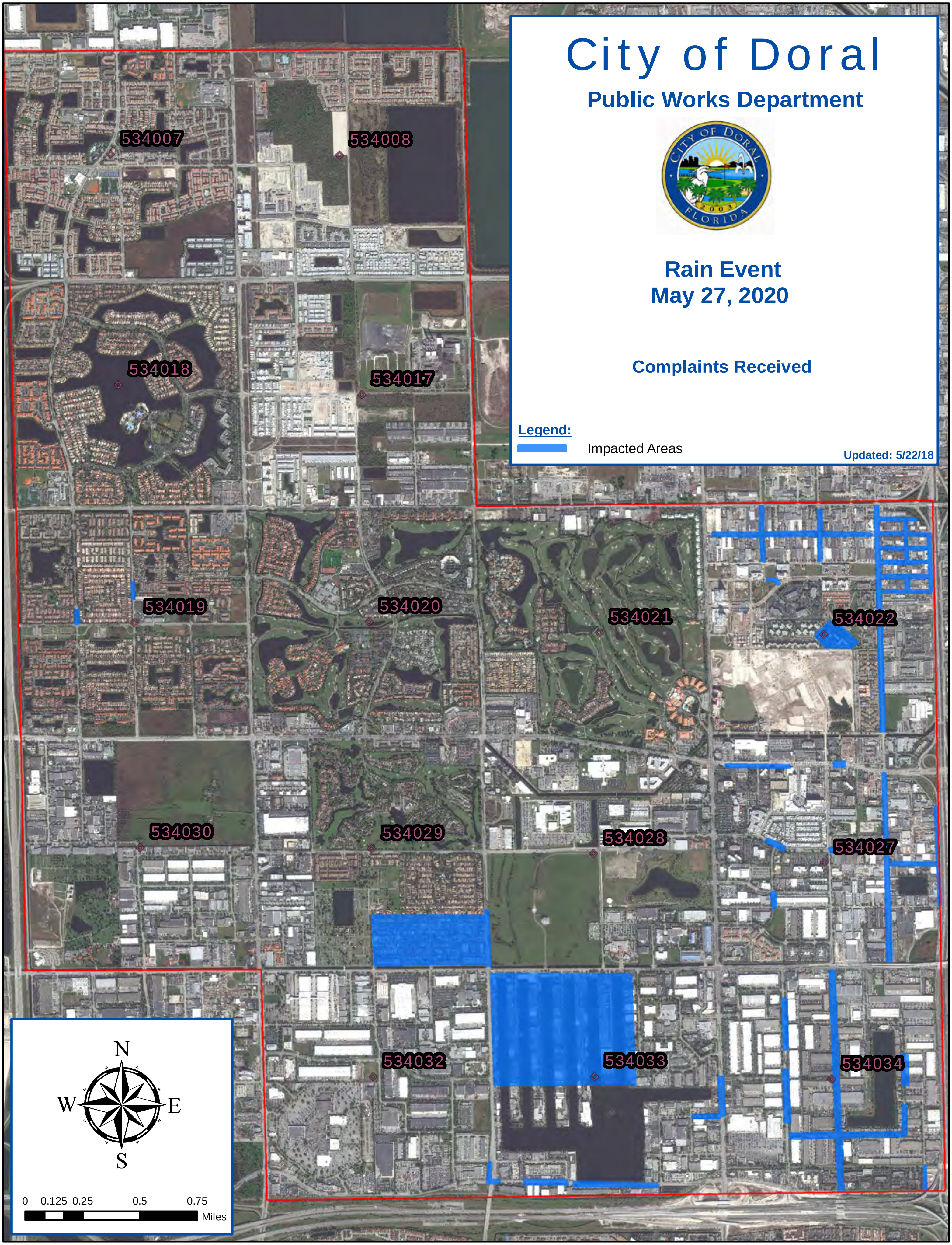


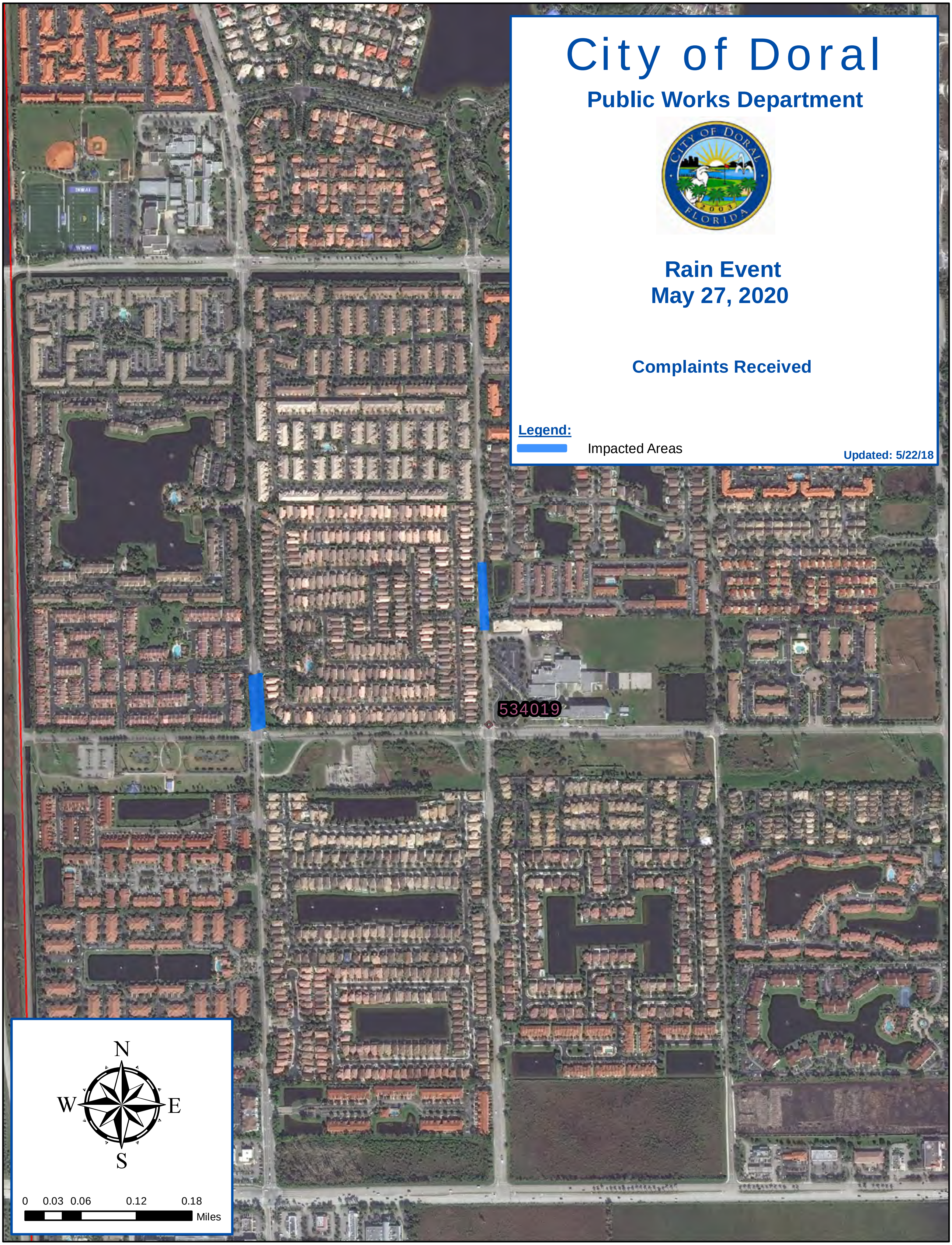
Stime-Stage Hydrograph BD4 2020 - Snapper Creek South
Stage (Ft-NAVD88)
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
400.00
Time (hr)
5YR24HR STAGE (FT-NAVD88)
10YR24HR STAGE (FT-NAVD88)
25YR72HR STAGE (FT-NAVD88)
100YR72HR STAGE (FT-NAVD88)
500YR72HR STAGE (FT-NAVD88)
1000YR72HR STAGE (FT-NAVD88)



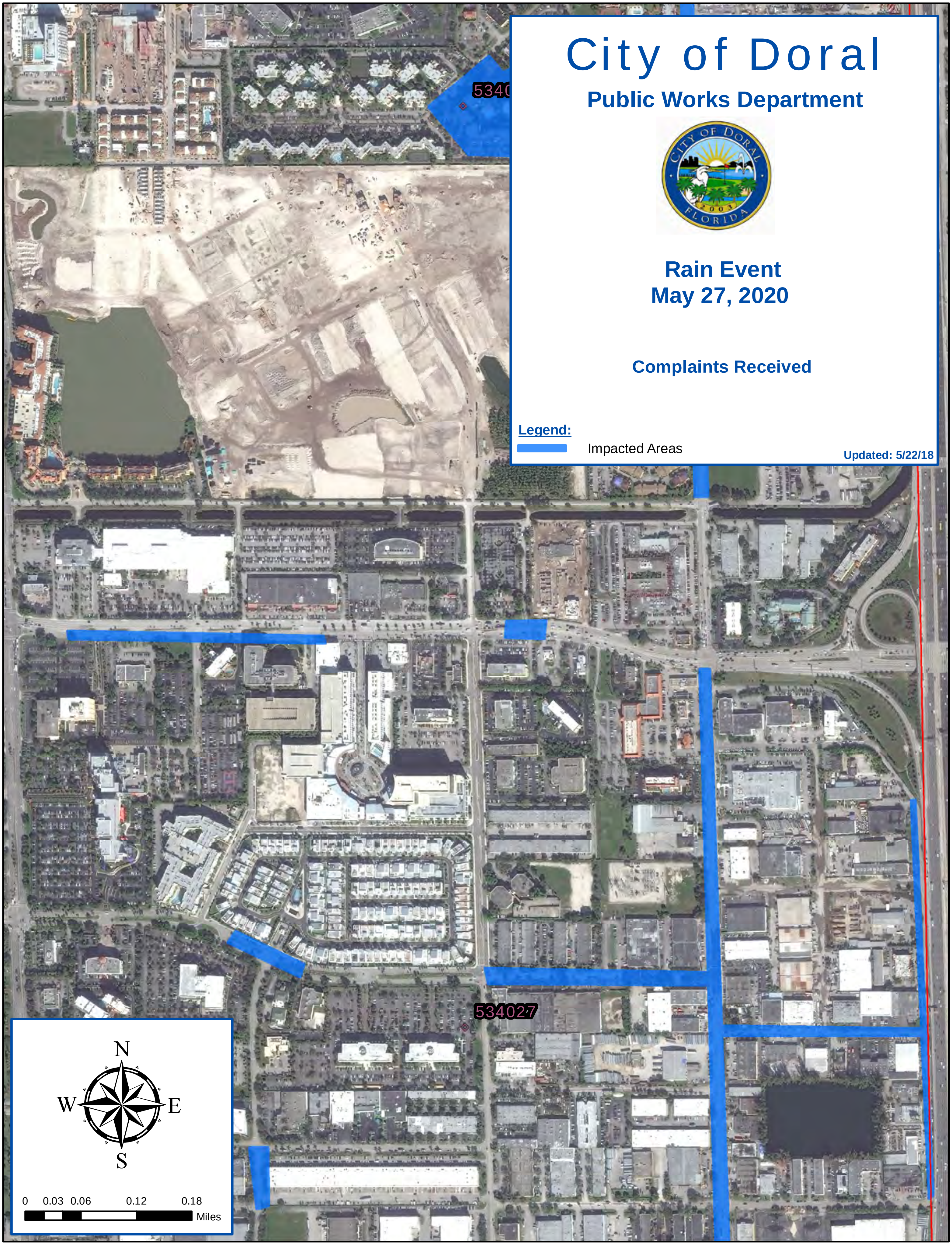
Time-Stage Hydrograph BD6 2020 - 25th Street Canal
Stage (Ft-NAVD88)
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
400.00
Time (hr)
5YR24HR STAGE (FT-NAVD88)
10YR24HR STAGE (FT-NAVD88)
25YR72HR STAGE (FT-NAVD88)
100YR72HR STAGE (FT-NAVD88)
500YR72HR STAGE (FT-NAVD88)
1000YR72HR STAGE (FT-NAVD88)

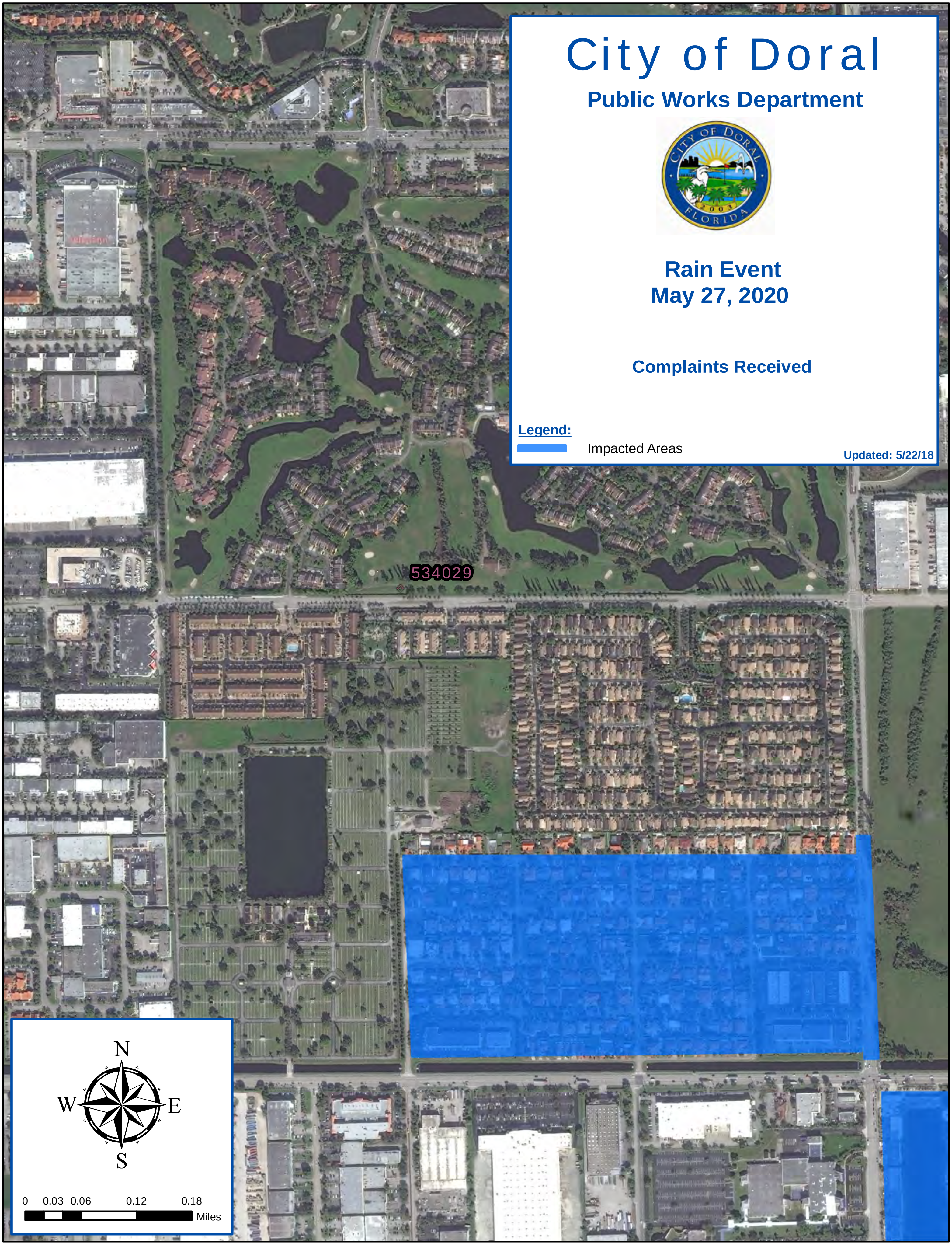
APPENDIX E. FLOODING COMPLAINTS AND FIELD OBSERVATIONS MAPS WITH PICTURES


City of Doral
Public Works Department
Rain Event
May 27, 2020
Complaints Received
Legend:
Impacted Areas
Updated: 5/22/18
534007
534008
534018
534017
534019
534020
534021
534022
534030
534029
534028
534027
534032
534033
534034
N
W
E
S
0 0.125 0.25 0.5 0.75
Miles


City of Doral
Public Works Department
CITY OF DORAL
2003
FLORIDA
Rain Event
May 27, 2020
Complaints Received
Legend:
Impacted Areas
Updated: 5/22/18
534019
N
W
E
S
0 0.03 0.06 0.12 0.18
Miles

City of Doral
Public Works Department
Rain Event
May 27, 2020
Complaints Received
Legend:
Impacted Areas
Updated: 5/22/18
534022
N
W
E
S
0 0.03 0.06 0.12 0.18
Miles


City of Doral
Public Works Department
CITY OF DORAL
2003
FLORIDA
Rain Event
May 27, 2020
Complaints Received
Legend:
Impacted Areas
Updated: 5/22/18
534027
N
W
E
S
0 0.03 0.06 0.12 0.18
Miles



City of Doral
Public Works Department
CITY OF DORAL
2003
FLORIDA
Rain Event
May 27, 2020
Complaints Received
Legend:
Impacted Areas
Updated: 5/22/18
534029
N
W
E
S
0 0.03 0.06 0.12 0.18
Miles


City of Doral
Public Works Department
Rain Event
May 27, 2020
Complaints Received
Legend:
Impacted Areas
Updated: 5/22/18
534033
N
W
E
S
0 0.03 0.06 0.12 0.18
Miles


City of Doral
Public Works Department
Rain Event
May 27, 2020
Complaints Received
Legend:
Impacted Areas
Updated: 5/22/18
534034
N
W
E
S
0
0.03
0.06
0.12
0.18
Miles

Rain Event
Images
May 2020 Event


STOP


NW 79 AV


May 26, 2020 8:19:34 PM


May 26, 2020 8:19:40 PM


May 26, 2020 8:33:41 PM


MIAMI-DADE COUNTY
STAFF GAUGE
NAVD 1988
DATUM PLANE
05/27/2020 08:24:15


MIAMI-DADE COUNTY
5281A
STOP
05/27/2020 08:23:13


MIAMI-DADE
COUNTY
STAFF GAUGE
NAVD 1988
DATUM PLANE
05/27/2020 08:23:32


TRAIL
X-ING
05/27/2020 08:44:28


MIAMI-DADE COUNTY
STAFF GAUGE
NAVD 1988
DATUM PLANE
05/27/2020 08:44:09

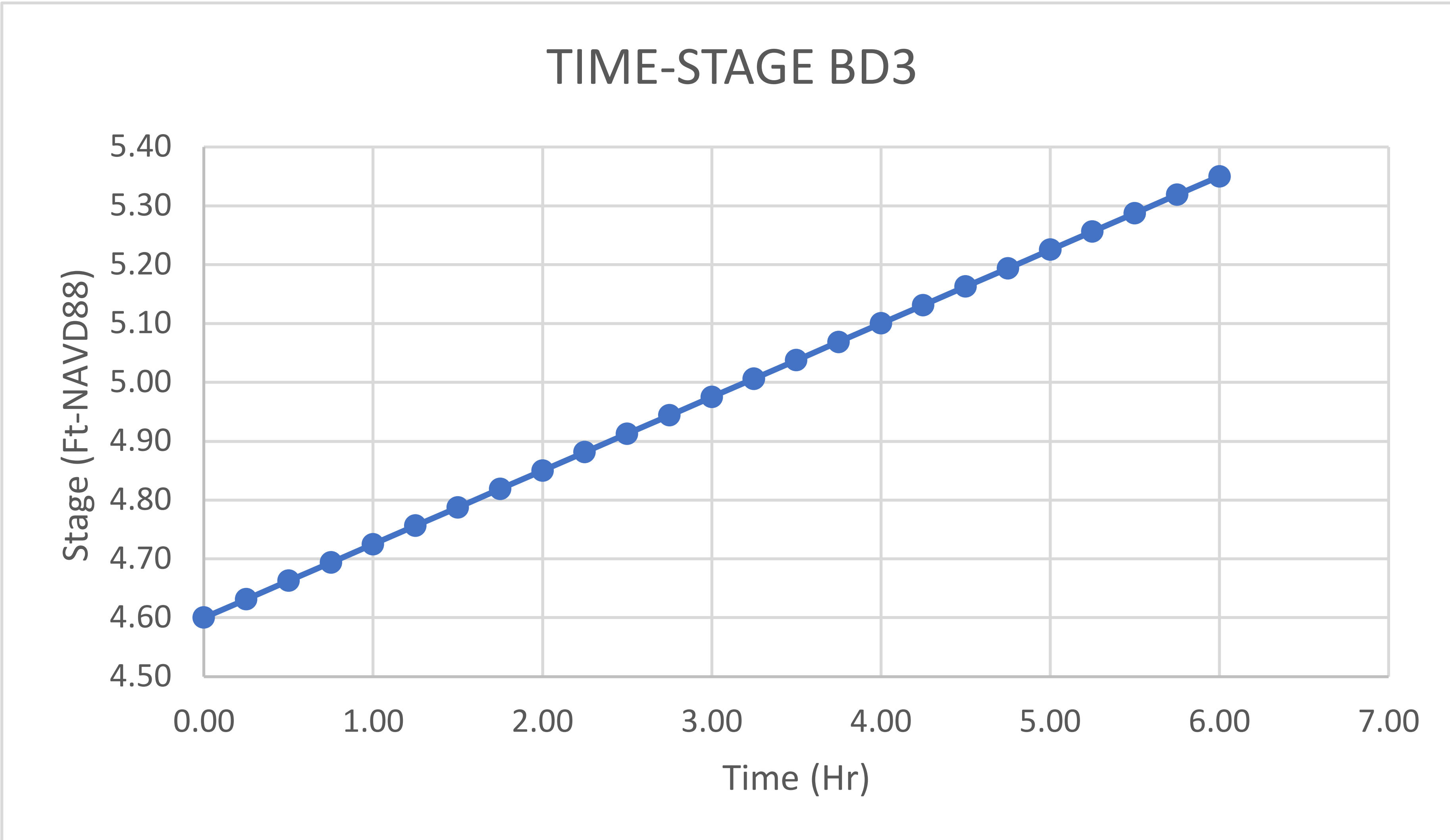

8.90
8.80
8.70
8.60
8.50
8.40
8.30
8.20
8.10
8.00
7.90
7.80
7.70
7.60
7.50
7.40
7.30
7.20
7.10
7.00
6.90
6.80
6.70
6.60
6.50
6.40
6.30
6.20
6.10
6.00
5.90
5.80
5.70
5.60
5.50
5.40
05/27/2020 08:56:34


05/27/2020 07:57:47

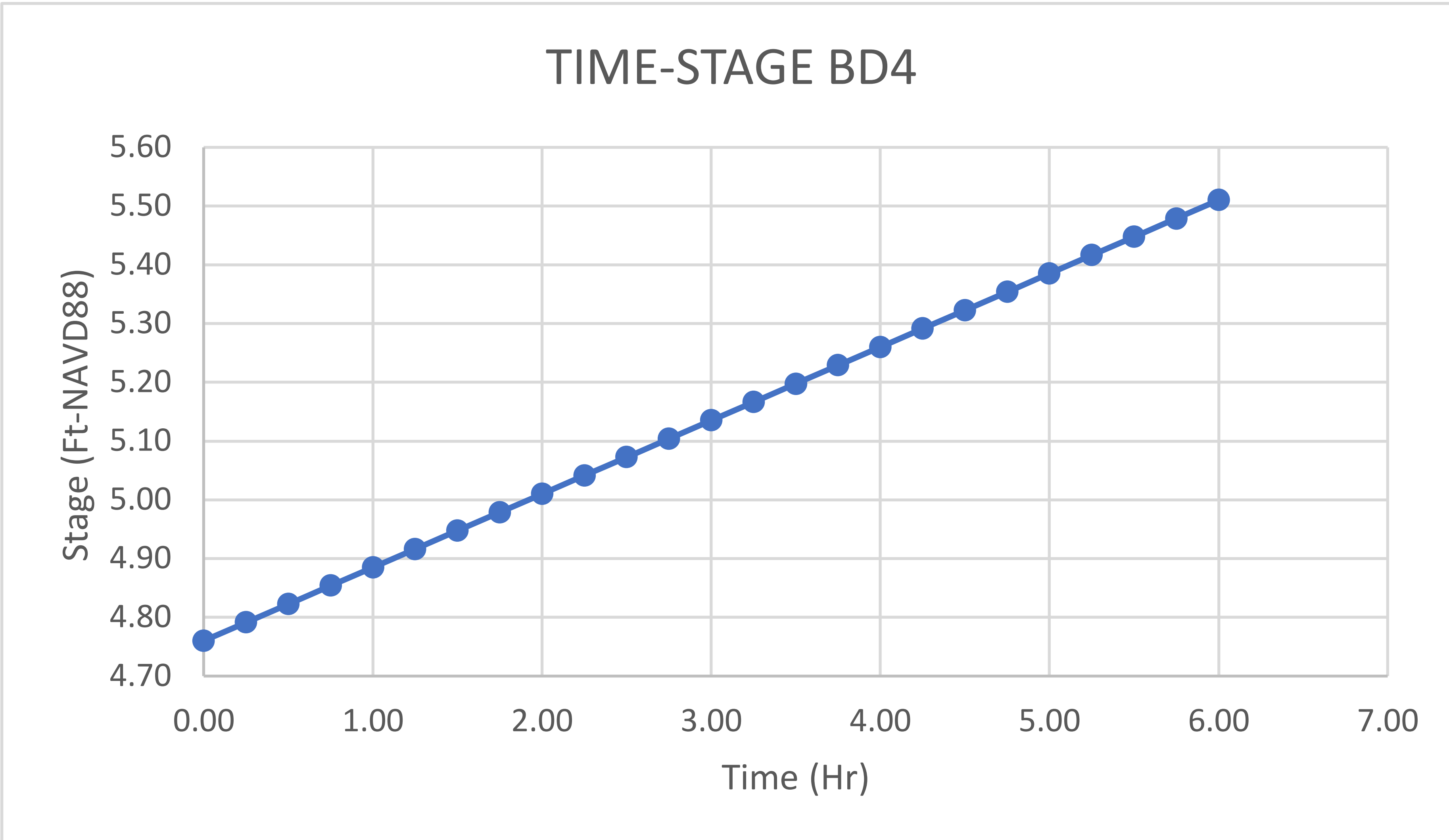

MIAMI-DADE COUNTY
STAFF GAUGE
NAVD 1988
DATUM PLANE
05/27/2020 07:58:30

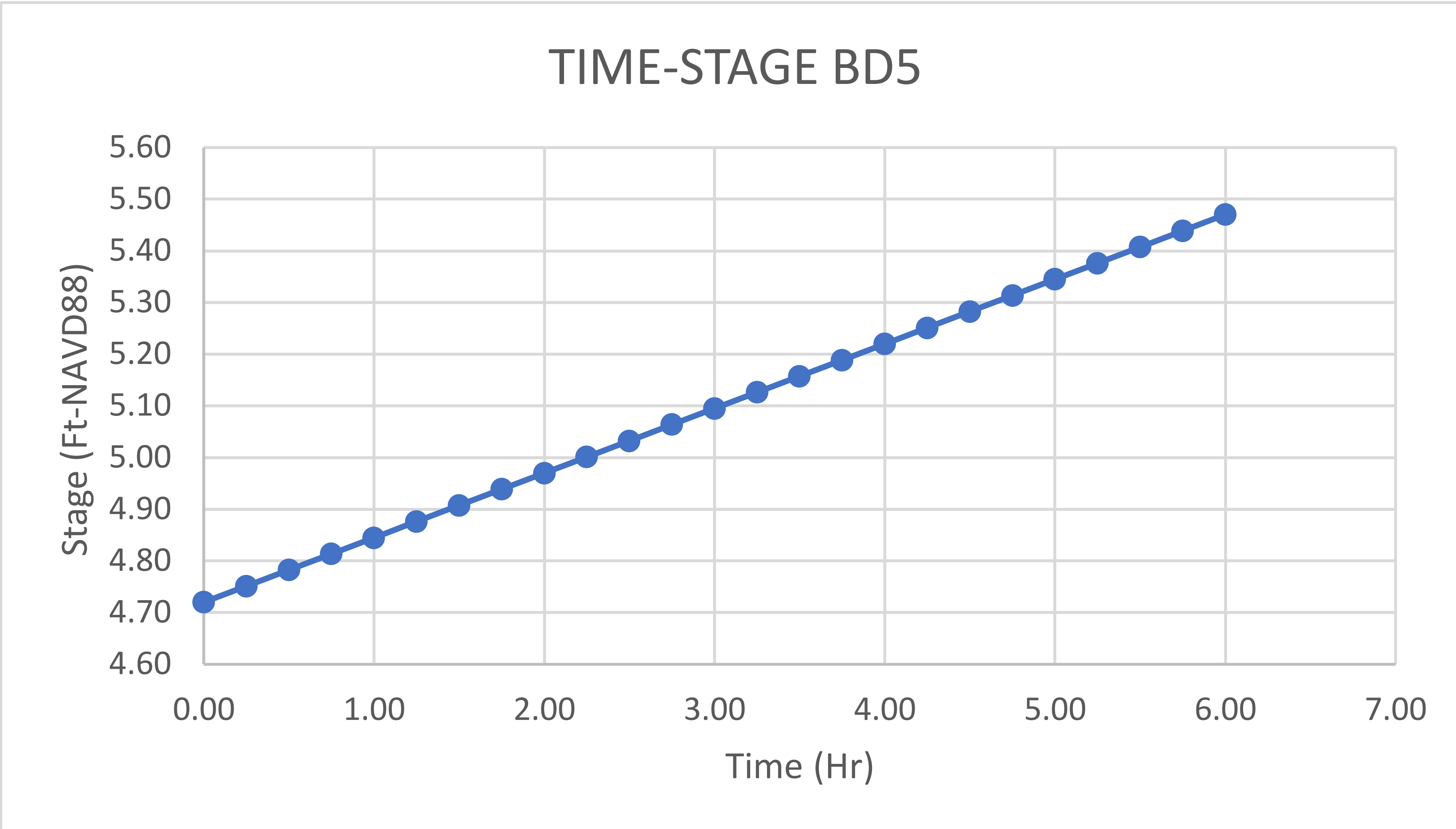

MIAMI-DADE
COUNTY
STAFF GAUGE
NAVD 1988
DATUM PLANE
05/27/2020 08:01:05

APPENDIX F. TIME-STAGE BOUNDARY CONDITIONS FOR VALIDATION EVENT

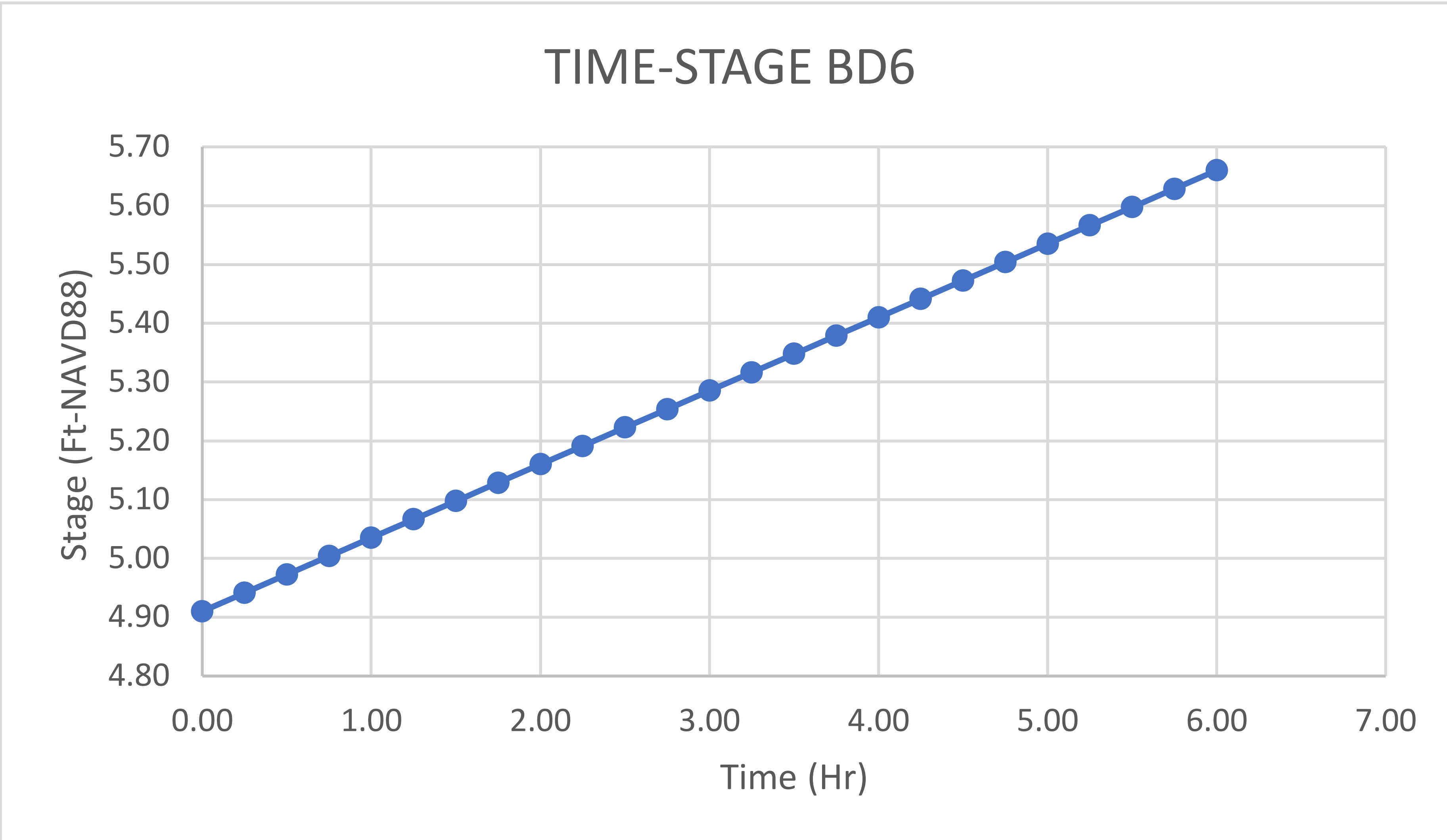


TIME-STAGE BD3
Stage (Ft-NAVD88)
5.40
5.30
5.20
5.10
5.00
4.90
4.80
4.70
4.60
4.50
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
Time (Hr)

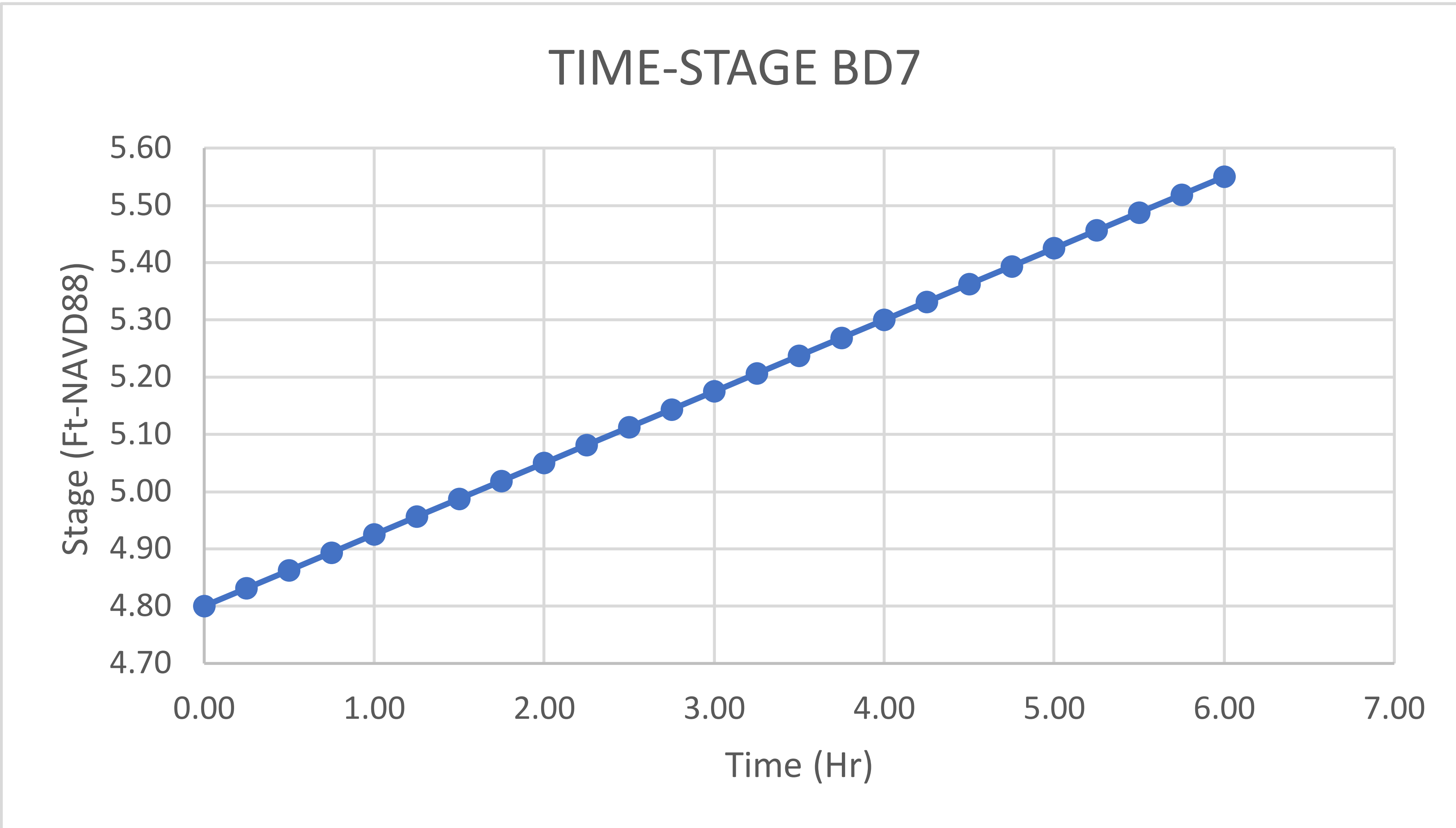

TIME-STAGE BD4
Stage (Ft-NAVD88)
5.60
5.50
5.40
5.30
5.20
5.10
5.00
4.90
4.80
4.70
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
Time (Hr)



TIME-STAGE BD5
Stage (Ft-NAVD88)
5.60
5.50
5.40
5.30
5.20
5.10
5.00
4.90
4.80
4.70
4.60
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
Time (Hr)

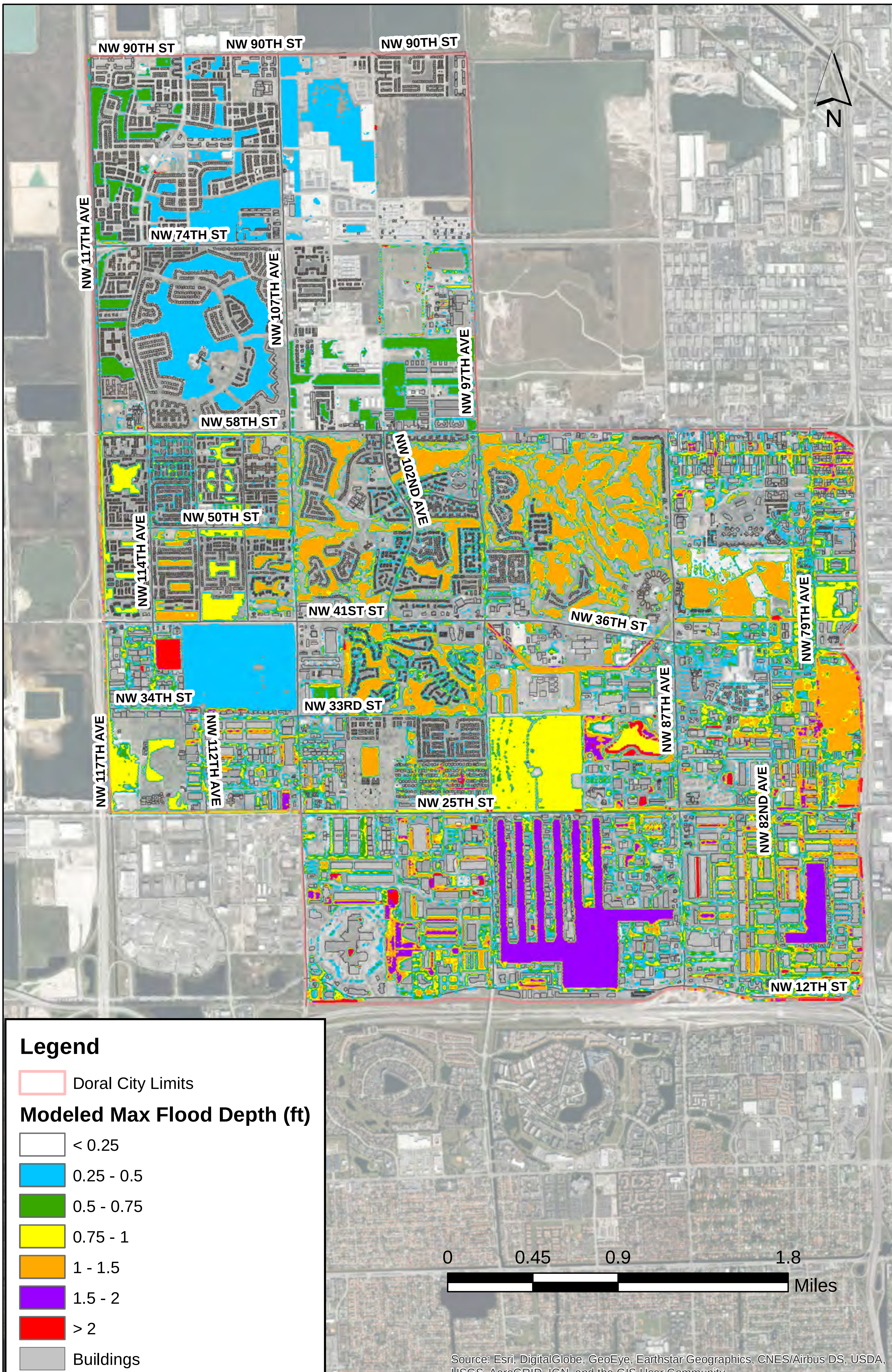


TIME-STAGE BD6
Stage (Ft-NAVD88)
5.70
5.60
5.50
5.40
5.30
5.20
5.10
5.00
4.90
4.80
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
Time (Hr)



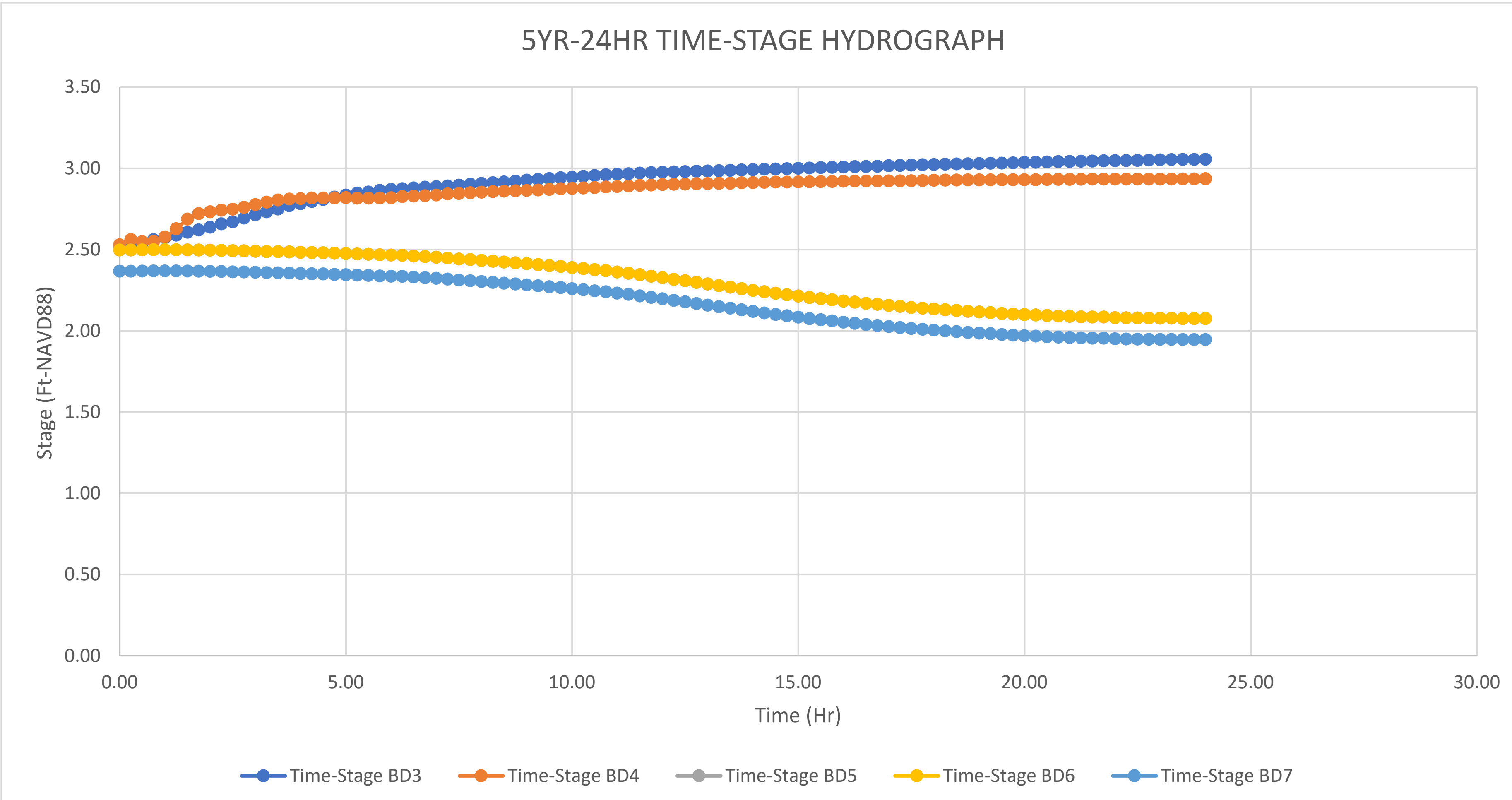
TIME-STAGE BD7
Stage (Ft-NAVD88)
5.60
5.50
5.40
5.30
5.20
5.10
5.00
4.90
4.80
4.70
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
Time (Hr)

APPENDIX G. VALIDATION EVENT FLOOD MAP

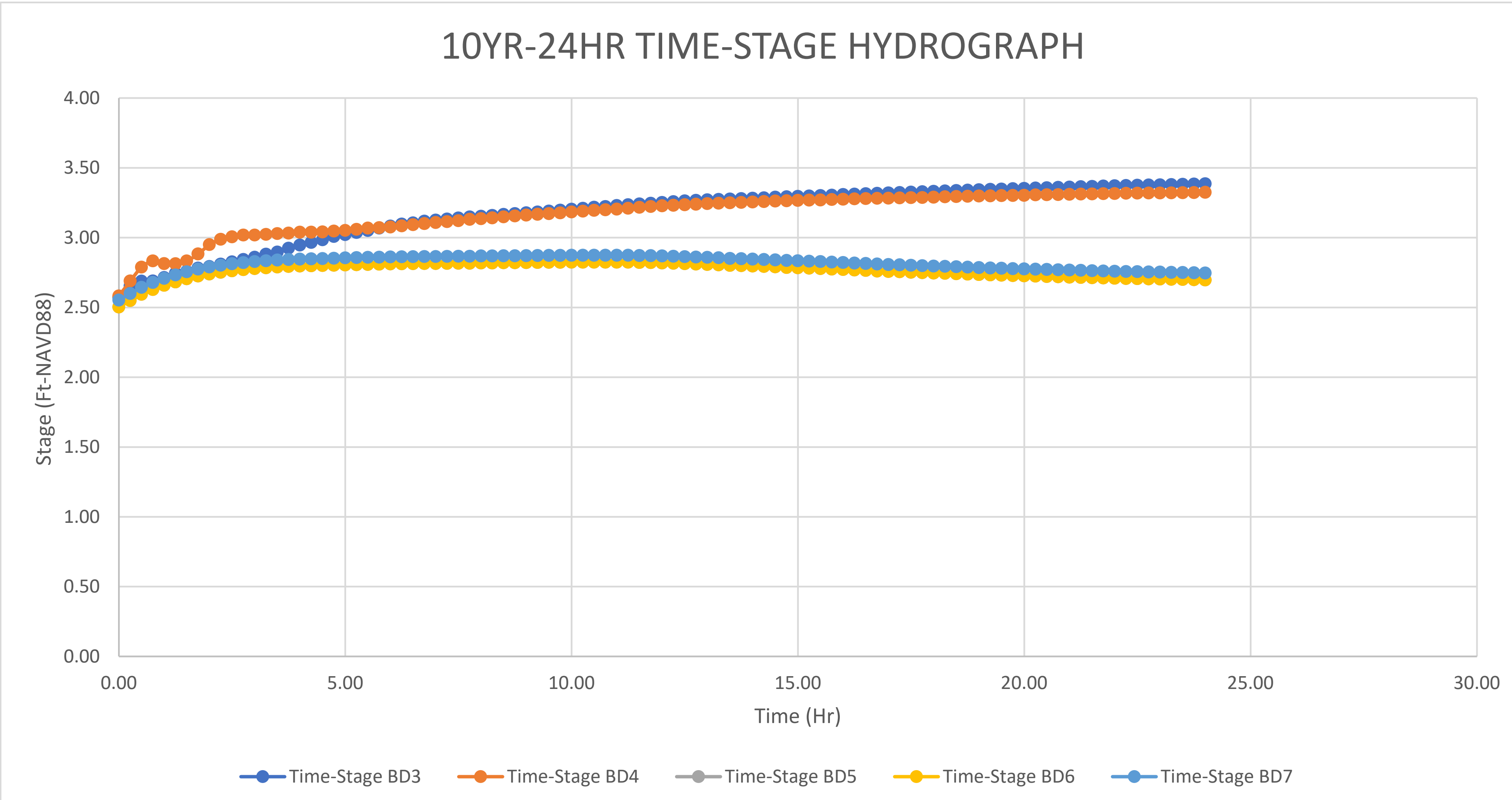


City of Doral Stormwater Management Master Plan
Flood Map Validation event

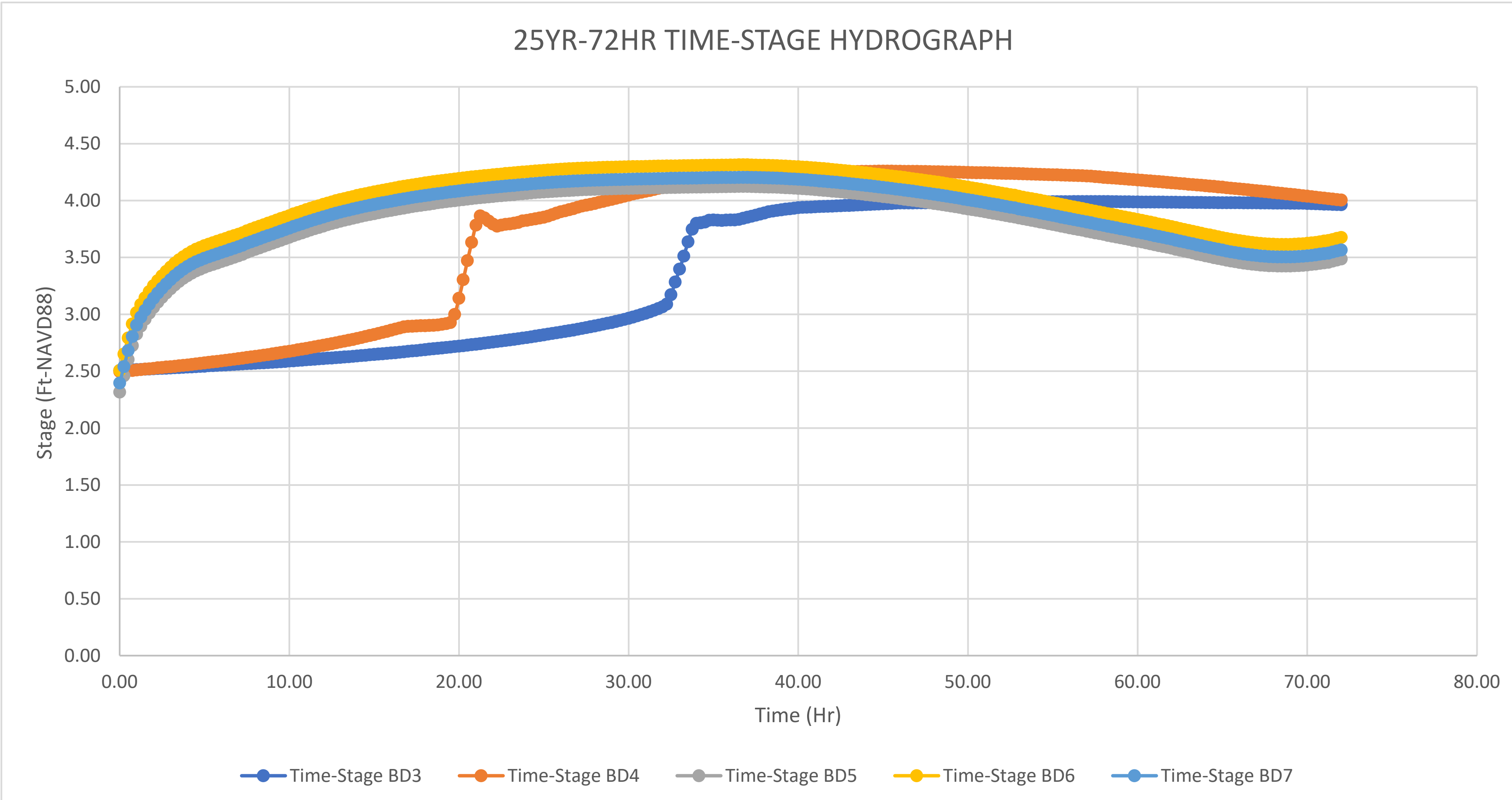
APPENDIX H. TIME-STAGE BOUNDARY CONDITIONS FOR DESIGN STORM EVENTS



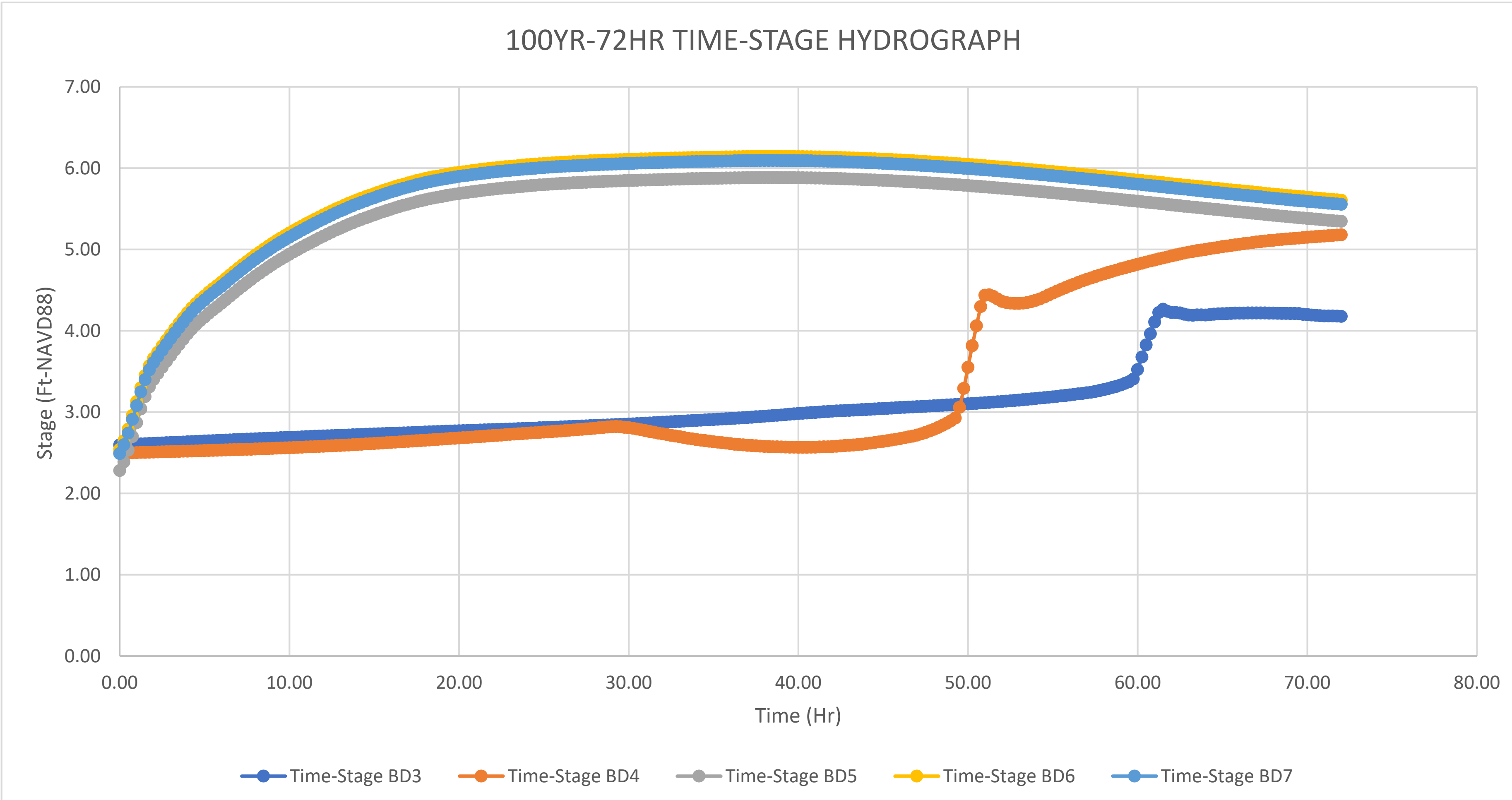
5YR-24HR TIME-STAGE HYDROGRAPH
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Stage (Ft-NAVD88)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
Time (Hr)
Time-Stage BD3
Time-Stage BD4
Time-Stage BD5
Time-Stage BD6
Time-Stage BD7

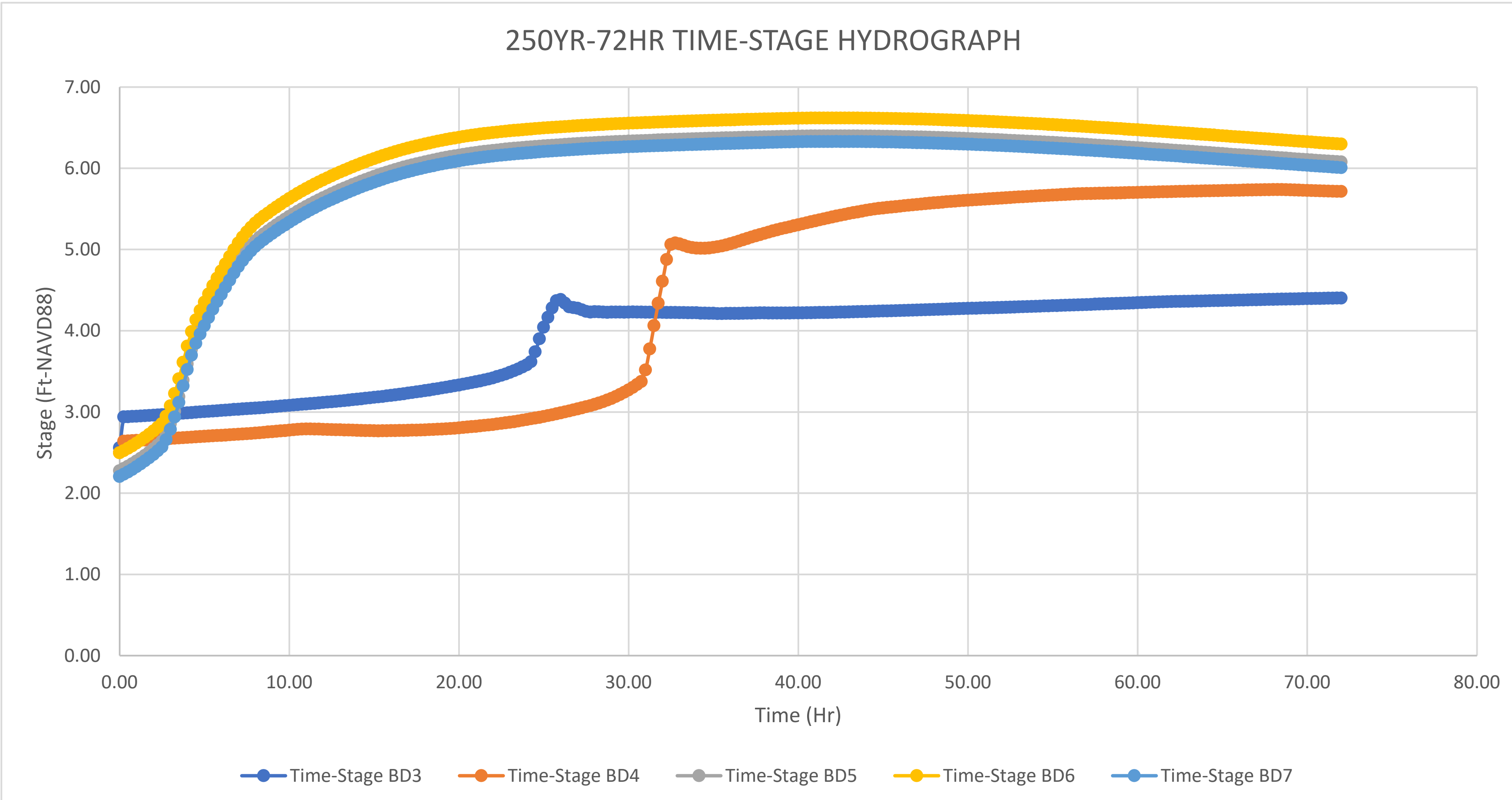


10YR-24HR TIME-STAGE HYDROGRAPH
Stage (Ft-NAVD88)
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
Time (Hr)
Time-Stage BD3
Time-Stage BD4
Time-Stage BD5
Time-Stage BD6
Time-Stage BD7

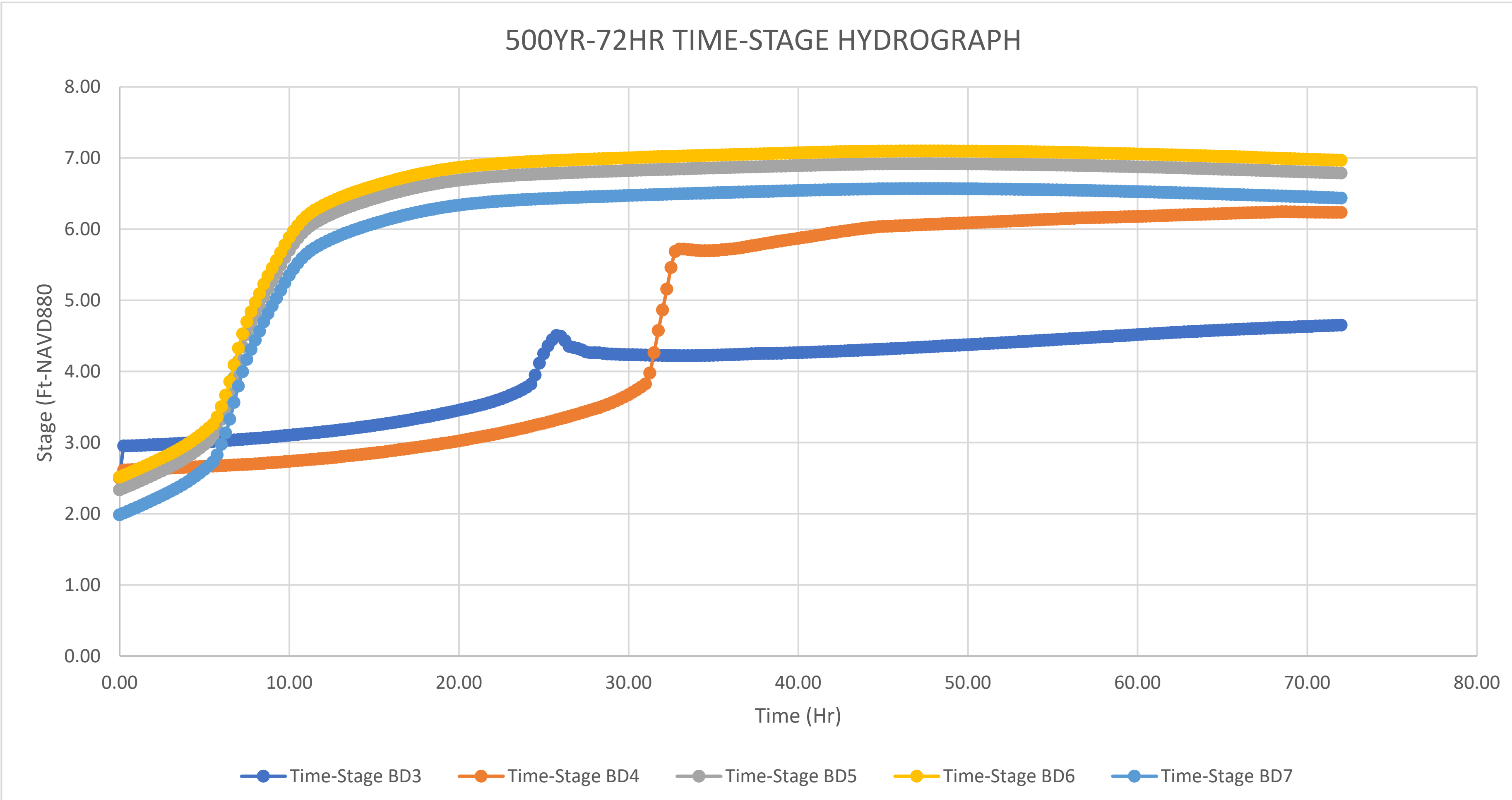


25YR-72HR TIME-STAGE HYDROGRAPH
Stage (Ft-NAVD88)
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Time (Hr)
Time-Stage BD3
Time-Stage BD4
Time-Stage BD5
Time-Stage BD6
Time-Stage BD7

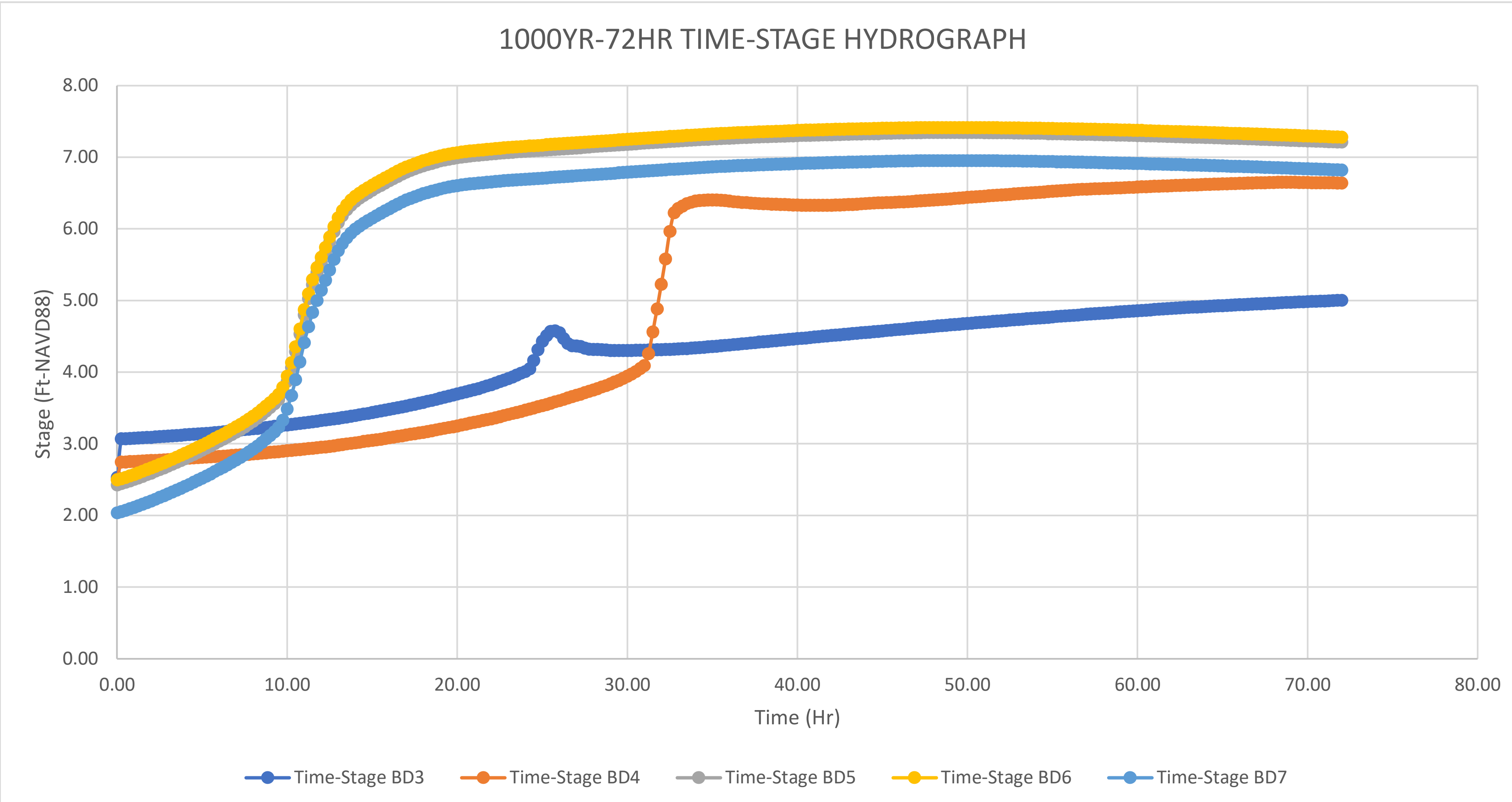

100YR-72HR TIME-STAGE HYDROGRAPH
Stage (Ft-NAVD88)
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Time (Hr)
Time-Stage BD3
Time-Stage BD4
Time-Stage BD5
Time-Stage BD6
Time-Stage BD7



250YR-72HR TIME-STAGE HYDROGRAPH
Stage (Ft-NAVD88)
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Time (Hr)
Time-Stage BD3
Time-Stage BD4
Time-Stage BD5
Time-Stage BD6
Time-Stage BD7

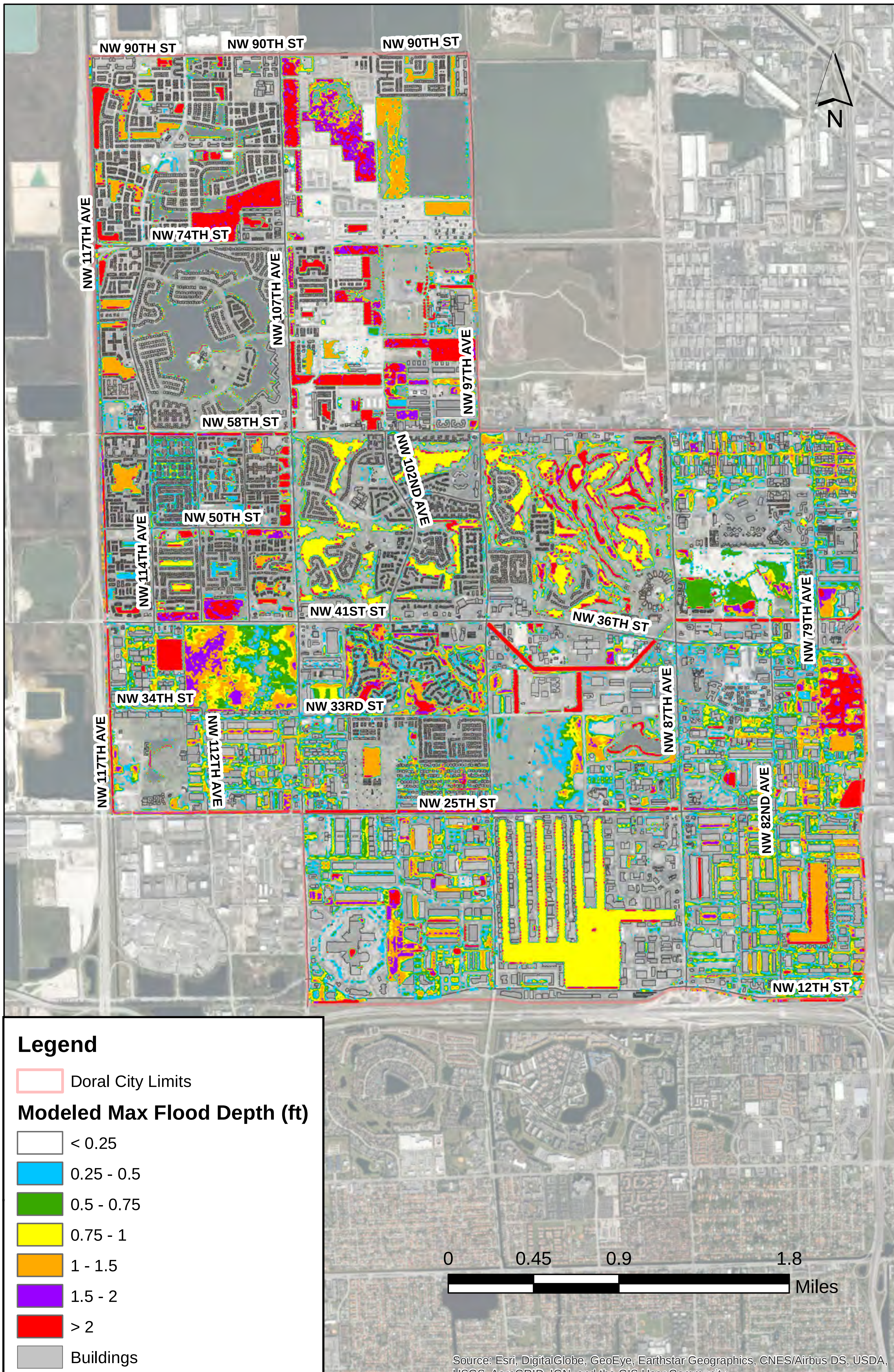


500YR-72HR TIME-STAGE HYDROGRAPH
Stage (Ft-NAVD880
Time (Hr)
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Time-Stage BD3
Time-Stage BD4
Time-Stage BD5
Time-Stage BD6
Time-Stage BD7



1000YR-72HR TIME-STAGE HYDROGRAPH
Stage (Ft-NAVD88)
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Time (Hr)
Time-Stage BD3
Time-Stage BD4
Time-Stage BD5
Time-Stage BD6
Time-Stage BD7

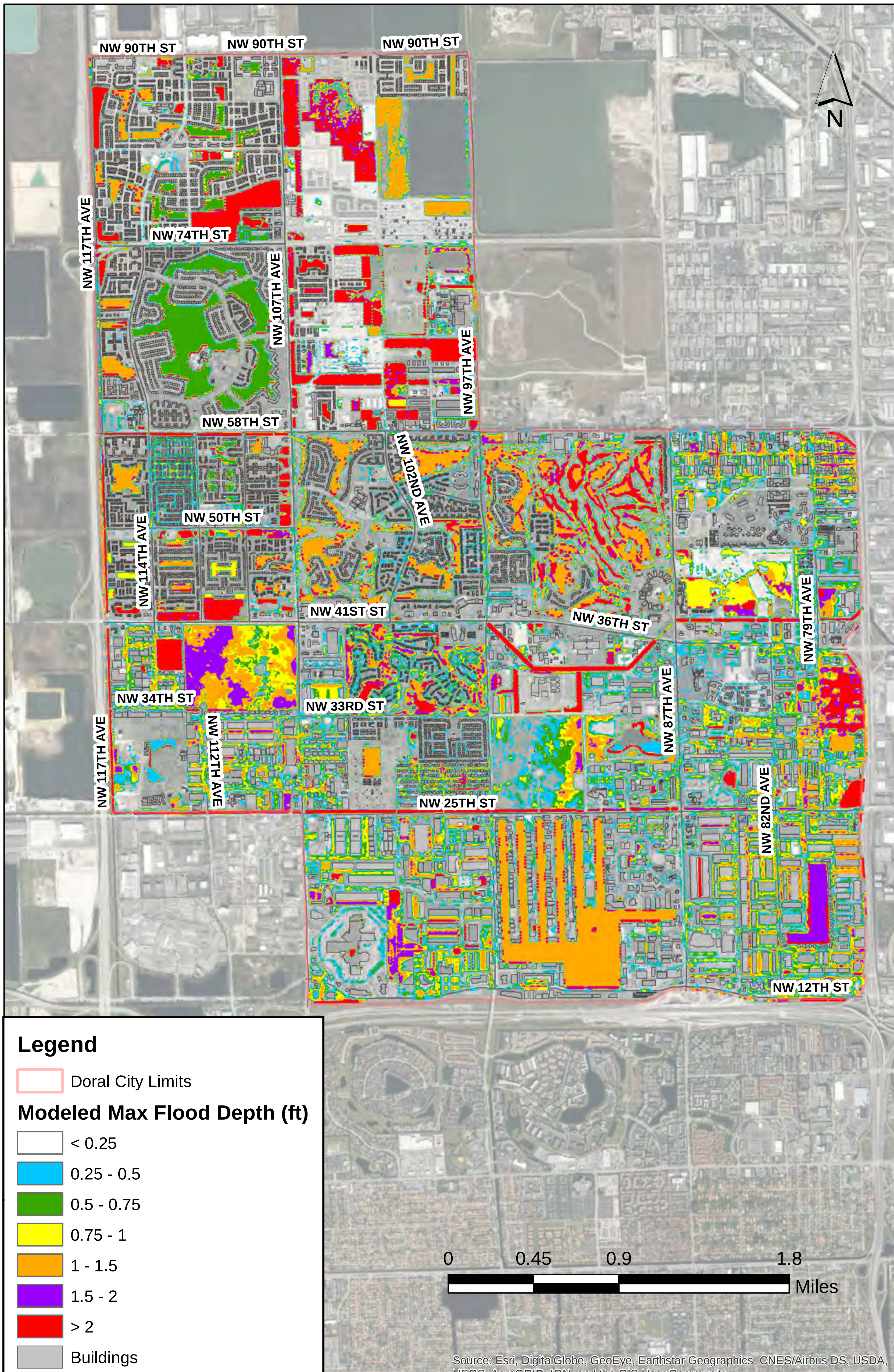
APPENDIX I. DESIGN STORM INUNDATION FLOOD MAPS



CITY OF DORAL
For all the right reasons!

City of Doral Stormwater Management Master Plan
Flood Map 5 year - 24 hours event

bc engineering

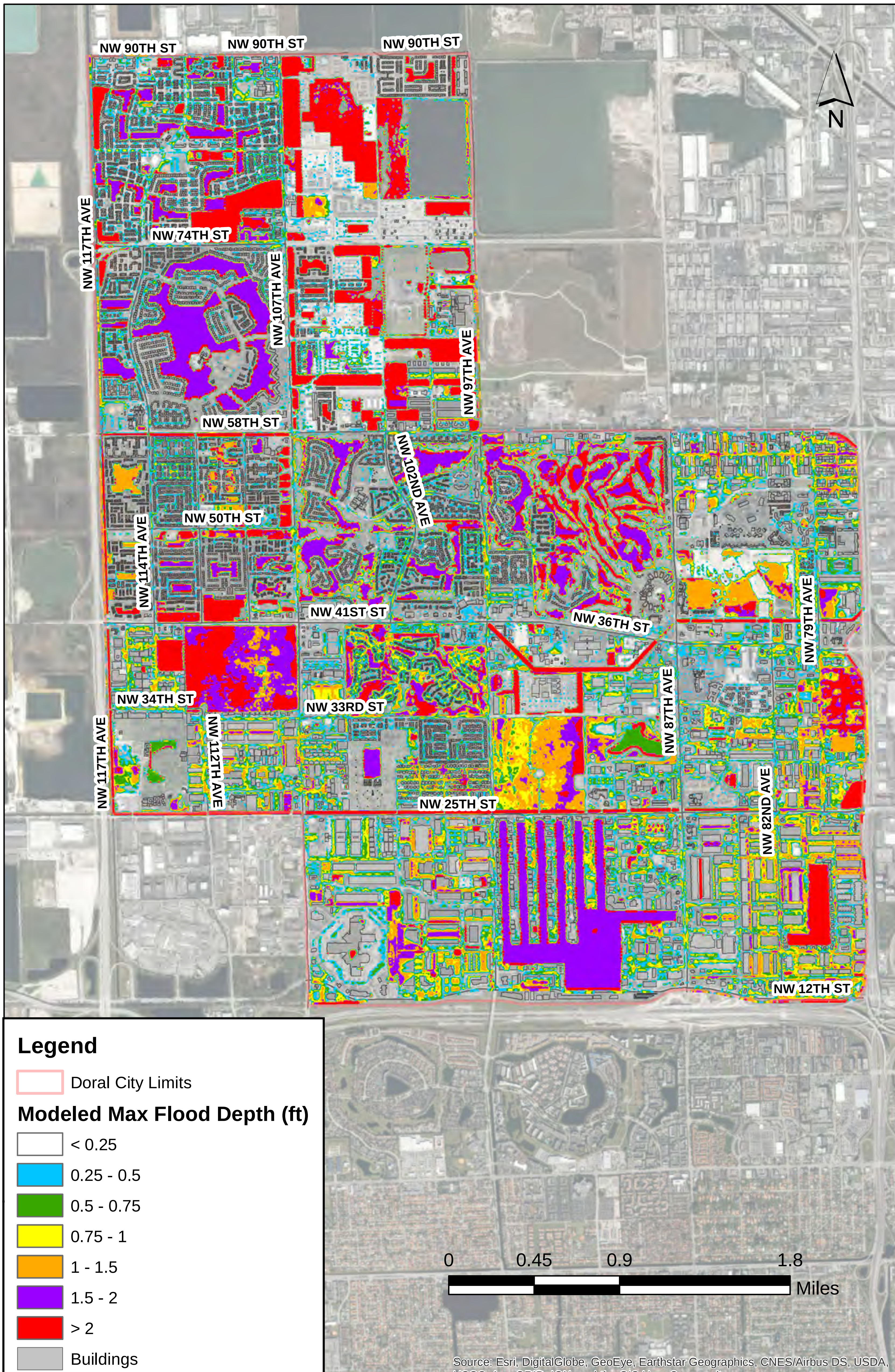


CITY OF DORAL

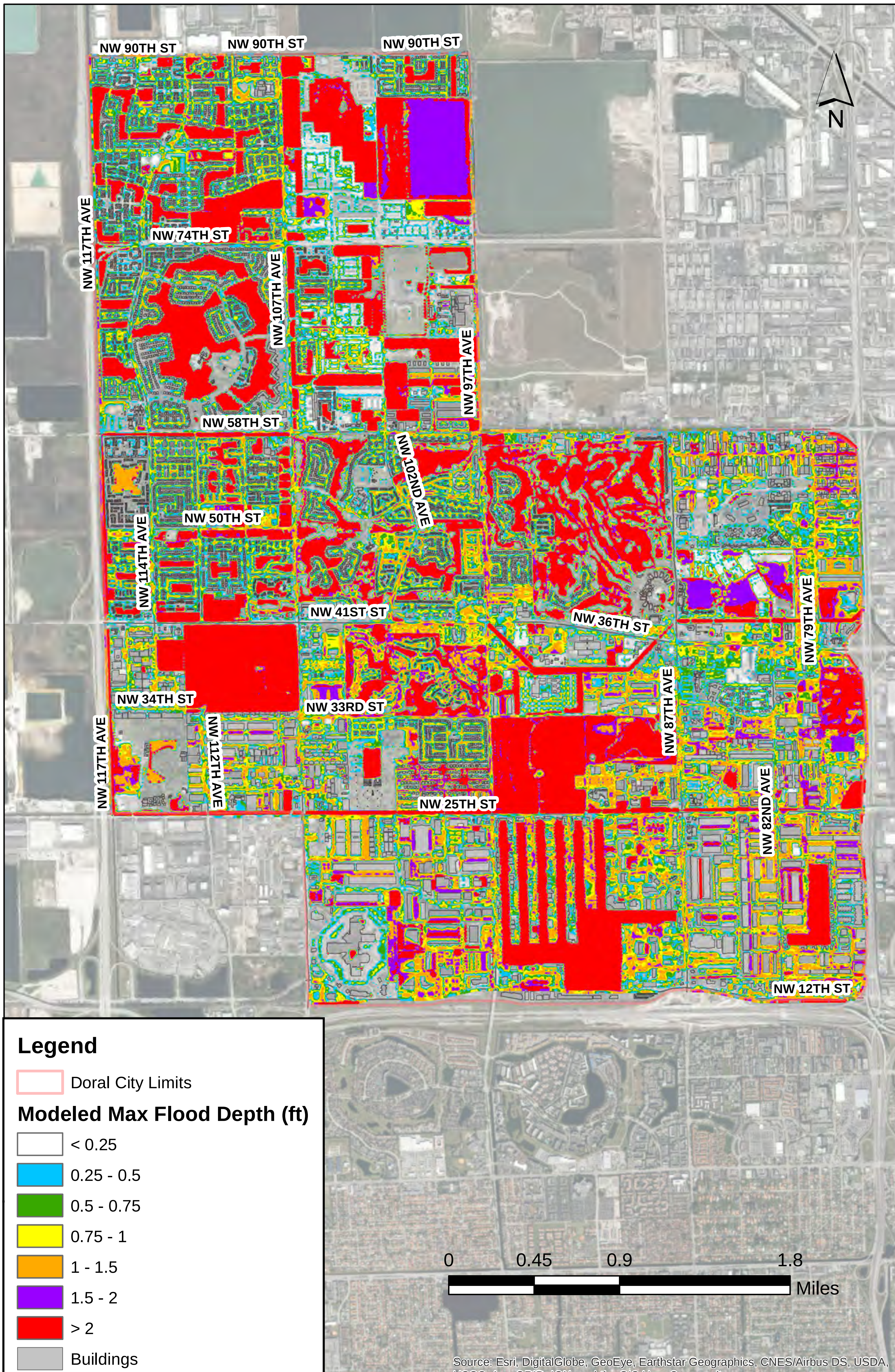
For all the right reasons!

City of Doral Stormwater Management Master Plan
Flood Map 10 year - 24 hours event

bc engineering



City of Doral Stormwater Management Master Plan
Flood Map 25 year - 72 hours event



City of Doral Stormwater Management Master Plan
Flood Map 100 year - 72 hours event

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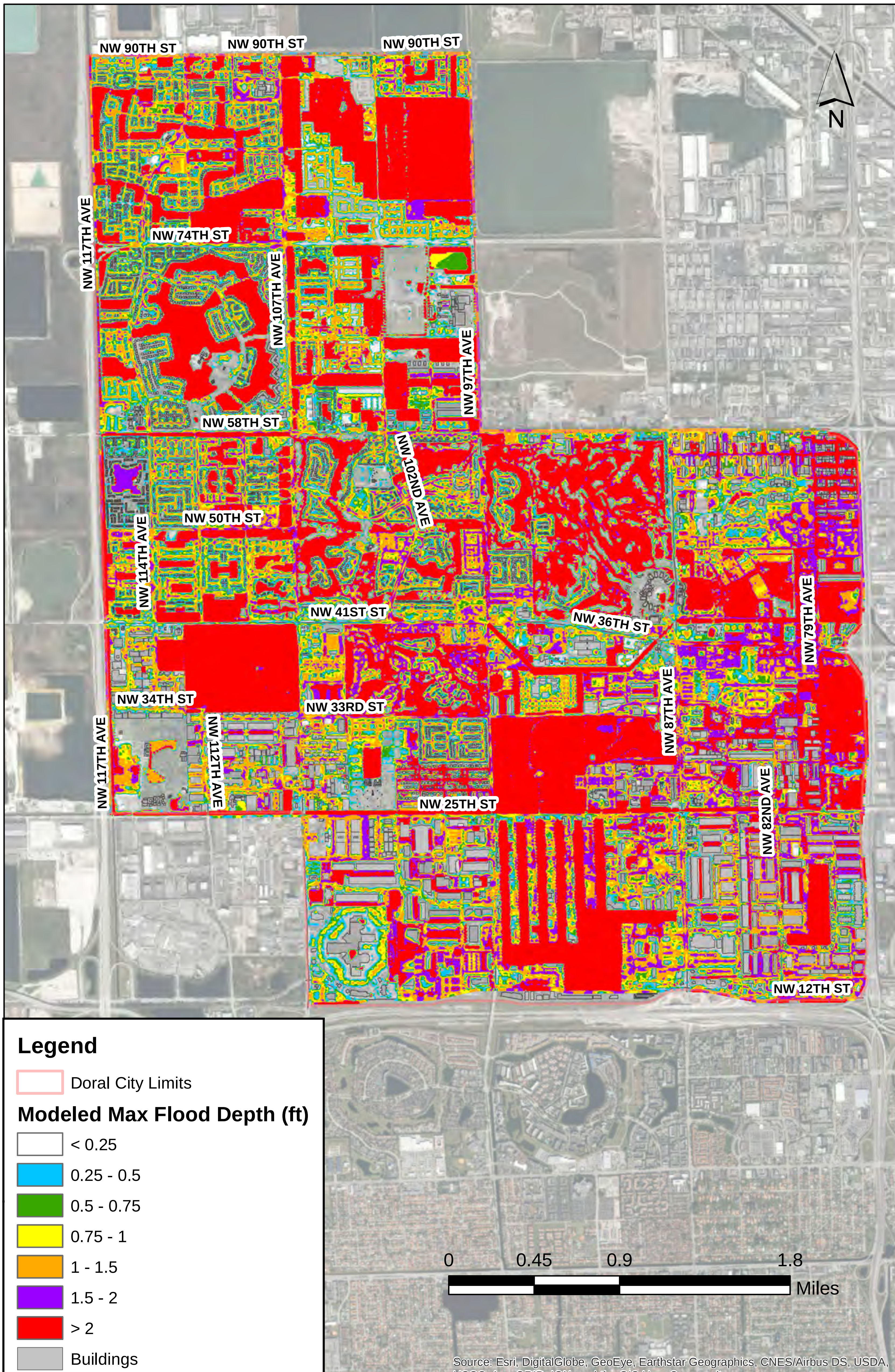
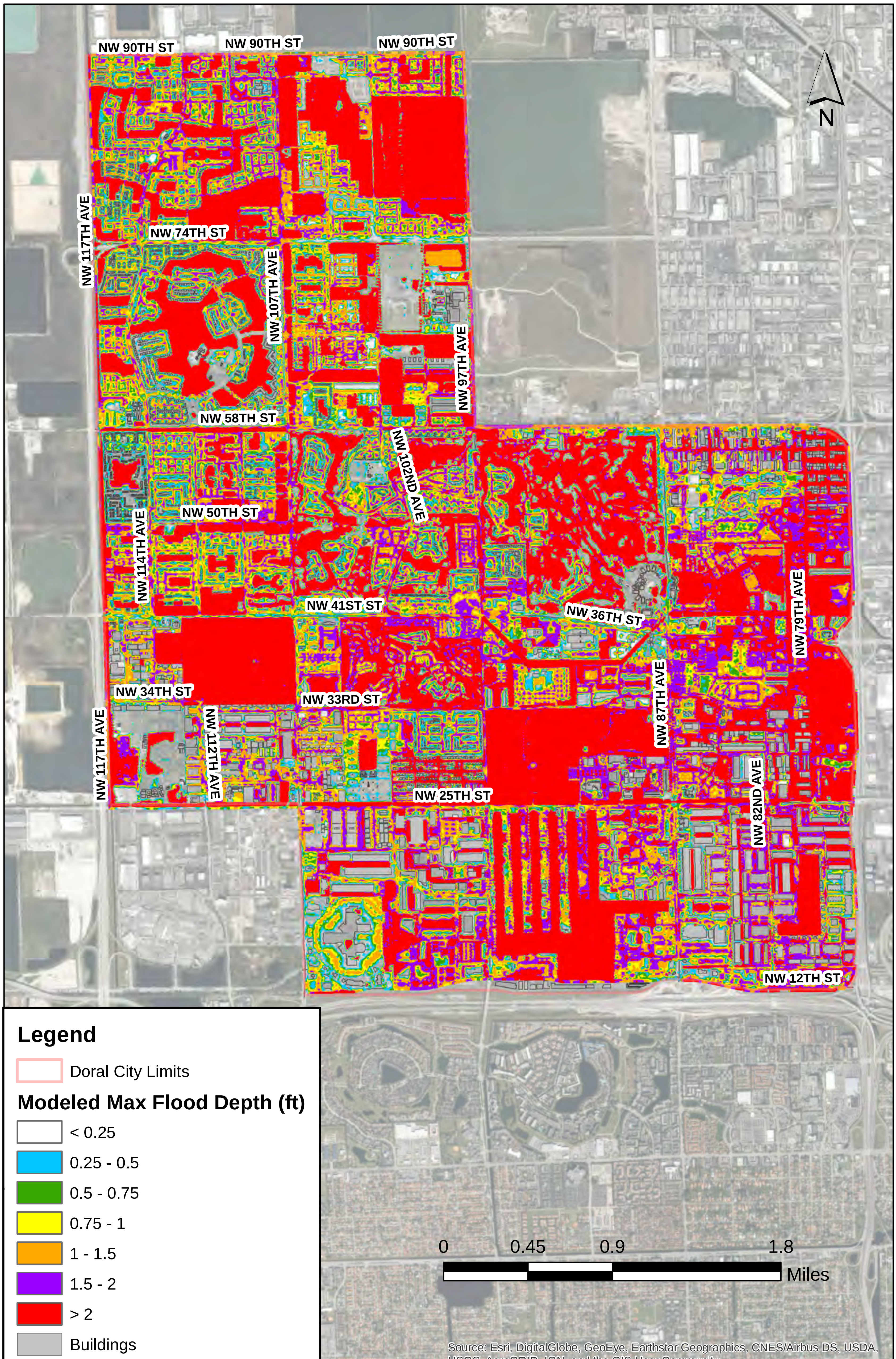


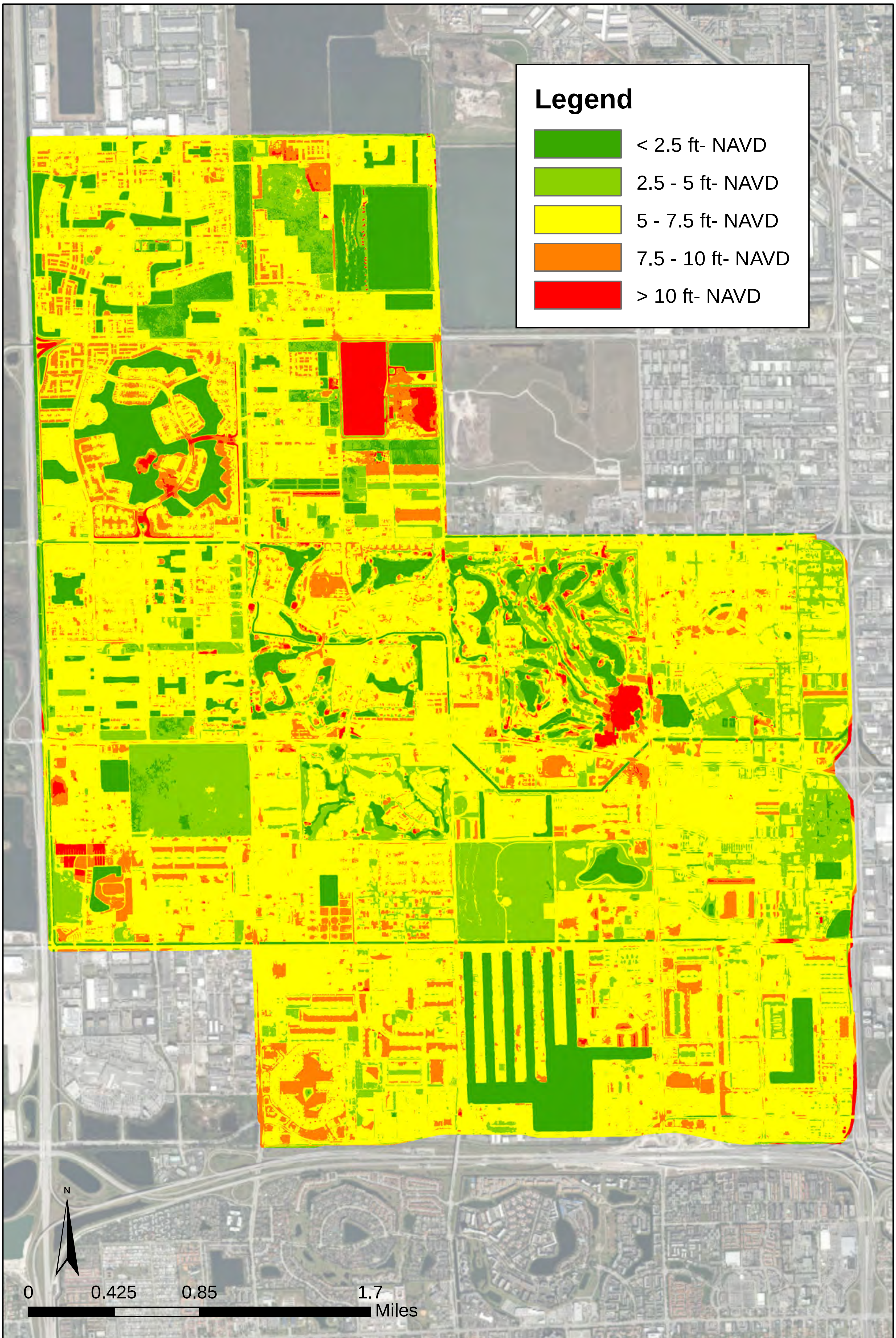
City of Doral Stormwater Management Master Plan
Flood Map 500 year - 72 hours event



City of Doral Stormwater Management Master Plan

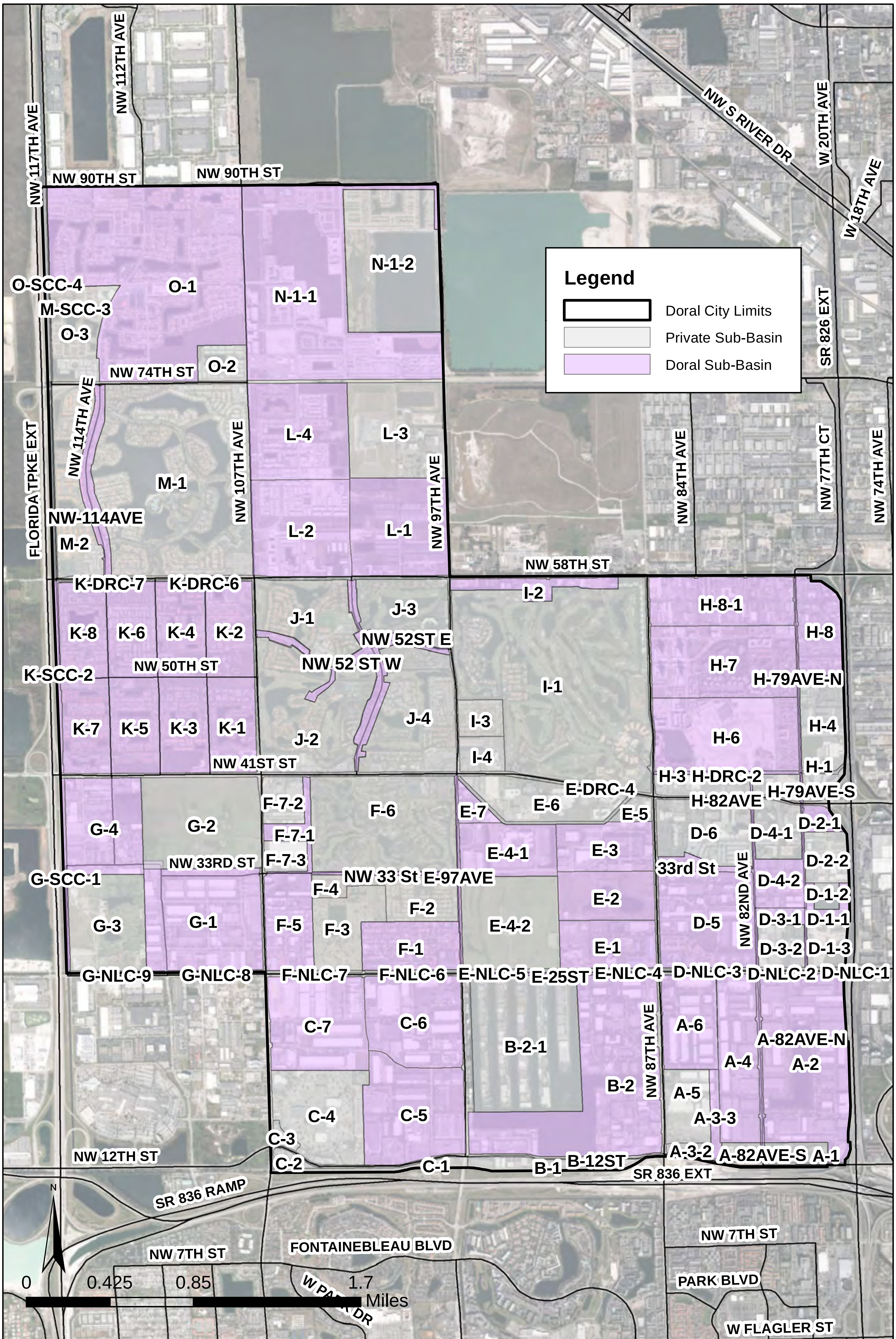
Flood Map 1000 year - 72 hours event

APPENDIX J. DEM RASTER MAP



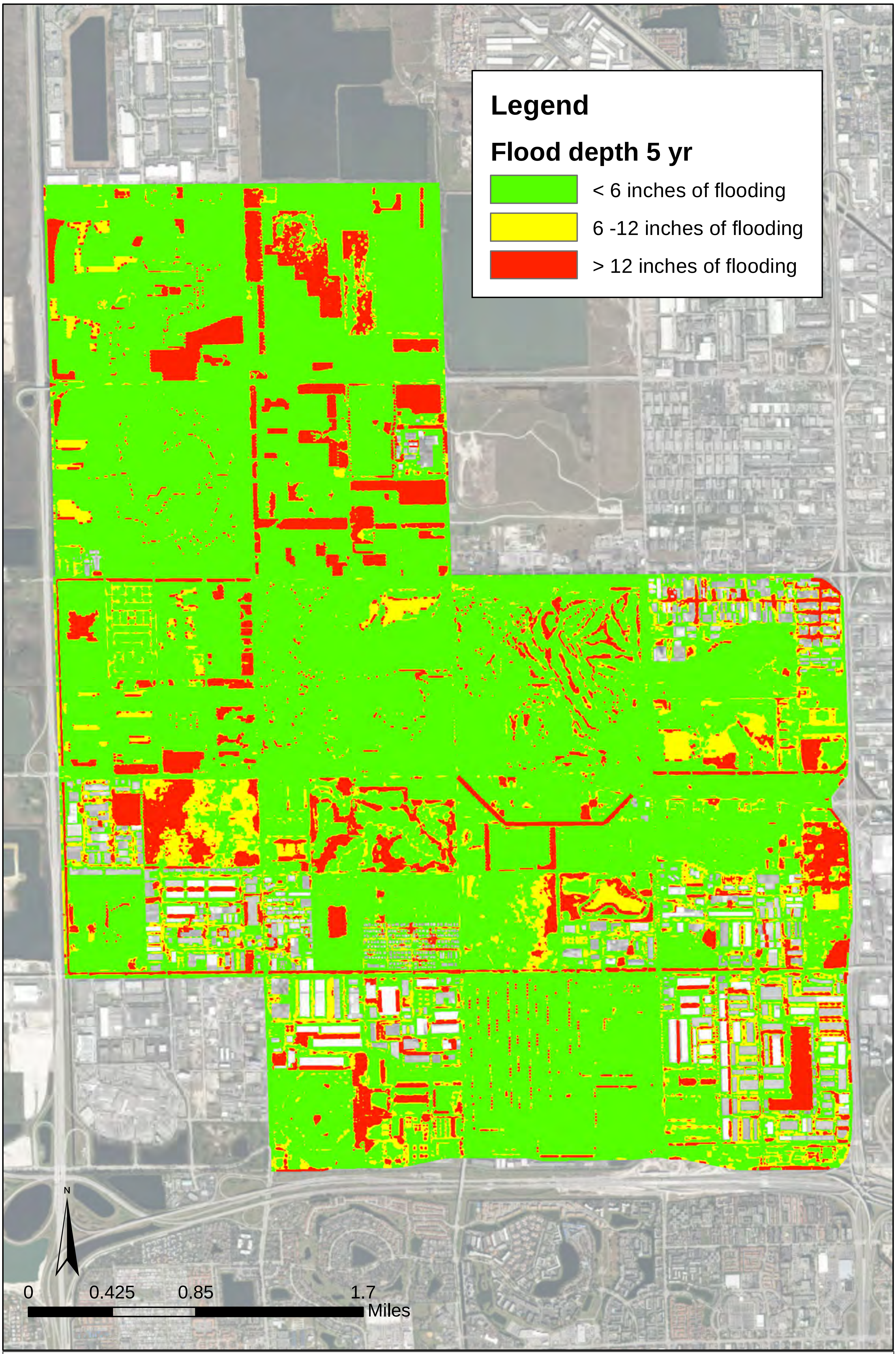
City of Doral Stormwater Management Master Plan
DEM Raster
Attachment A

APPENDIX K. SUB BASIN DELINEATION MAP



City of Doral Stormwater Management Master Plan
Doral Sub-Basin Delineation

APPENDIX L. LOCATION AND SEVERITY OF FLOODING FOR DESIGN STORM EVENTS



City of Doral Stormwater Management Master Plan
5 yr - 24 hour Design Storm Event Flooding
Attachment C

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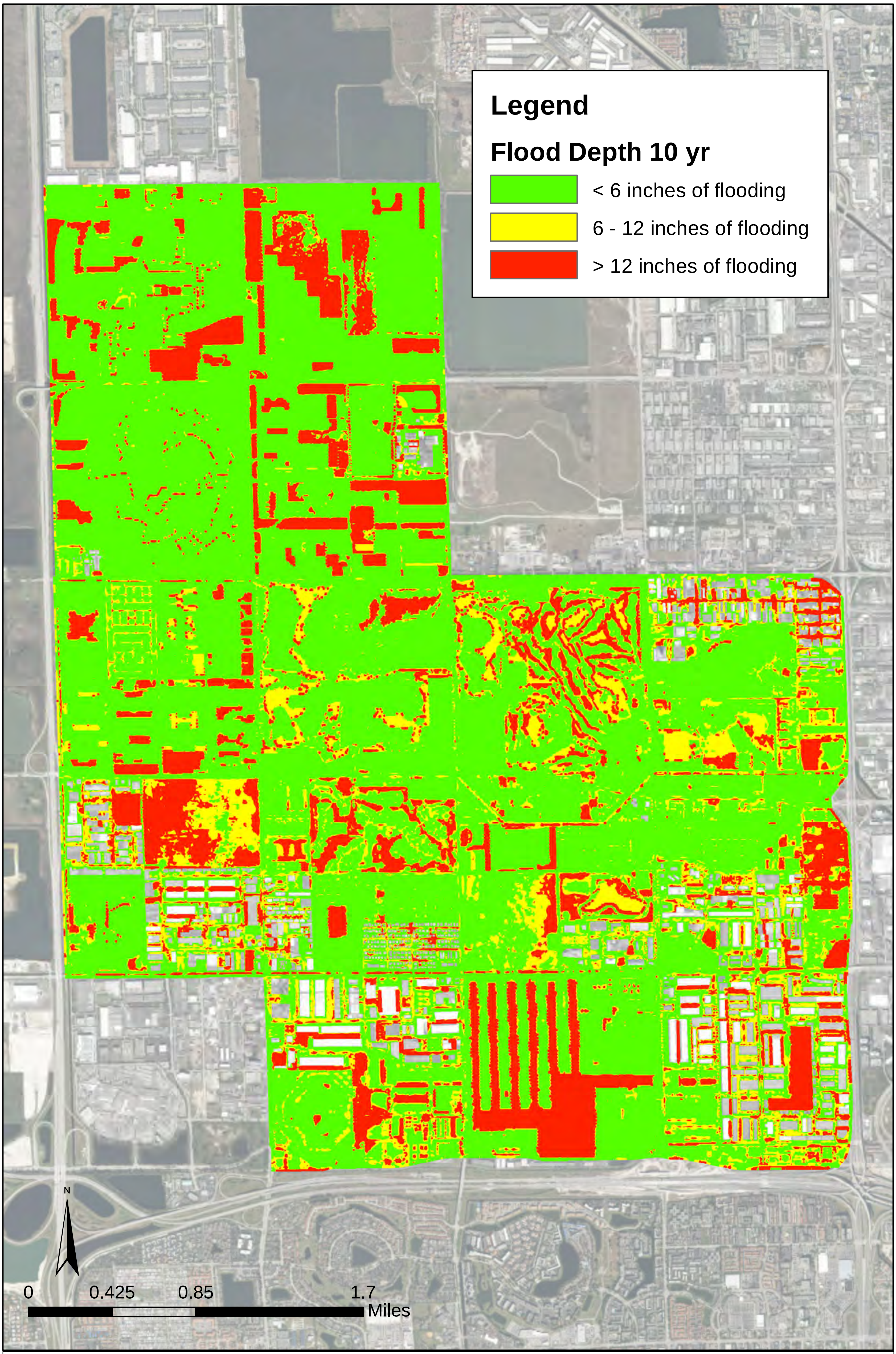
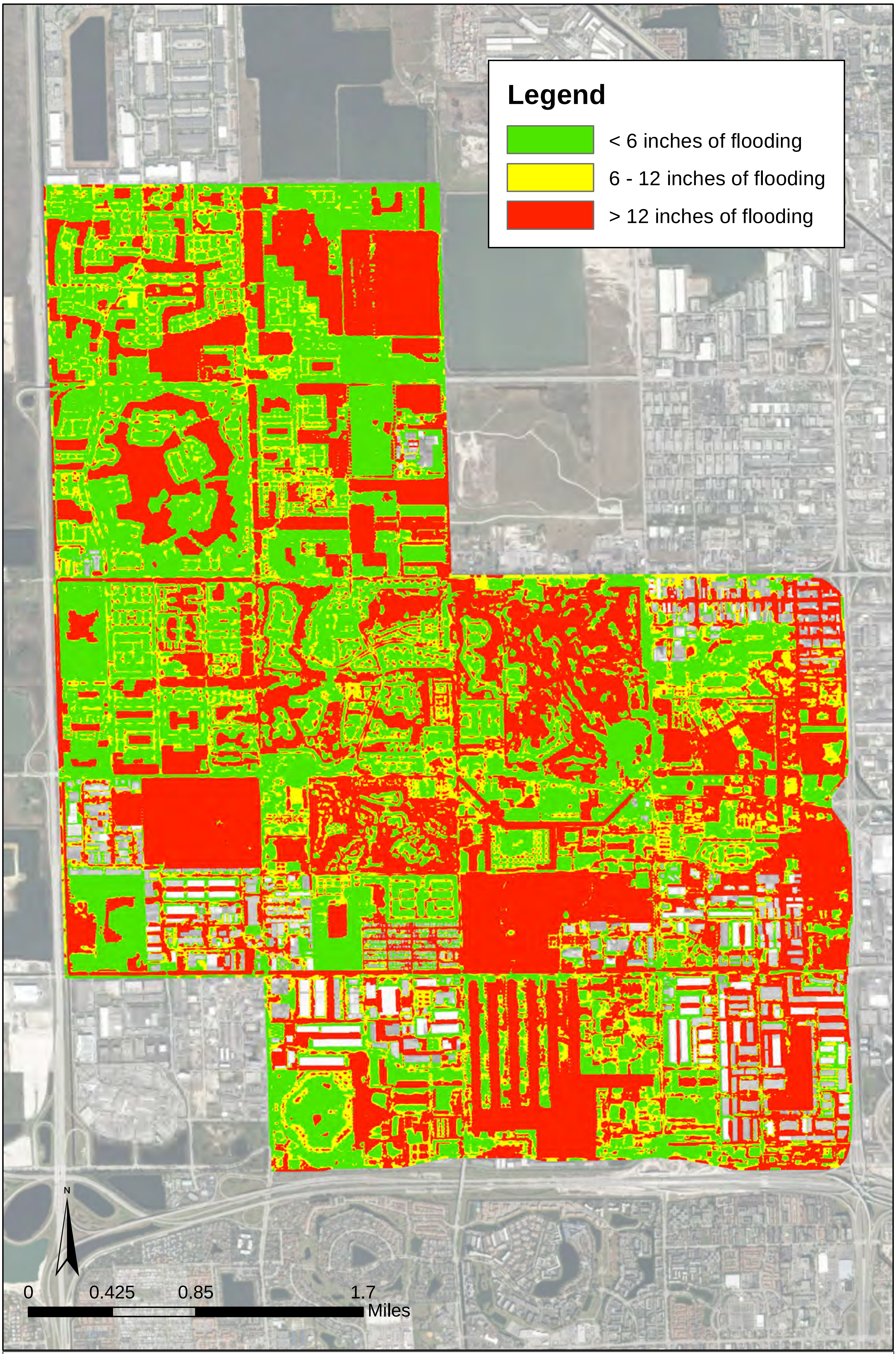


City of Doral Stormwater Management Master Plan
10 yr - 24 hour Design Storm Event Flooding
Attachment C



City of Doral Stormwater Management Master Plan
100 yr -72 hour Design Storm Event Flooding
Attachment C

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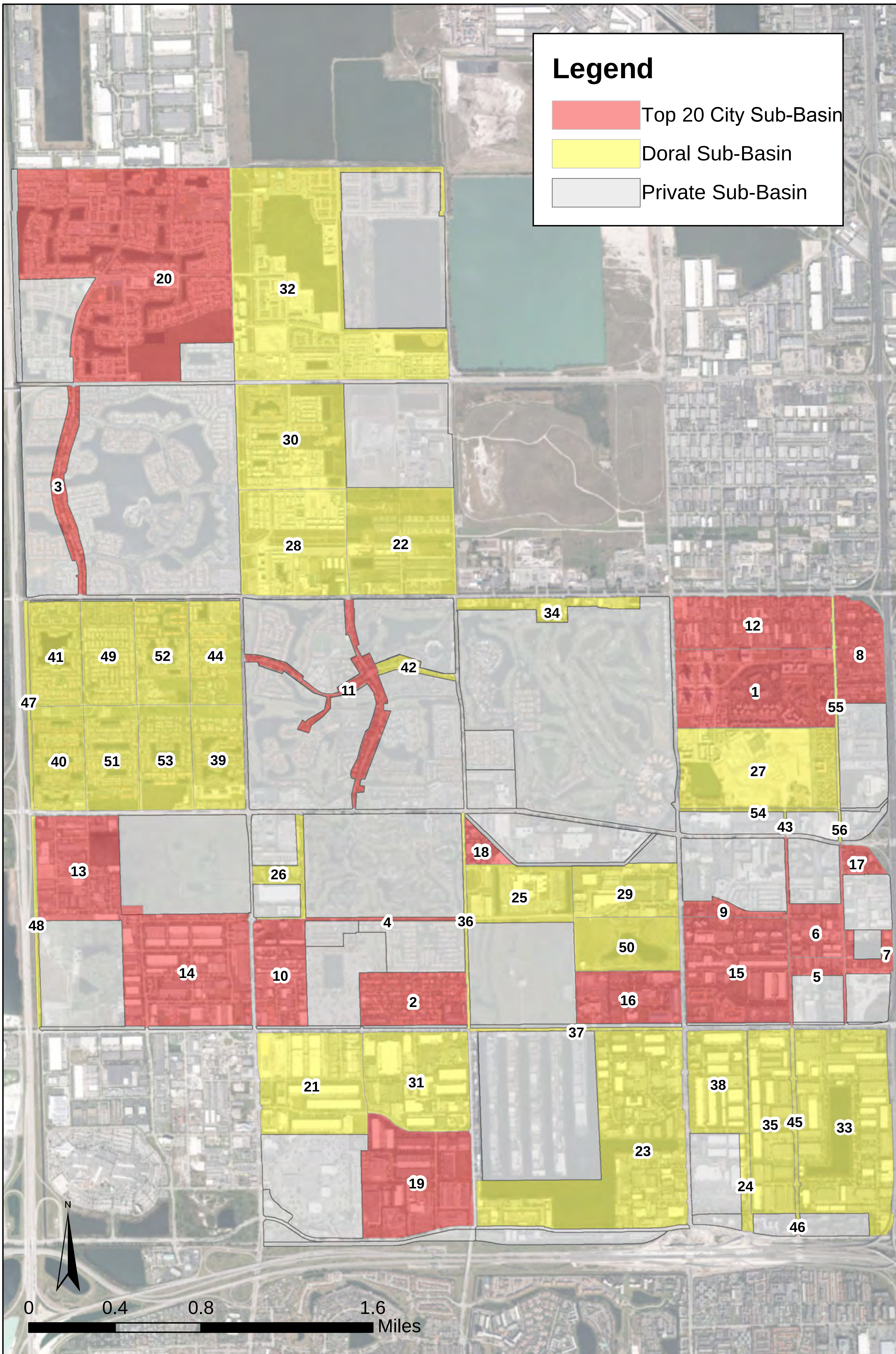
APPENDIX M. SUB-BASIN SEVERITY SCORE

Sub-Basin	Sub-Basin Area (Acres)	FPSS	RANK	WEIGHTED FPSS	RANK
H-7	172.13	11205.34	1	65.10	1
F-1	78.08	3533.54	2	45.25	2
NW 102AVE	34.18	1336.13	6	39.09	3
NW 33 St	8.36	265.84	48	31.80	4
D-3-1	54.96	394.38	24	31.10	5
D-4-2	79.99	1061.32	12	28.14	6
D-1-1	17.97	463.83	20	25.81	7
H-8	67.88	1599.57	4	23.56	8
NW 52 ST W	16.69	285.20	28	17.09	9
F-5	76.91	1203.25	7	15.64	10
NW-114AVE	37.79	441.48	22	11.68	11
H-8-1	116.44	1157.82	9	9.94	12
G-4	121.64	1085.08	11	8.92	13
G-1	199.44	1543.48	5	7.74	14
D-5	167.89	1203.10	8	7.17	15
E-1	76.37	466.89	19	6.11	16
D-2-1	14.07	85.32	34	6.06	17
E-7	16.00	91.02	33	5.69	18
C-5	159.98	869.90	14	5.44	19
O-1	347.34	2647.38	3	5.10	20
C-7	149.19	727.31	15	4.88	21
L-1	96.48	657.85	16	4.11	22
B-2	317.01	1156.53	10	3.65	23
A-3-3	14.11	49.77	40	3.53	24
E-4-1	84.10	295.54	27	3.51	25
F-7-1	22.32	75.23	35	3.37	26
H-6	120.37	572.80	17	3.27	27
L-2	43.88	452.24	21	2.86	28
E-3	76.69	213.44	30	2.78	29
L-4	34.21	425.96	23	2.68	30
C-6	138.00	351.94	25	2.55	31
N-1-1	154.62	960.99	13	2.34	32
A-2	245.46	524.82	18	2.14	33
I-2	34.52	72.21	36	2.09	34
A-4	111.07	223.28	29	2.01	35
E-25ST	9.50	10.50	46	1.11	36
A-6	85.69	94.41	32	1.10	37
NW 52ST E	10.45	349.27	26	33.42	38
K-1	22.95	67.30	37	0.90	39

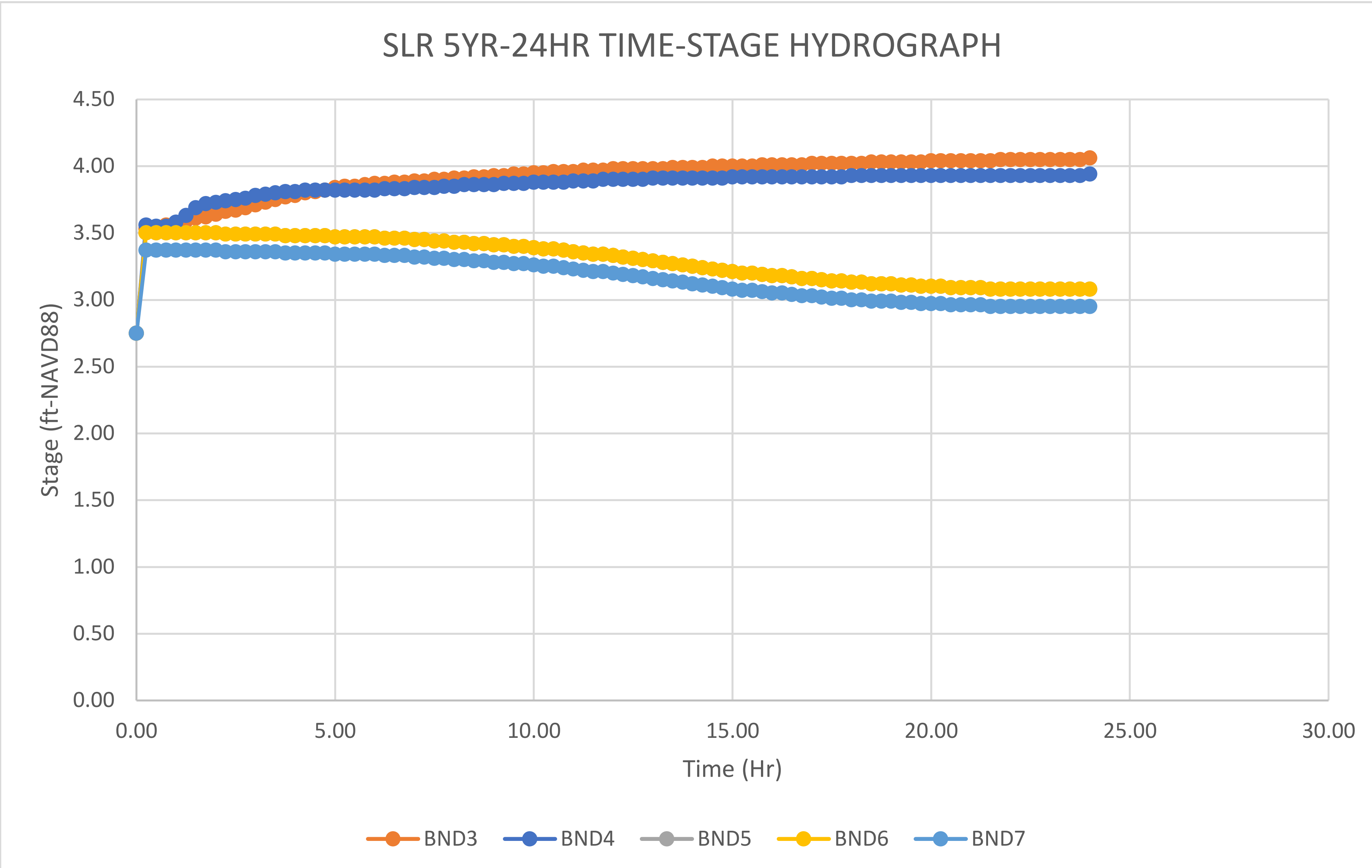
Sub-Basin	Sub-Basin Area (Acres)	FPSS	RANK	WEIGHTED FPSS	RANK
K-7	21.06	67.07	38	0.89	40
K-8	19.94	62.17	39	0.82	41
H-79AVE-N	8.59	4.91	64	0.57	42
H-82AVE	0.67	0.34	84	0.50	43
K-2	16.81	30.34	41	0.41	44
H-79AVE-S	1.30	0.52	82	0.40	45
A-82AVE-N	11.29	3.33	72	0.29	46
A-82AVE-S	1.17	0.32	85	0.27	47
K-SCC-2	12.67	3.12	74	0.25	48
G-SCC-1	12.28	1.62	81	0.13	49
K-6	25.85	8.23	51	0.11	50
E-2	78.61	6.77	55	0.09	51
K-5	24.77	2.35	76	0.03	52
K-4	22.49	2.30	77	0.03	53
K-3	22.39	2.04	78	0.03	54
H-DRC-2	8.01	0.05	86	0.01	55

APPENDIX N. RANKING MAP

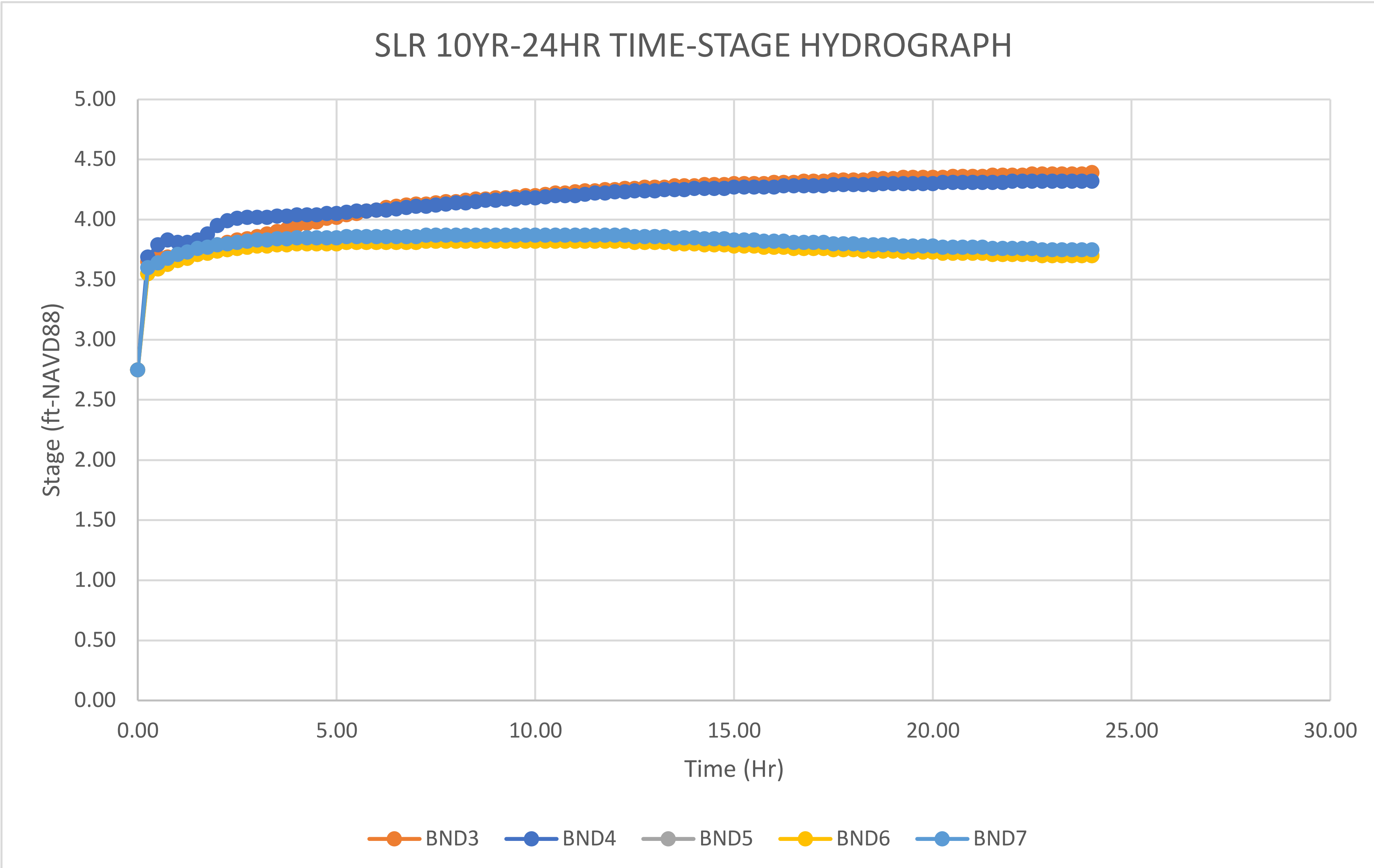


City of Doral Stormwater Management Master Plan
Doral Top 20 Sub-Basin Ranking
Existing Condition

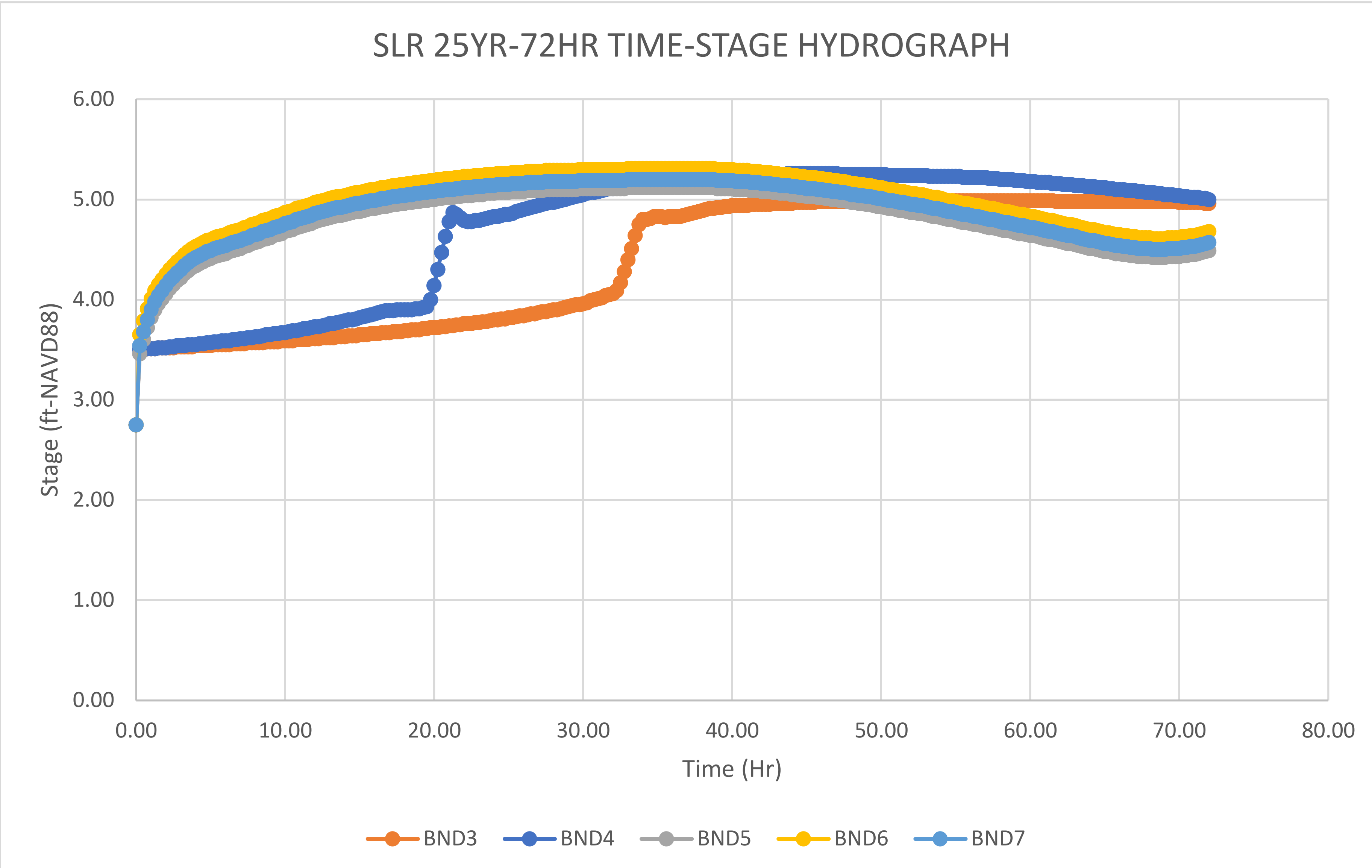
APPENDIX O. TIME-STAGE BOUNDARY CONDITIONS FOR SEA LEVEL RISE EVENT

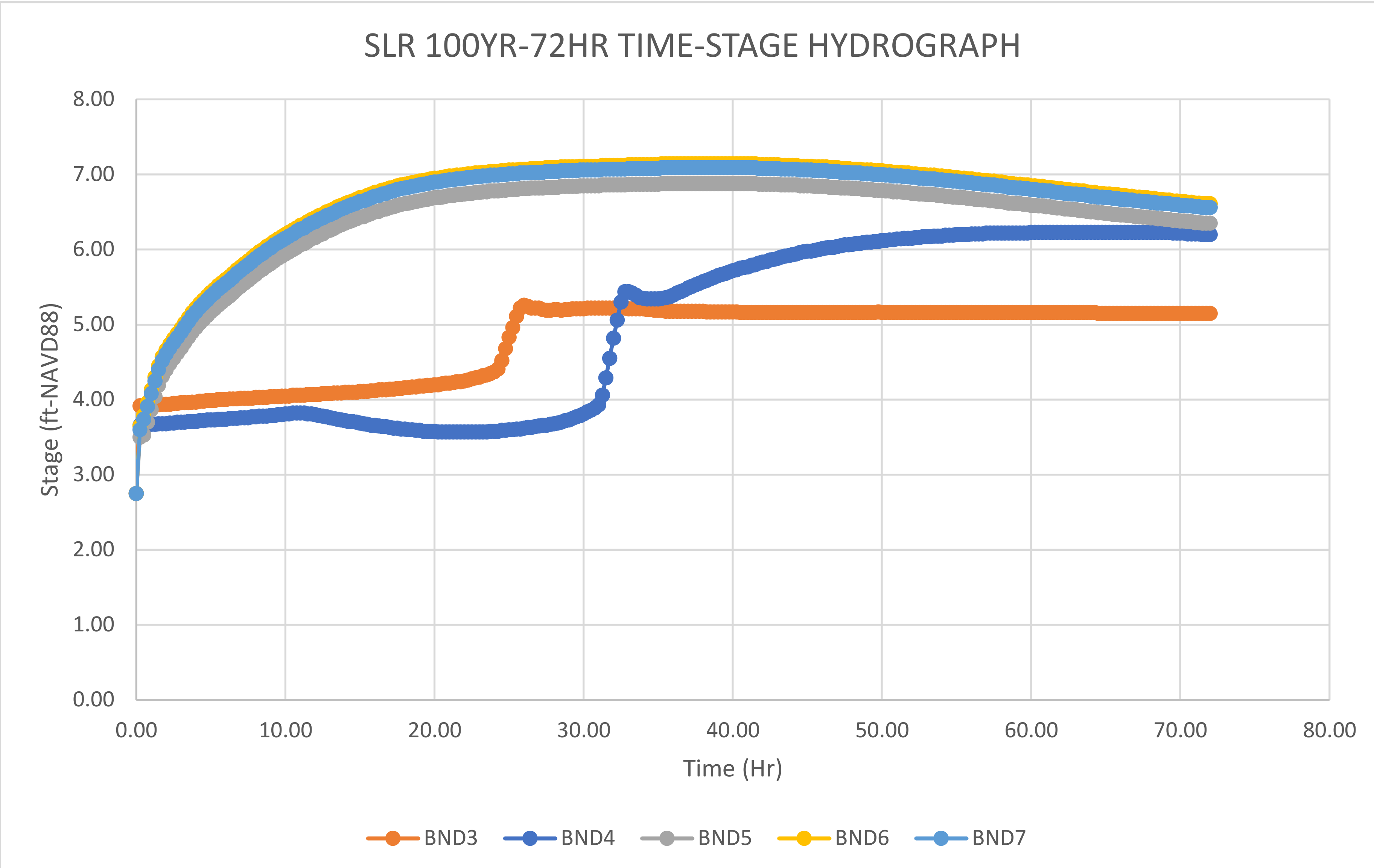


SLR 5YR-24HR TIME-STAGE HYDROGRAPH
Stage (ft-NAVD88)
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
Time (Hr)
BND3
BND4
BND5
BND6
BND7



SLR 10YR-24HR TIME-STAGE HYDROGRAPH
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Stage (ft-NAVD88)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
Time (Hr)
BND3
BND4
BND5
BND6
BND7


SLR 25YR-72HR TIME-STAGE HYDROGRAPH
Stage (ft-NAVD88)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Time (Hr)
BND3
BND4
BND5
BND6
BND7



SLR 100YR-72HR TIME-STAGE HYDROGRAPH
Stage (ft-NAVD88)
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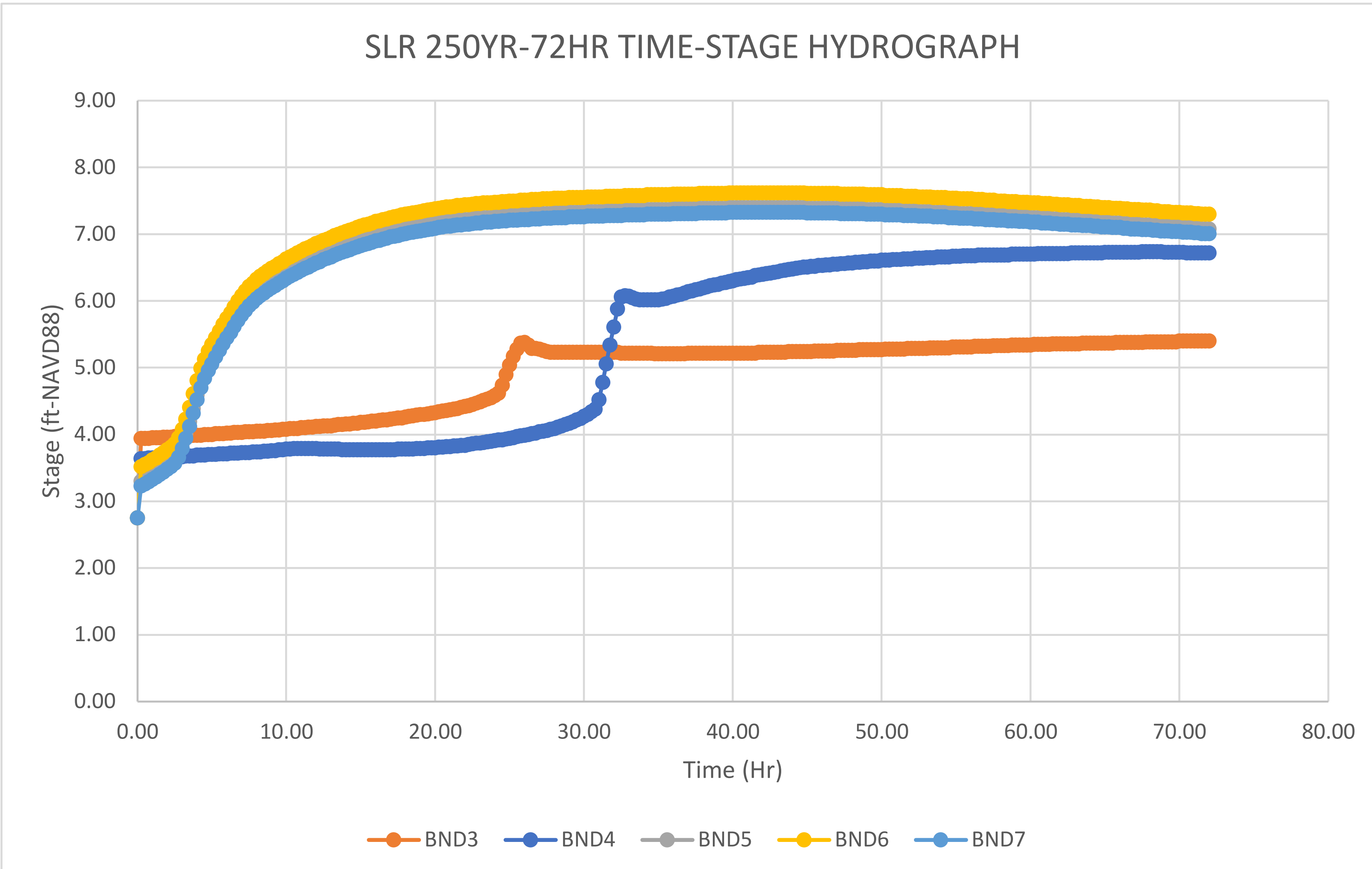
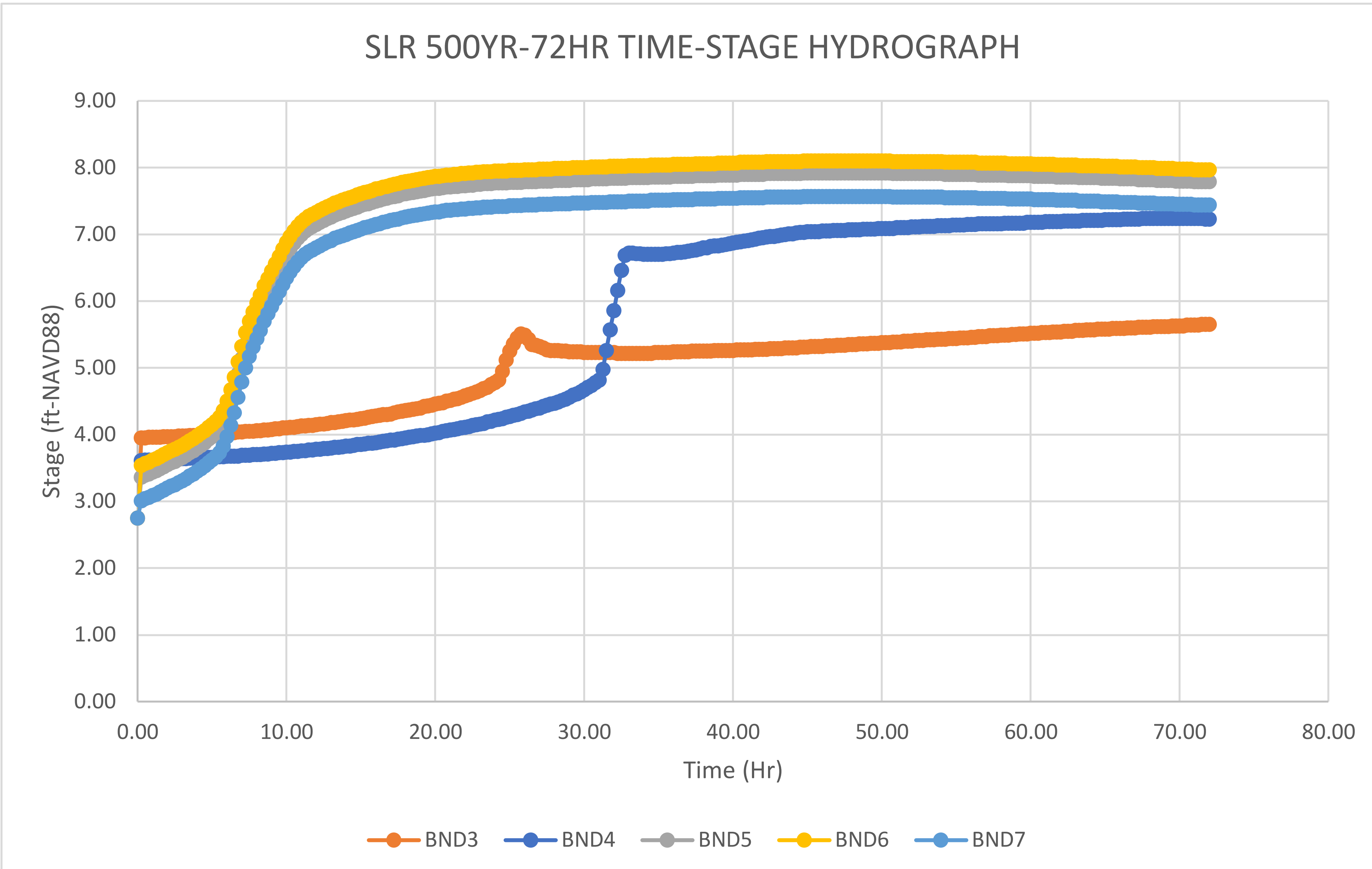
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Time (Hr)
BND3
BND4
BND5
BND6
BND7


SLR 250YR-72HR TIME-STAGE HYDROGRAPH
Stage (ft-NAVD88)
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Time (Hr)
BND3
BND4
BND5
BND6
BND7


SLR 500YR-72HR TIME-STAGE HYDROGRAPH
Stage (ft-NAVD88)
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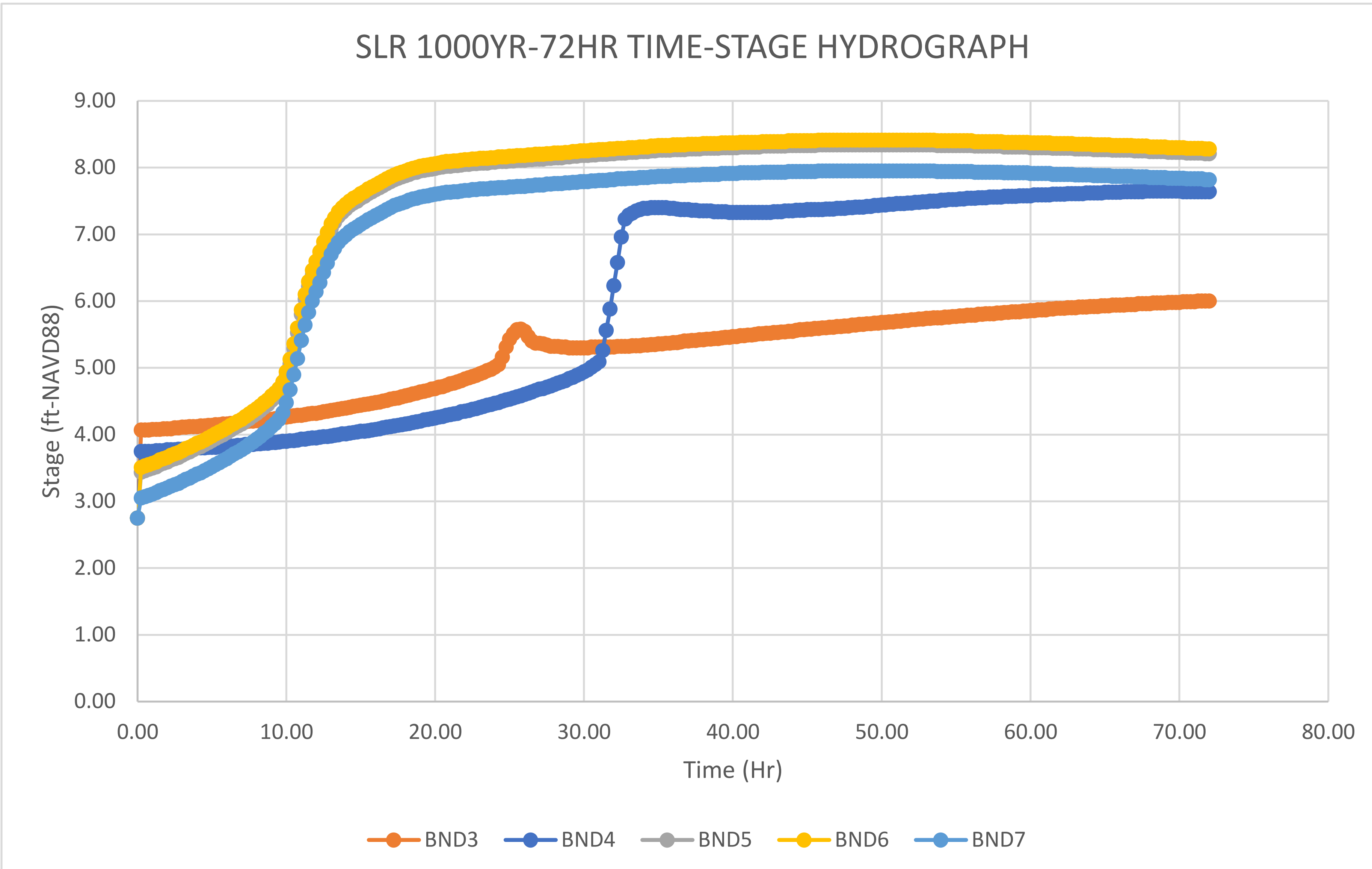
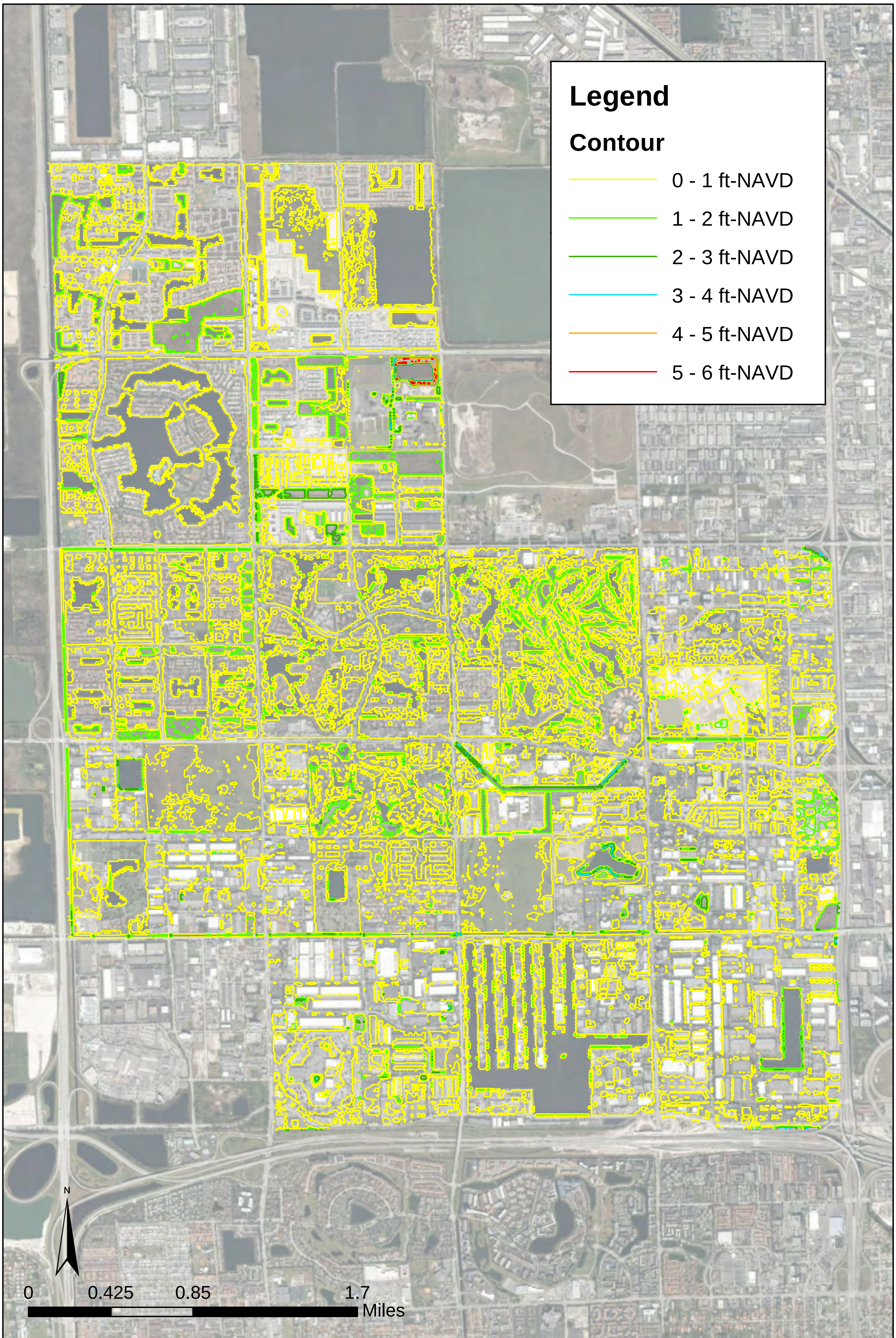
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Time (Hr)
BND3
BND4
BND5
BND6
BND7


SLR 1000YR-72HR TIME-STAGE HYDROGRAPH
Stage (ft-NAVD88)
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Time (Hr)
BND3
BND4
BND5
BND6
BND7

APPENDIX P. SEA LEVEL RISE EVENT INUNDATION FLOOD MAPS



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City of Doral Stormwater Management Master Plan
Design Storm Inundation Flood Map
with Sea Level Rise
5 years - 24 hour

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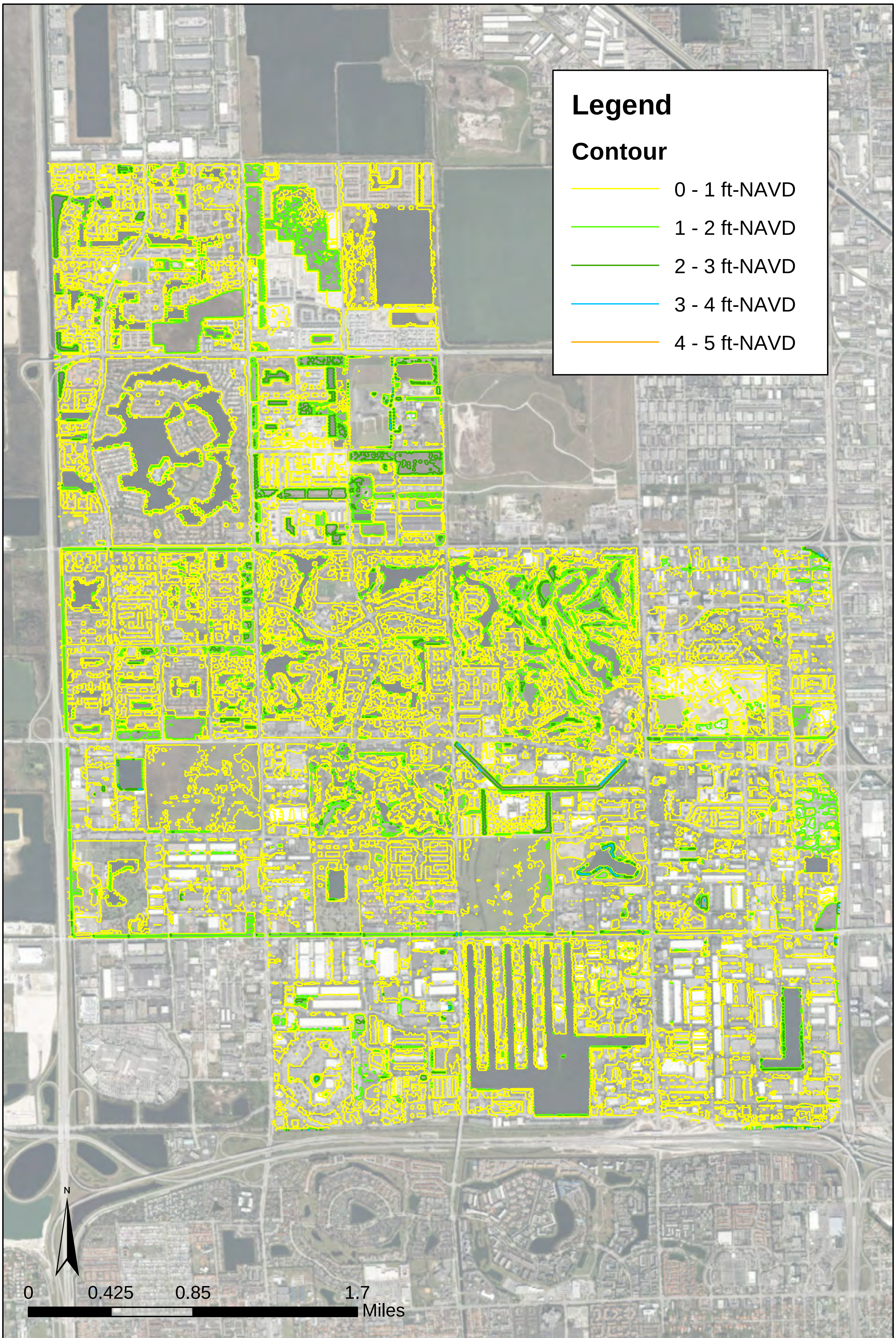

CITY OF DORAL
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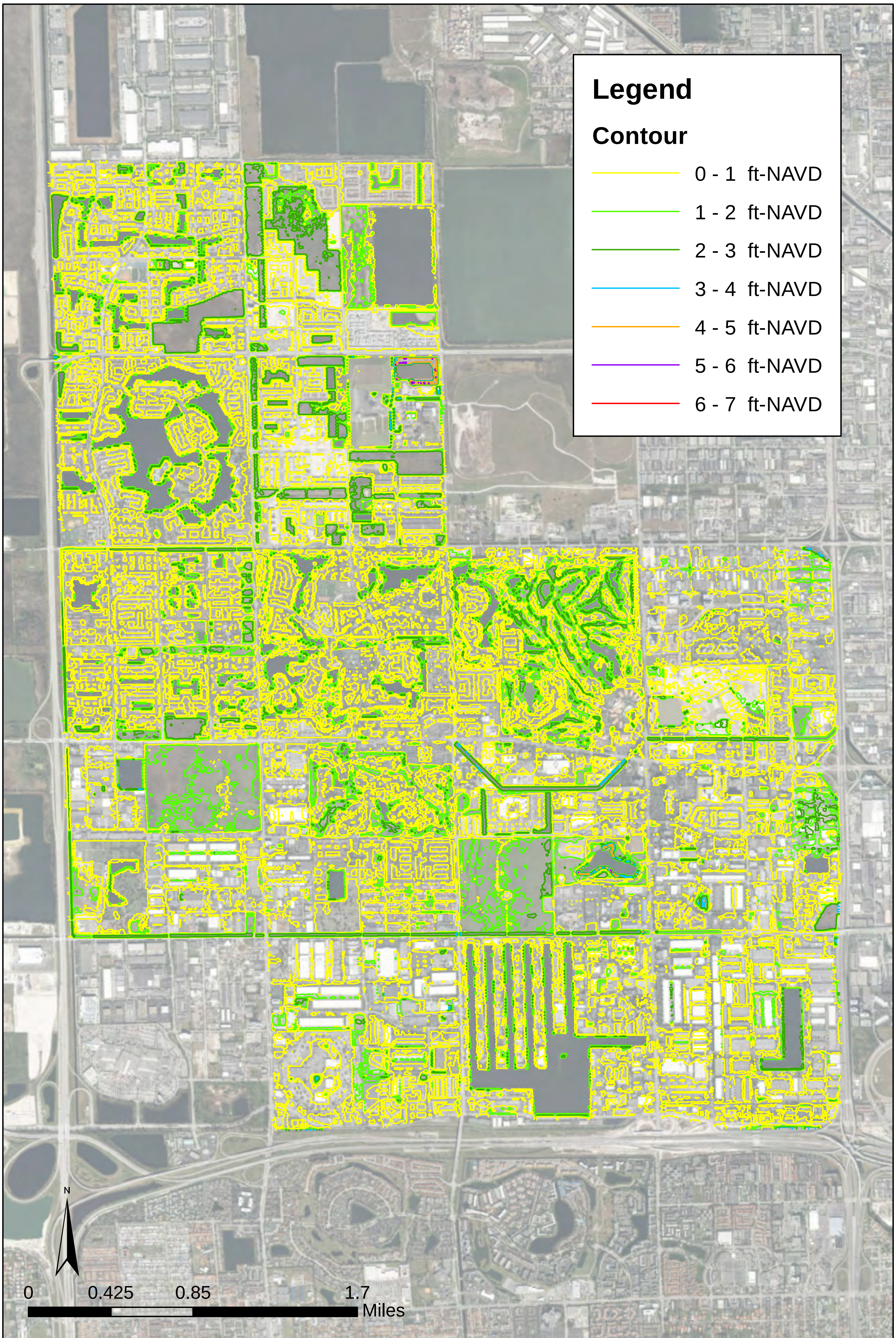
City of Doral Stormwater Management Master Plan
Design Storm Inundation Flood Map
with Sea Level Rise
10 years - 24 hour

bc engineering



CITY OF DORAL
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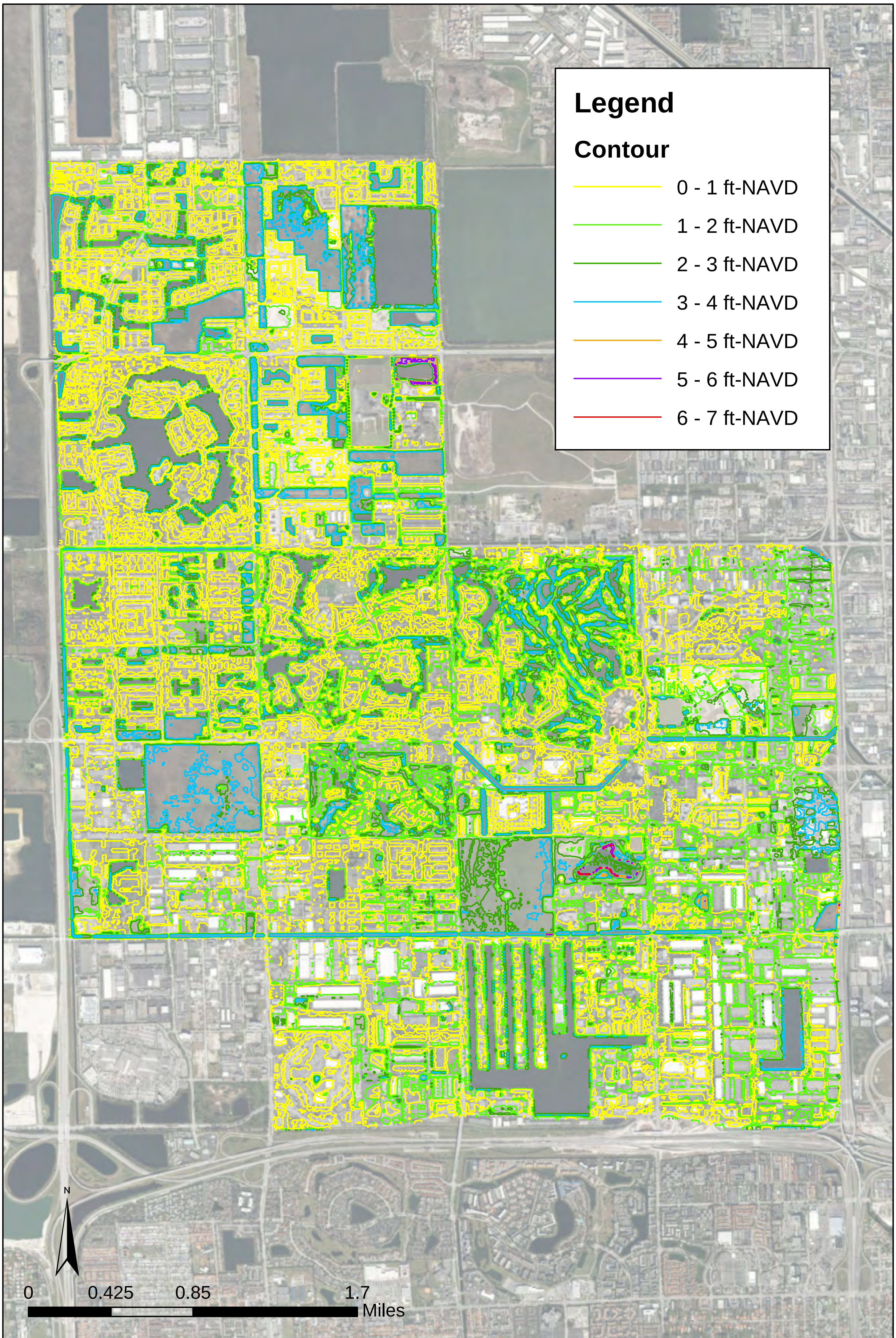
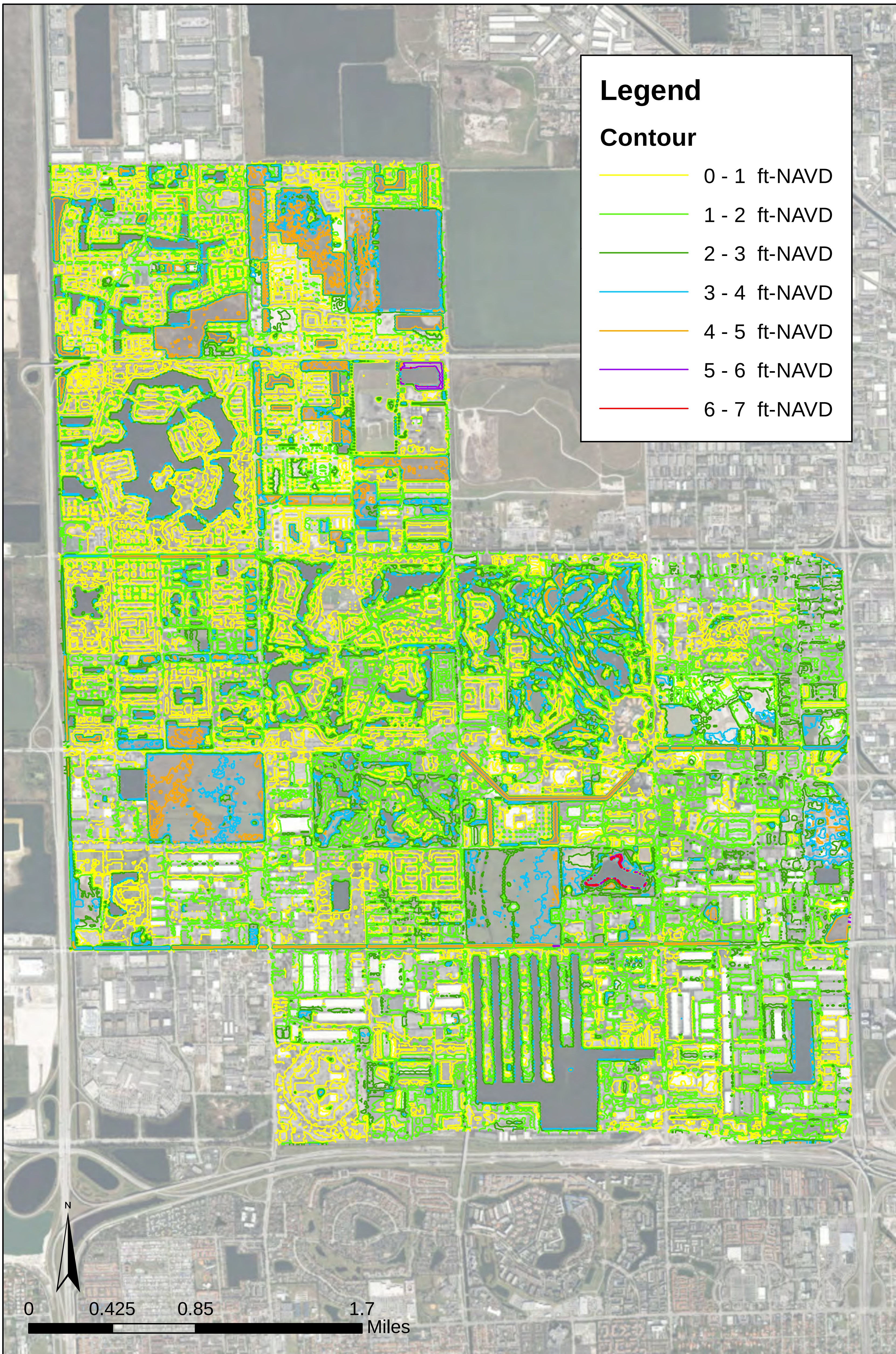
City of Doral Stormwater Management Master Plan
Design Storm Inundation Flood Map
with Sea Level Rise
25 years - 72 hour

bc engineering



City of Doral Stormwater Management Master Plan
Design Storm Inundation Flood Map
with Sea Level Rise
100 years - 72 hour



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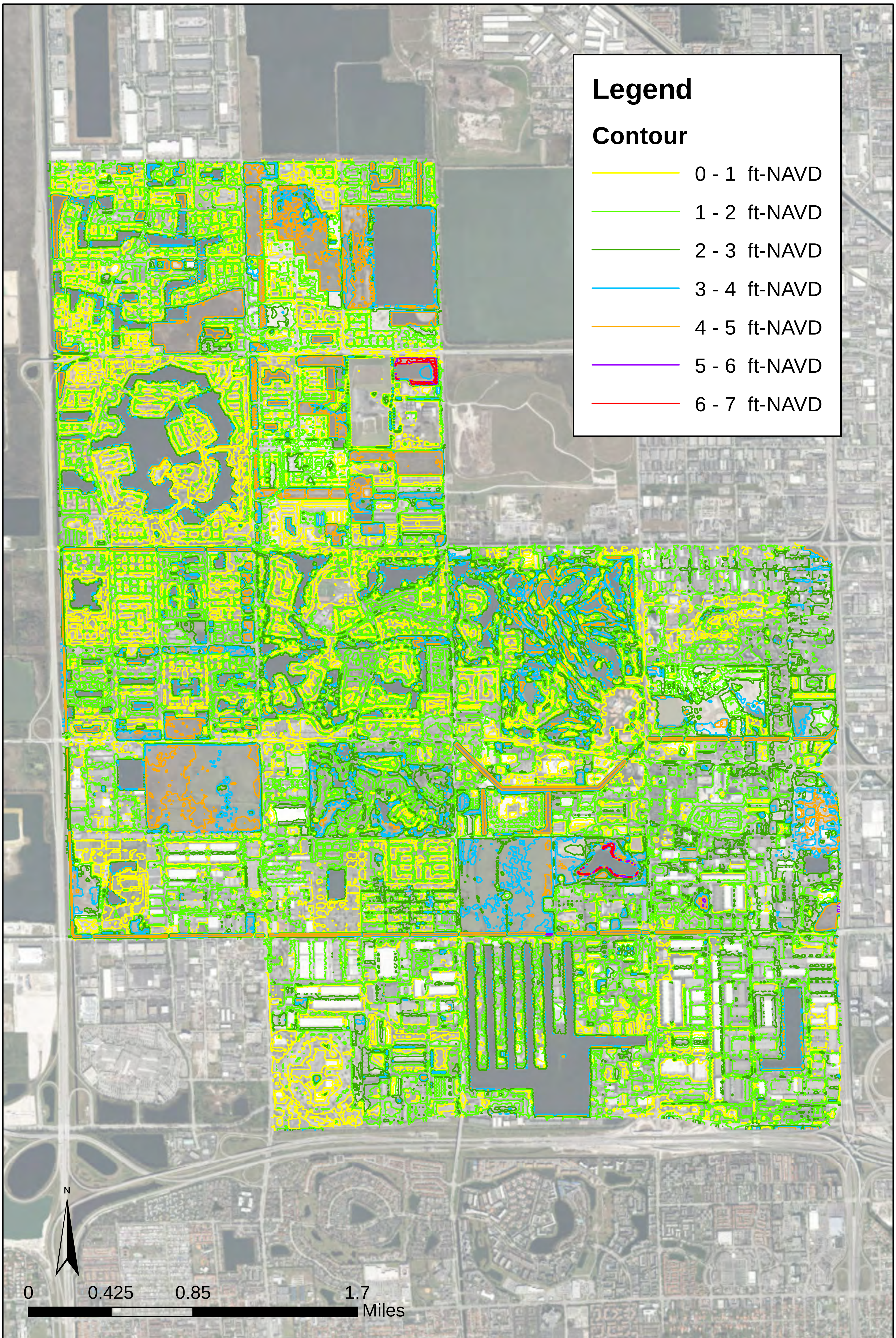
City of Doral Stormwater Management Master Plan
Design Storm Inundation Flood Map
with Sea Level Rise
250 years - 72 hour

bc engineering



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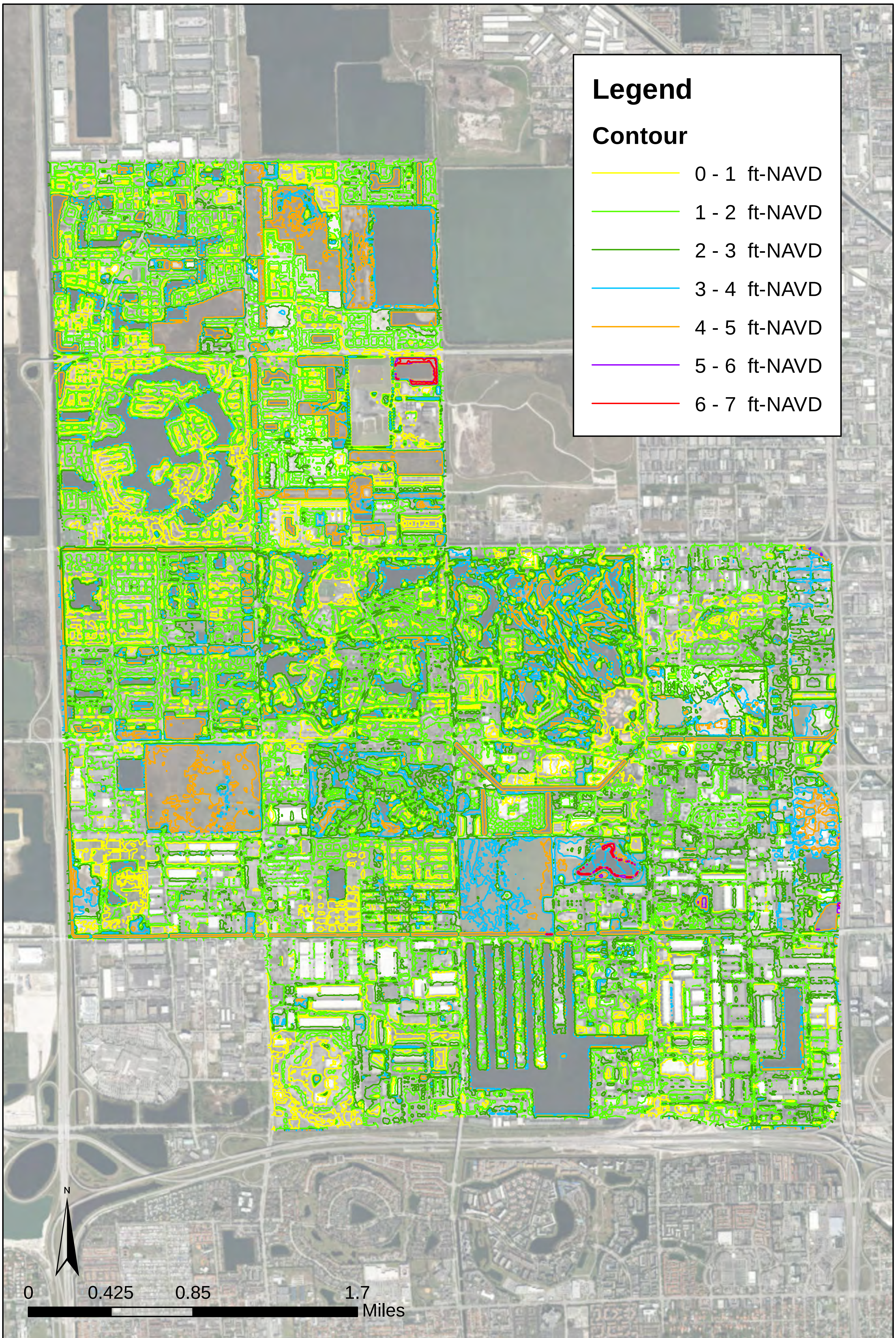
City of Doral Stormwater Management Master Plan
Design Storm Inundation Flood Map
with Sea Level Rise
500 years - 72 hour

bc engineering



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City of Doral Stormwater Management Master Plan
Design Storm Inundation Flood Map
with Sea Level Rise
1000 years - 72 hour

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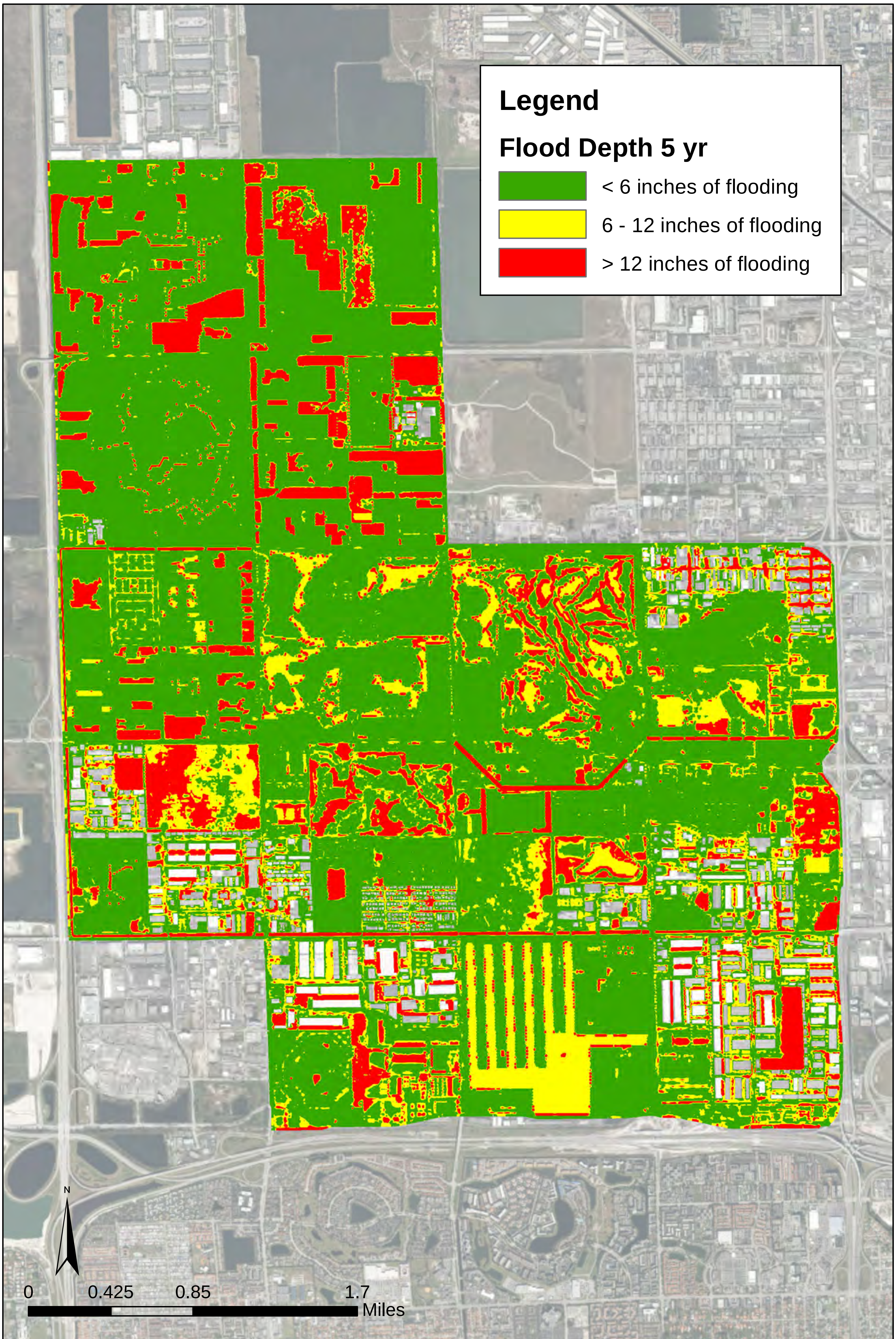
APPENDIX Q. SEA LEVEL RISE EVENT SEVERITY OF FLOODING FOR 5-, 10-, AND 100-YEAR



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City of Doral Stormwater Management Master Plan
5 years - 24 hour Sea Level Rise Event Severity of Flooding
Attachment D

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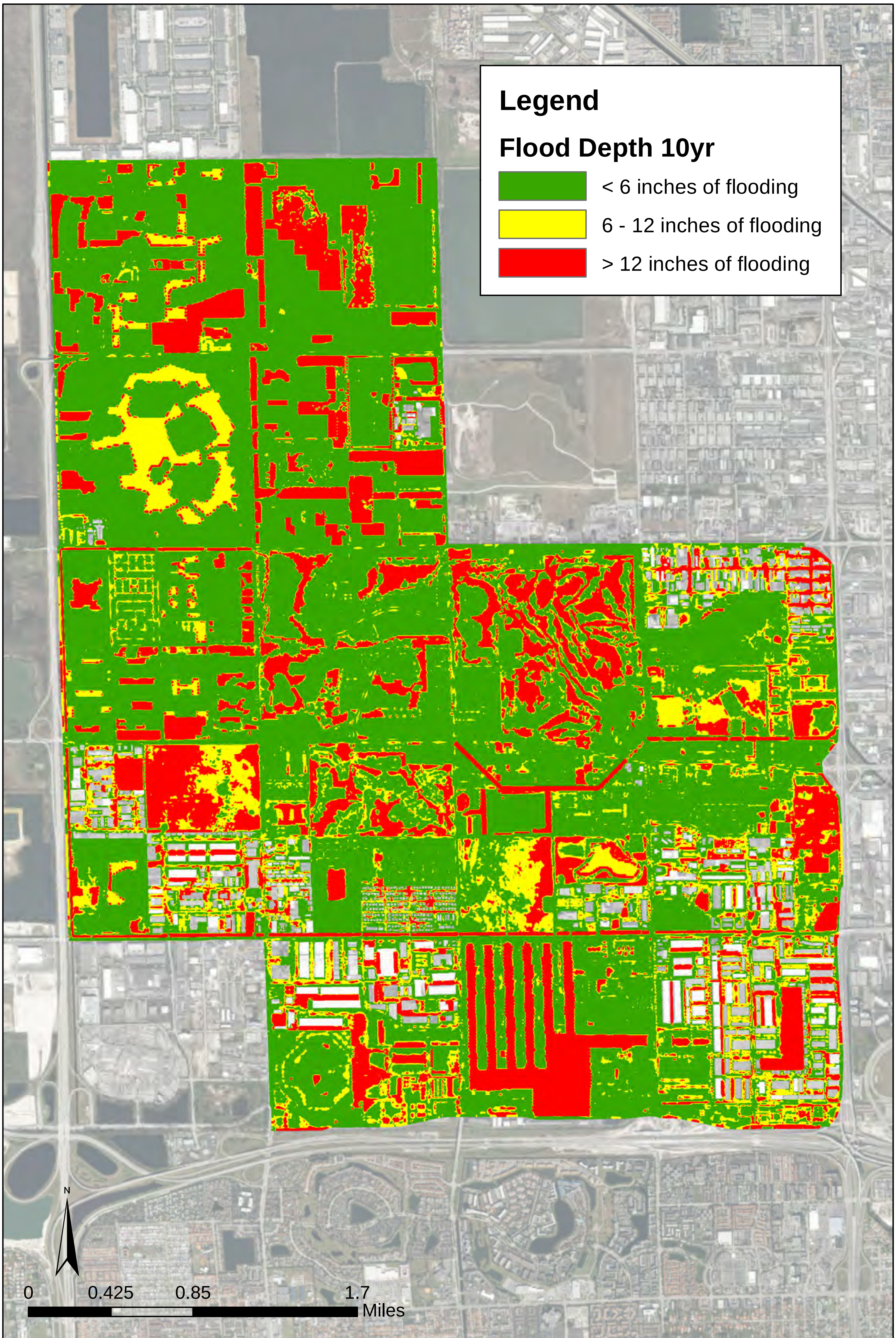
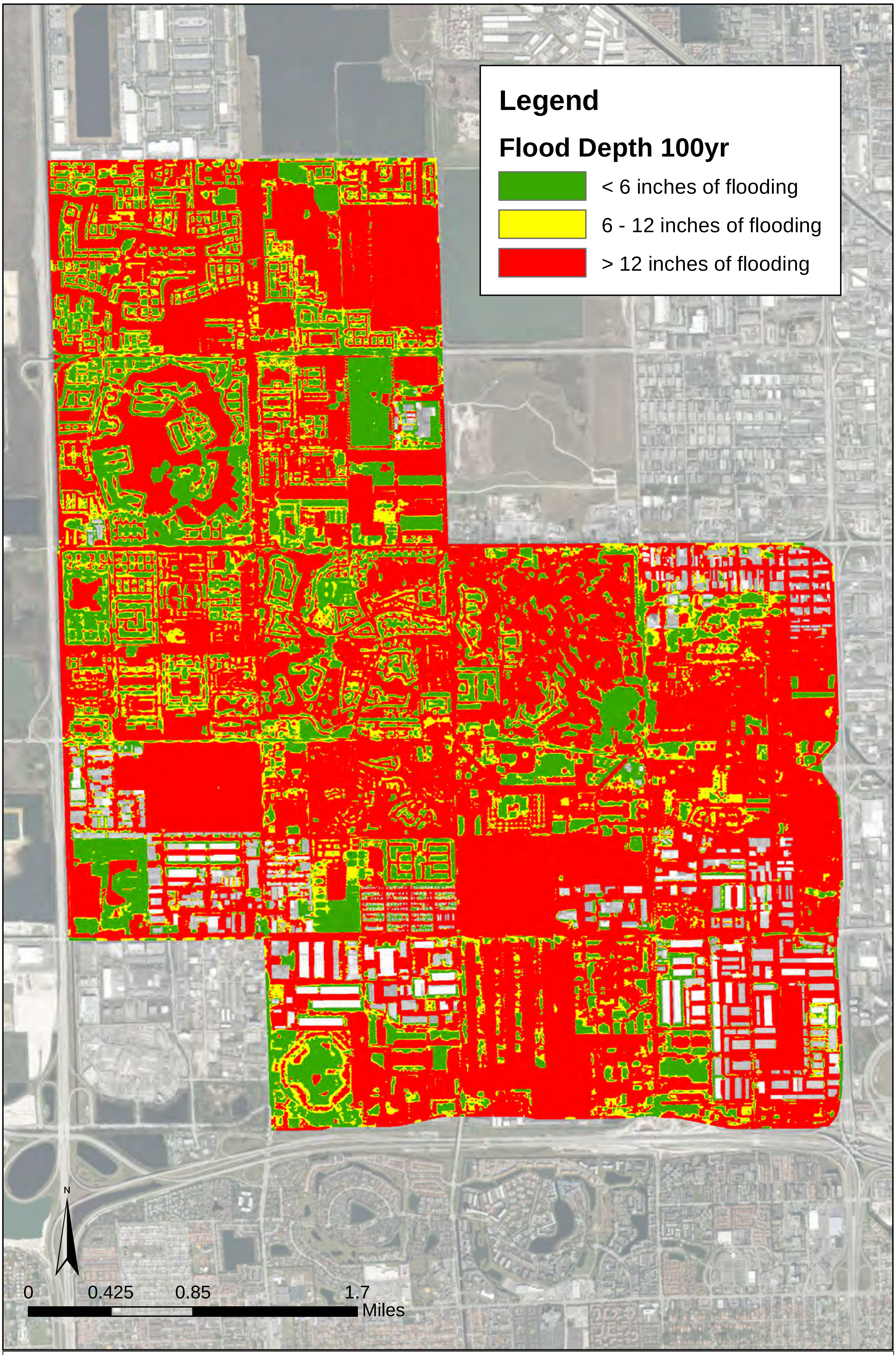


City of Doral Stormwater Management Master Plan
10 years - 24 hour Sea Level Rise Event Severity of Flooding
Attachment D



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City of Doral Stormwater Management Master Plan
100 years - 72 hour Sea Level Rise Event Severity of Flooding
Attachment D

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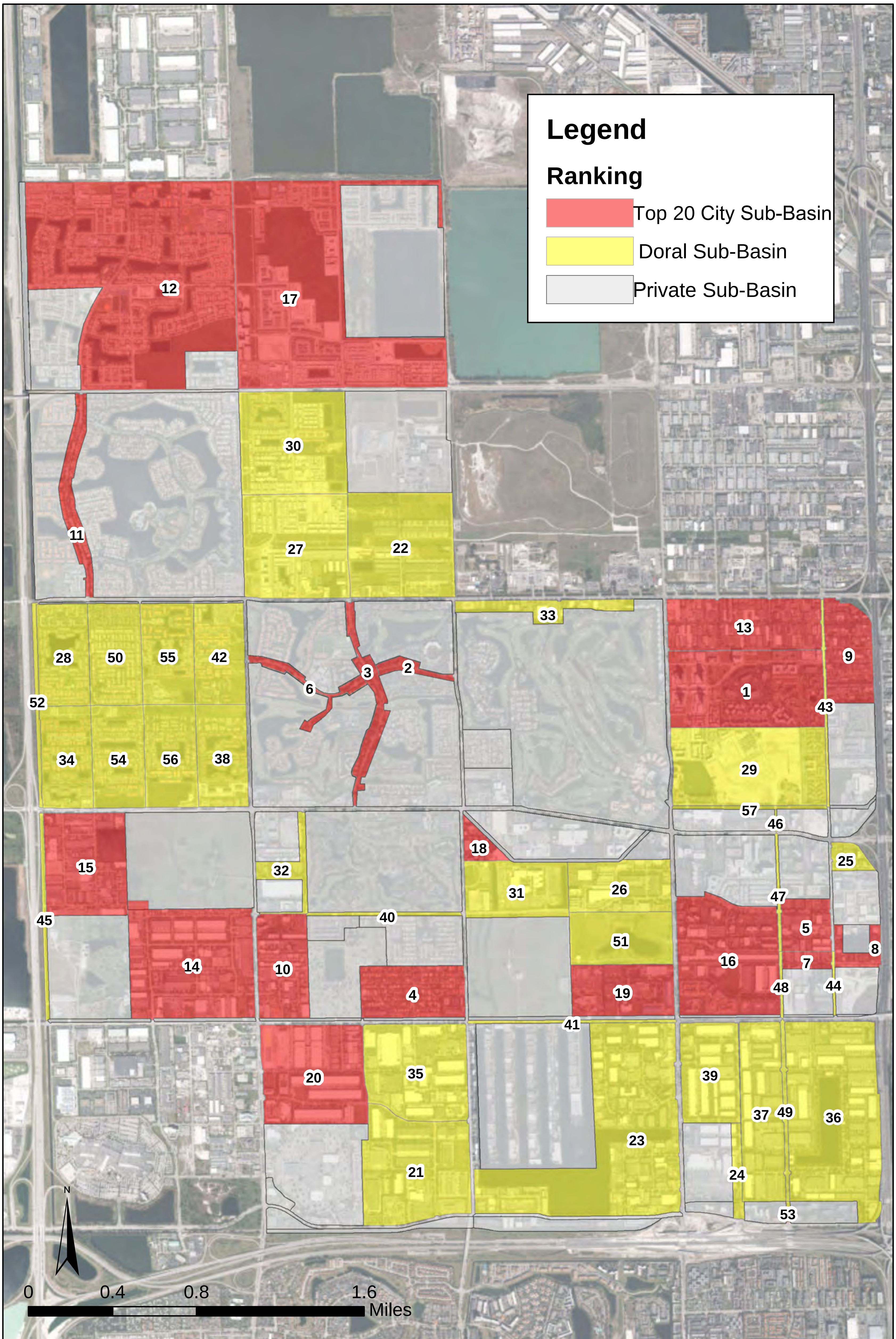
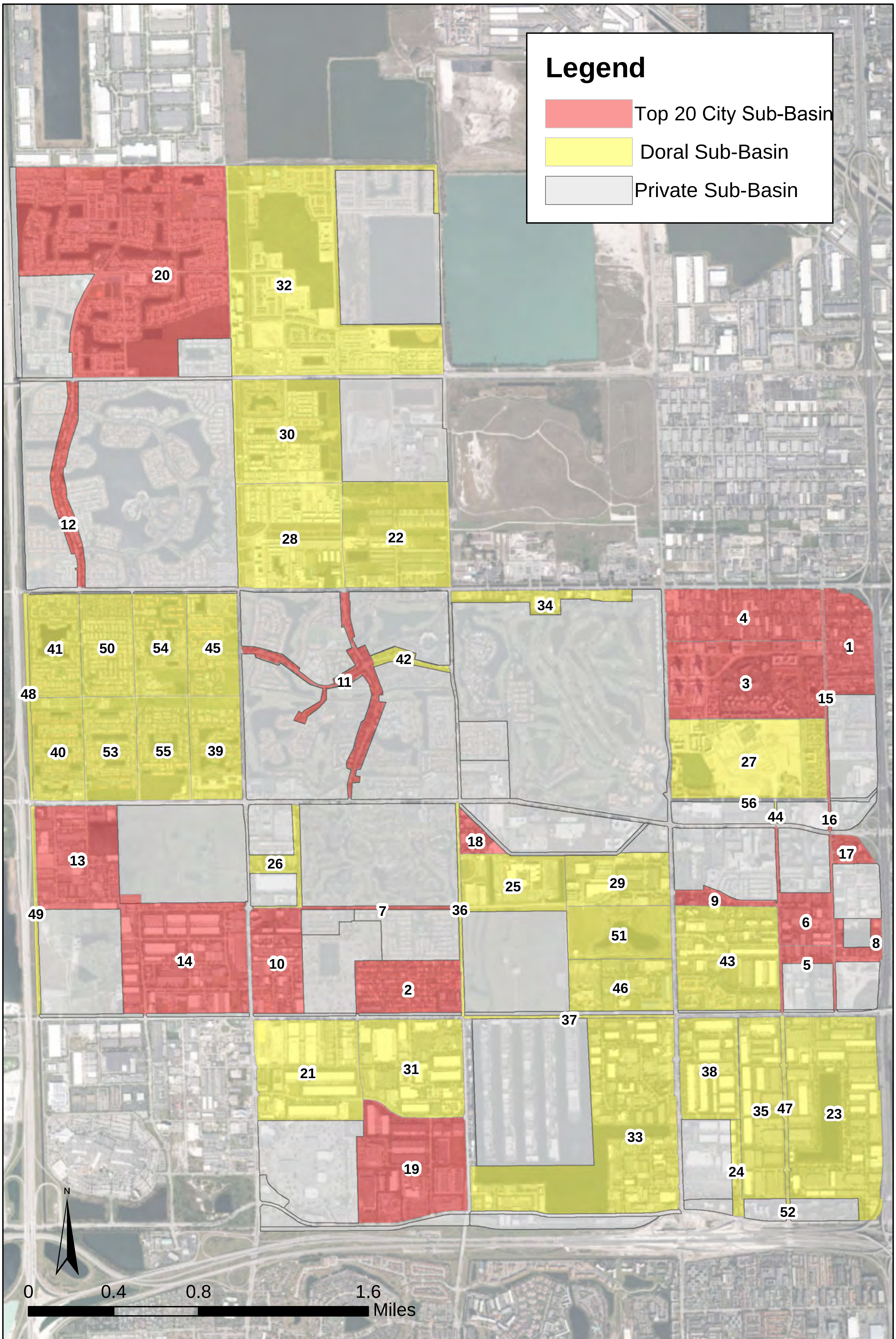
APPENDIX R. SEA LEVEL RISE EVENT RANKING TABLE AND MAP

Sub-Basin	Sub-Basin Area (Acres)	FPSS	RANK	NEW WEIGHTED FPSS	Rank SLR	% Increase from existing	Existing Rank
H-7	172.13	33581.49	1	195.098	1	200%	1
NW 52ST E	10.45	787.26	22	75.328	2	125%	
NW 102AVE	34.18	2386.05	6	69.805	3	79%	3
F-1	78.08	4062.46	4	52.028	4	15%	2
D-4-2	45.53	1824.34	10	40.072	5	72%	6
NW 52 ST W	16.69	561.25	24	33.628	6	97%	9
D-1-1	17.97	536.27	25	29.838	7	16%	7
H-8	67.88	2020.74	9	29.770	8	26%	8
F-5	76.91	2224.82	8	28.926	9	85%	10
NW-114AVE	37.79	1077.38	17	28.511	10	144%	11
N-1-1	154.62	4318.03	3	27.927	11	349%	33
L-4	34.21	890.61	20	26.034	12	109%	31
K-8	19.94	470.43	28	23.587	13	657%	51
L-2	43.88	1011.57	18	23.052	14	124%	29
O-1	347.34	7846.05	2	22.589	15	196%	21
D-3-1	20.50	401.53	30	19.591	16	2%	5
L-1	96.48	1416.97	14	14.687	17	115%	23
K-7	21.06	306.80	33	14.570	18	357%	49
H-8-1	116.44	1688.18	12	14.498	19	46%	12
G-1	199.44	2287.32	7	11.469	20	48%	14
G-4	121.64	1320.96	16	10.860	21	22%	13
D-5	167.89	1811.58	11	10.790	22	51%	15
E-7	16.00	163.04	37	10.188	23	79%	19
E-1	76.37	713.30	23	9.340	24	53%	16
C-7	149.19	1375.76	15	9.222	25	89%	22
C-5	159.98	1458.79	13	9.119	26	68%	20
K-1	22.95	193.40	35	8.428	27	187%	47
H-6	120.37	1000.65	19	8.313	28	75%	28
B-2	317.01	2405.03	5	7.587	29	108%	24
A-3-3	14.11	103.76	39	7.352	30	108%	25
D-2-1	14.07	93.11	40	6.617	31	9%	17
E-3	76.69	501.72	27	6.542	32	135%	30
E-4-1	84.10	445.73	29	5.300	33	51%	26
K-2	16.81	84.64	41	5.035	34	179%	70
F-7-1	22.32	112.07	38	5.020	35	49%	27
I-2	34.52	168.27	36	4.874	36	133%	35
C-6	138.00	509.38	26	3.691	37	45%	32

Sub-Basin	Sub-Basin Area (Acres)	FPSS	RANK	NEW WEIGHTED FPSS	Rank SLR	% Increase from existing	Existing Rank
A-2	245.46	816.35	21	3.326	38	56%	34
A-4	111.07	314.66	32	2.833	39	41%	36
A-6	85.69	196.85	34	2.297	40	109%	42
NW 33 St	8.36	16.01	48	1.915	41	78%	43
E-25ST	9.50	14.80	50	1.558	42	41%	41
K-6	25.85	20.50	42	0.793	43	149%	81
H-79AVE-N	8.59	5.48	71	0.638	44	12%	59
G-SCC-1	12.28	6.52	66	0.531	45	303%	80
H-82AVE	0.67	0.33	84	0.500	46	-1%	64
H-79AVE-S	1.30	0.49	83	0.374	47	-6%	71
A-82AVE-N	11.29	3.40	75	0.301	48	2%	75
K-SCC-2	12.67	3.09	76	0.244	49	-1%	79
E-2	78.61	12.71	55	0.162	50	88%	82
A-82AVE-S	1.17	0.18	85	0.155	51	-43%	78
K-5	24.77	2.41	78	0.097	52	3%	83
K-4	22.49	2.18	79	0.097	53	-5%	84
K-3	22.39	2.11	80	0.094	54	4%	85
H-DRC-2	8.01	0.05	86	0.007	55	0%	86



City of Doral Stormwater Management Master Plan
Doral Top 20 Sub-Basin Ranking
Sea Level Rise Conditions



City of Doral Stormwater Management Master Plan
Doral Top 20 Sub-Basin Ranking
Combined

APPENDIX S. RER MEETING MINUTES

bcc engineering

Meeting Minutes

Project: Doral 2020 SWMP Update Coordination Meeting with RER

Date: 10/26/2020 at 2:00 pm via Teams

Attendees:

Name	Organization	Email
Stephanie Bortz, CFM	City of Doral	stephanie.bortz@cityofdoral.com
Alex Vazquez, PE, CFM	BCC Engineering, LLC.	avazquez@bcceng.com
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Alberto Pisani	RER	alberto.pisani@miamidade.gov
Amy Cook	RER	amy.cook@miamidade.gov
Elius Nortelus	RER	elius.nortelus@miamidade.gov
Carlos Calvache	RER	carlos.calvache@miamidade.gov

Discussion Notes:

The purpose of this meeting was to update the Miami-Dade County Department of Regulatory and Economic Resources (RER) on the status of the NW 58th Canal outfall project, update RER on the status of the City's Stormwater Master Plan (SWMP) update, and obtain input from RER on possible stormwater improvement projects to be evaluated as part of the SWMP update. The following are the key issues discussed at the meeting.

1. **Status of the NW 58th Street Outfall Design and Permitting**
    1. Ms. Bortz discussed the prior conversations the City and RER had over the last two years regarding the proposed outfall into the NW 58th Street Canal to alleviate the flooding from the northeast end of the City. She also stated that the consultant for the City, EAC Consulting, Inc., is in the process of finalizing the 60% design, and the City plans to submit for the Class II permit sometime in November.
    2. Ms. Bortz asked if a Class III permit could be combined with the Class II permit since RER had requested to regrade the canal bank to the minimum County Flood Criteria elevation. Ms. Monlina stated that the County does not issue joint Class II/Class III permits. Each permit would have to be submitted separately. However, Ms. Molina stated that she does not think that a Class III permit would be needed if the work within the canal right-of-way is incidental to the work associated with the Class II permit improvements.

2. Status of City's Stormwater Master Plan Update

1. Ms. Bortz stated that BCC Engineering (BCC) is in the process of finalizing the City's SWMP updated. As part of the update, BCC has some questions regarding the types of stormwater improvement projects that should be evaluated. Ms. Bortz passed the meeting to Mr. Vazquez.
2. Mr. Vazquez presented the overall sub-basin ranking map based on projected future sea-level rise, groundwater rise, and increased rainfall intensity. This map is attached to the meeting minutes. This map depicts the sub-basin ranking based on the level of flooding, with the red sub-basins depicting the top 20 high priority sub-basins. The City plans to identify stormwater improvement projects for the top 20 high priority sub-basin.

3. Viable Stormwater Improvement Projects to be Considered as Part of the SFWMP Update

1. Mr. Vazquez stated that high priority sub-basins 1, 3, 4, and 16 located at the northeast end of the City would benefit from the approved outfall that will discharge to the NW 58th Street Canal. However, high priority sub-basins 10, 13, 14, and others are landlocked. Mr. Vazquez asked if outfalls from these sub-basins to the C-2 and Northline canal can be proposed and evaluated to alleviate the flooding within these sub-basins.
2. Ms. Molina stated that the County is currently evaluating potential issues with the Northline Canal capacity that may be caused by the recently constructed via-duct culvert and downstream control structures. She also stated that the County is in the process of widening NW 25th Street from NW 87th Avenue to NW 117th Avenue. The County will need to identify if this project is also going to have other adverse capacity impacts to the Northline Canal.
3. Ms. Cook stated the Northline Canal is one of the County's primary canals, and it is presumed that the canal is at the maximum capacity. She stated that the County is in the process of evaluating how much excess capacity the Northline Canal will have after the NW 25th Street project is designed. She suggested that the City identify and provide to the County how much flow and volume would be discharged by the proposed stormwater improvement projects, and the County would determine if the canal can accommodate those flows and volumes.
4. Ms. Monlina stated that the County is having a meeting the first week of November regarding the status of the NW 25th Street project. Ms. Cook would be attending this meeting, and she will provide an update to the City regarding the status, propose improvements and schedules.
5. Ms. Molina also stated that the City of Sweetwater has proposed is a stormwater pump station discharge project to the Northline Canal, and they would need to evaluate if the canal can accommodate those flows and volumes.
6. Mr. Vazquez asked if the City of Doral can also evaluate stormwater pump stations as well as gravity outfalls. Ms. Molina state that it would be considered, but it will be based on how much capacity, if any, the Northline Canal can accommodate. This will be determined after the County finishes their study. Mr. Vazquez asked how long would that study take, and Ms. Cook stated that it could be at least a year or longer.

7. Mr. Bortz asked since the City of Sweetwater is also requesting discharge to the Northline Canal, would the available capacity be distributed equally between the two cities. Ms. Molina stated that they had not contemplated the distribution of capacity, but they will evaluate how the available capacity would be distributed if there is available capacity in the Northline Canal.

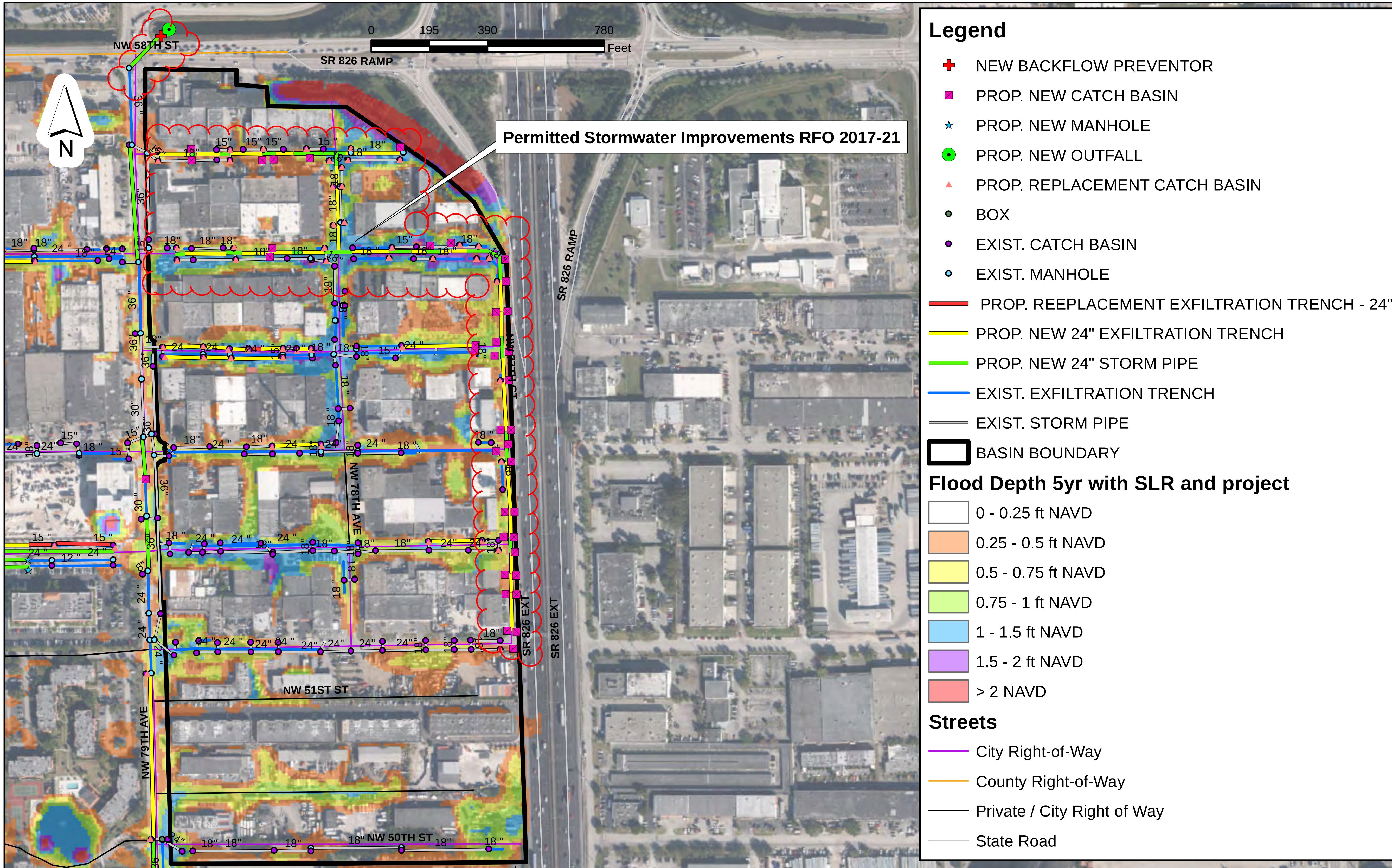
4. Misc Discussion Items

1. Ms. Bortz stated that Carlos Arroyo could not attend the meeting, but he had some questions that he wanted to direct to the County:
    a. Mr. Arroyo had past discussions with Public Works regarding culvert alignment along NW 25th Street and wanted to find out the status of that project. Ms. Molina stated that she was not aware of this project and has not seen any permits proposing any culvert alignment. She suggested the City speak with Alex Barrios from Public Works.
    b. Mr. Arroyo also wanted to know if the County is planning to perform a hydraulic analysis of the impacts of the via-duct culvert on NW 25th Street and control structures. Ms. Cook stated that there is currently no specific plan to do that analysis, but that an analysis will be performed sometime in the future.

Action Items:

1. City to submit Class II permit for the proposed outfall to the NW 58th Street canal sometime in November.
2. BCC to provide the County with proposed discharge flows and volumes to the Northline Canals from potential stormwater improvement projects as part of the SWMP update.
3. The County will provide the City with an update of the NW 25th Street improvement project after the meeting scheduled during the first week of November.

APPENDIX T. PROPOSED STORMWATER MANAGEMENT PROJECT SCHEMATICS FOR THE TOP 20 RANKED SUB-BASINS



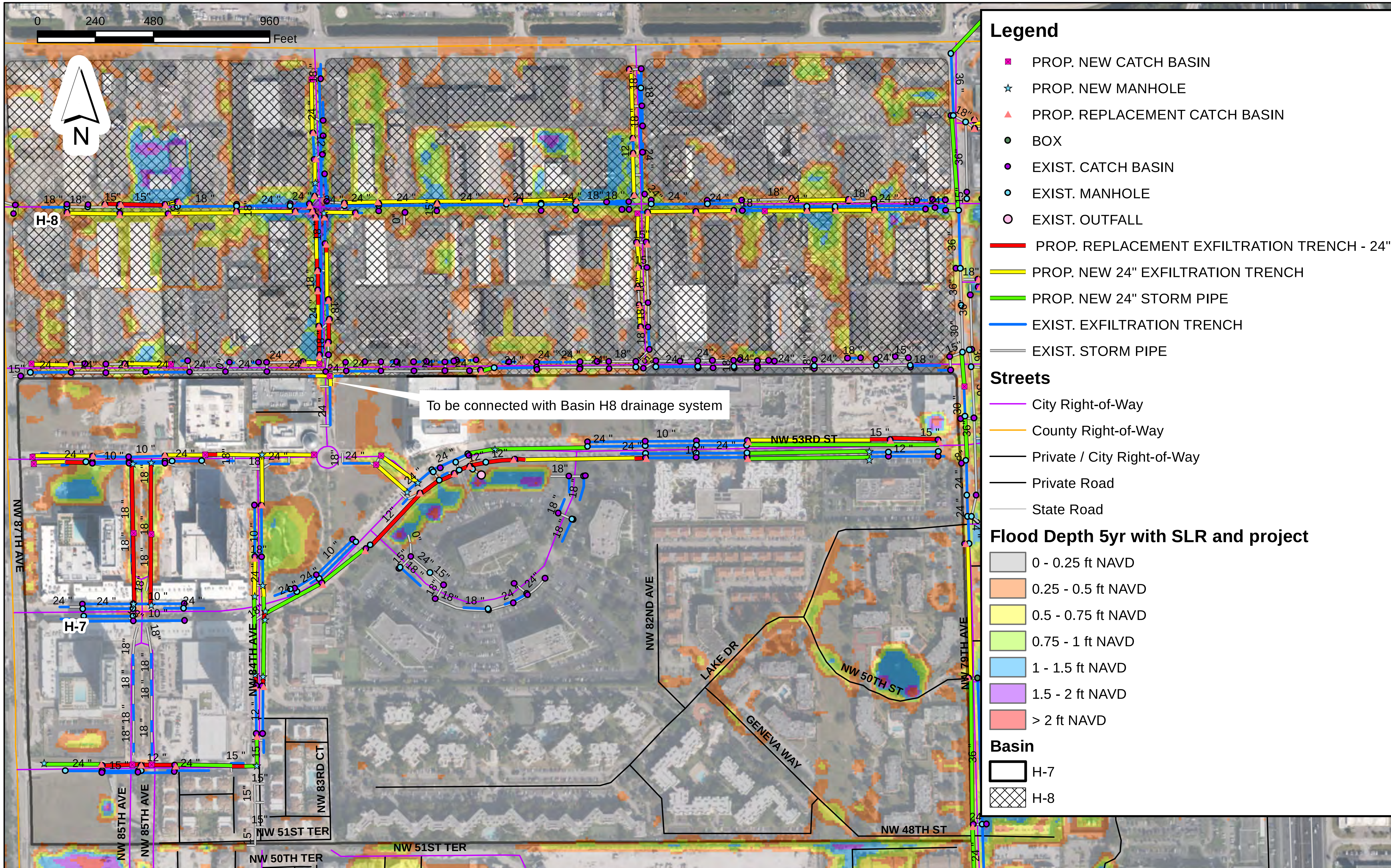
City of Doral Stormwater Management Master Plan
Proposed Stormwater Projects
Basin H5
(Basin Rank 1)
Cost Rank 7 - $645,402.70

City of Doral Stormwater Management Master Plan
Proposed Stormwater Projects
Basin F1 no PS
(Basin Ranking 2)
Cost Effectiveness Rank 11 - $2,345,582.00

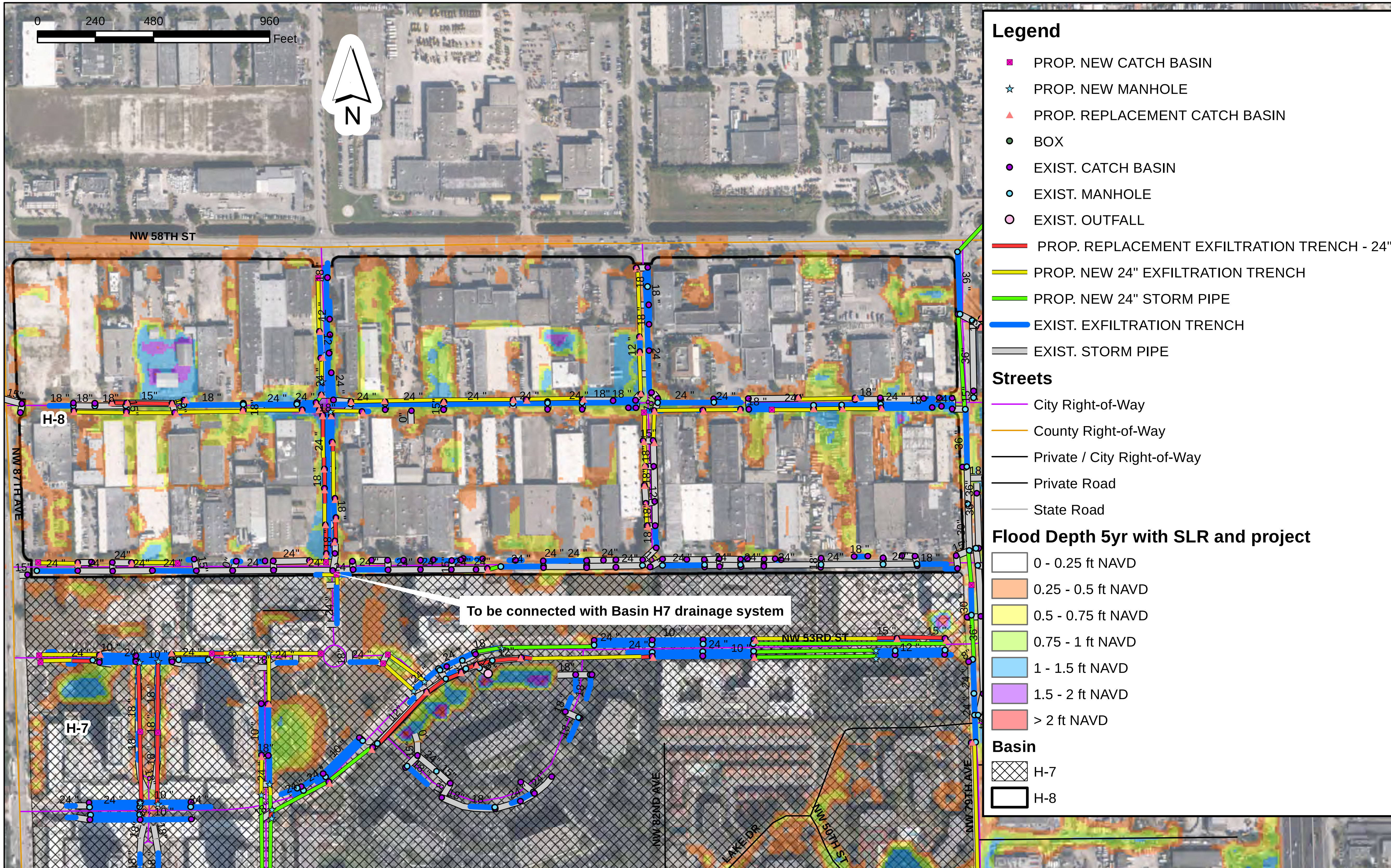
CITY OF DORAL
For all the right reasons!

bc engineering

City of Doral Stormwater Management Master Plan
Proposed Stormwater Projects
Basin F1 with PS
(Basin Rank 2)
Cost Rank - $8,225,582.00



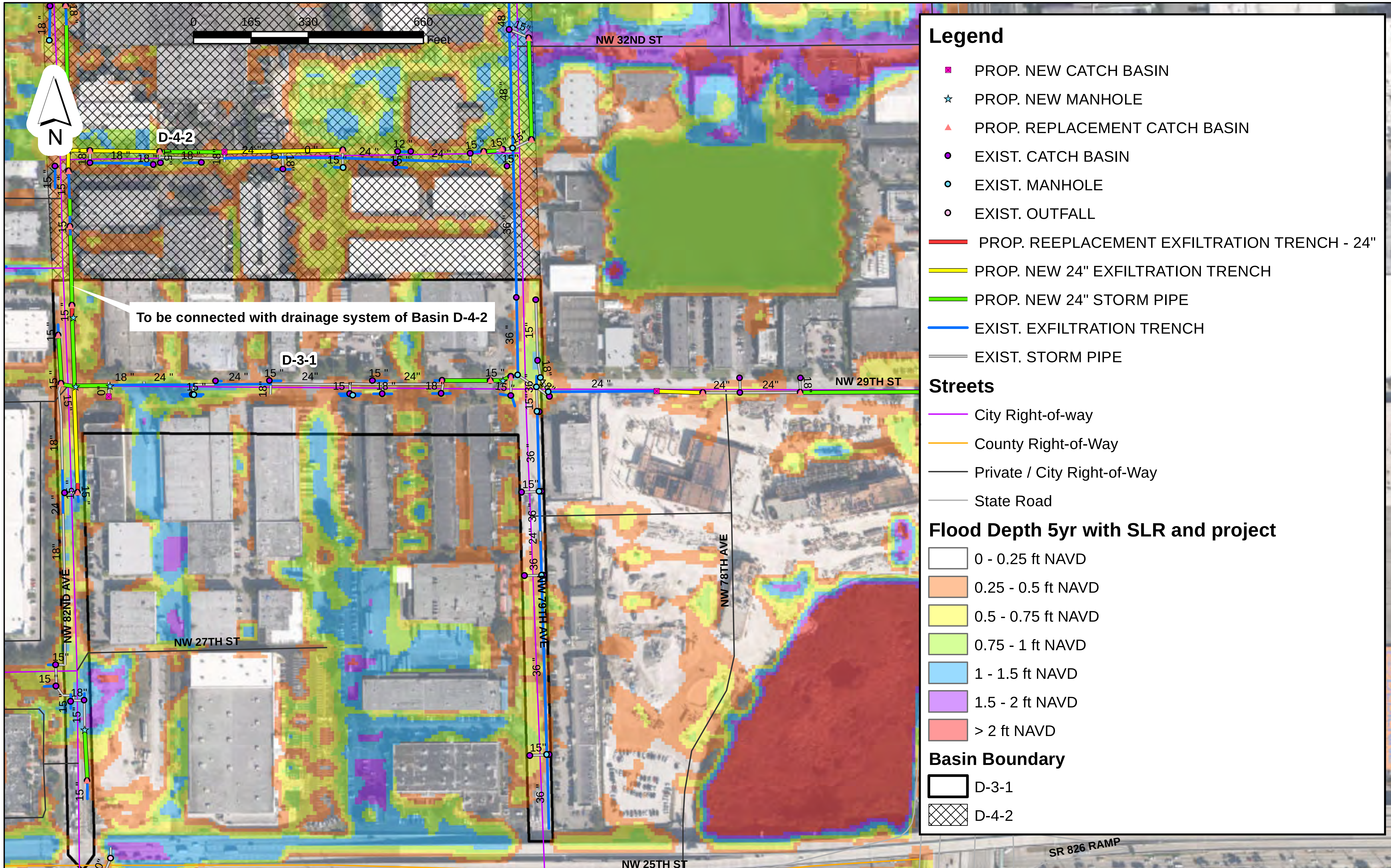
City of Doral Stormwater Management Master Plan
Proposed Stormwater Projects
Basin H7
(Basin Rank 3)
Cost Rank 18 - $2,781,300.98



CITY OF DORAL

City of Doral Stormwater Management Master Plan
Proposed Stormwater Projects
Basin H8
(Basin Rank 4)
Cost Rank 16 - $2,347,477.31

bc engineering



City of Doral Stormwater Management Master Plan
Proposed Stormwater Projects
Basin D-3-1
(Basin Rank 5)
Cost Rank 6 - $421,231.74

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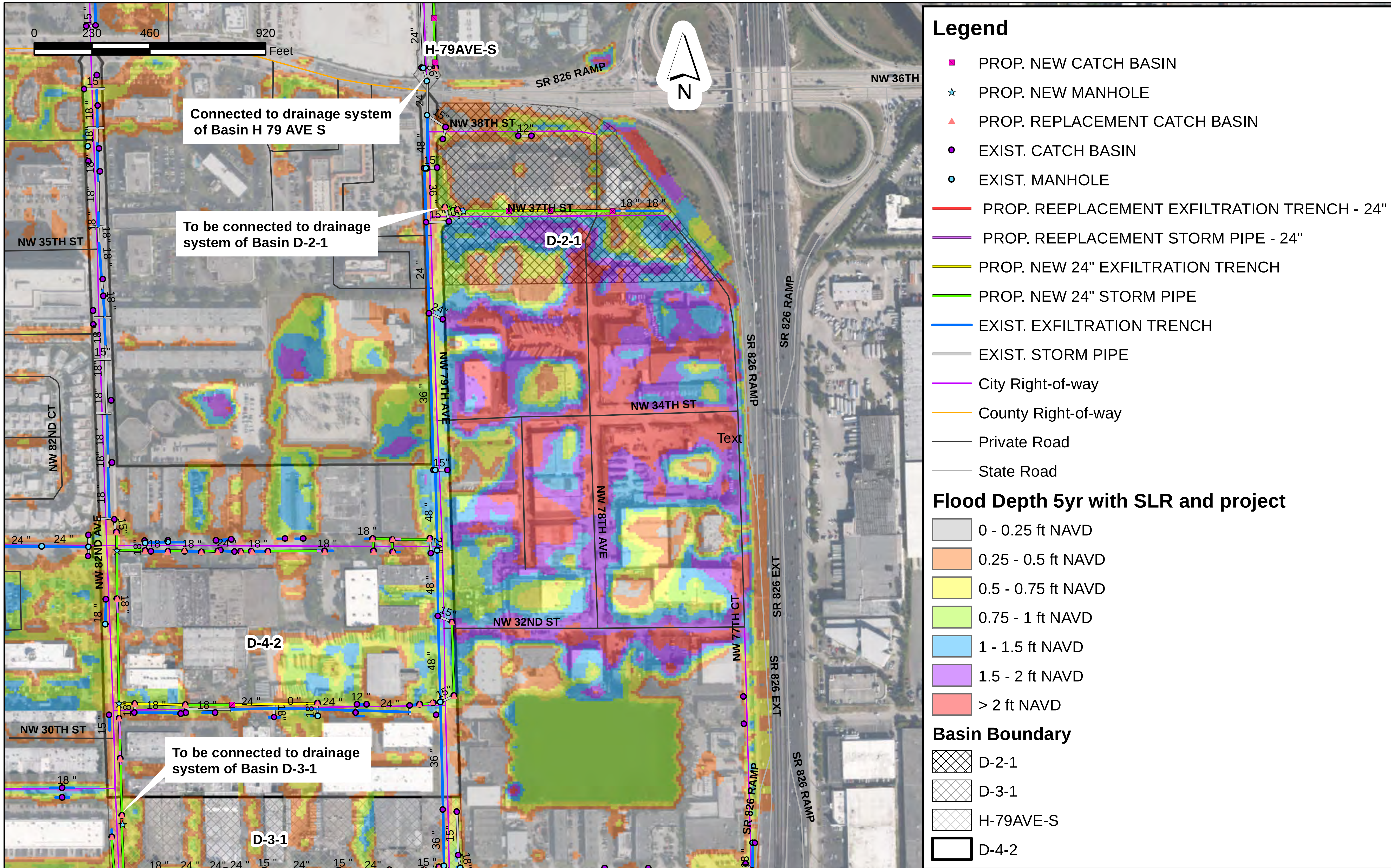

City of Doral Stormwater Management Master Plan
Proposed Stormwater Projects
Basin D-4-2
(Basin Rank 6)
Cost Rank 5 - $937,994.33

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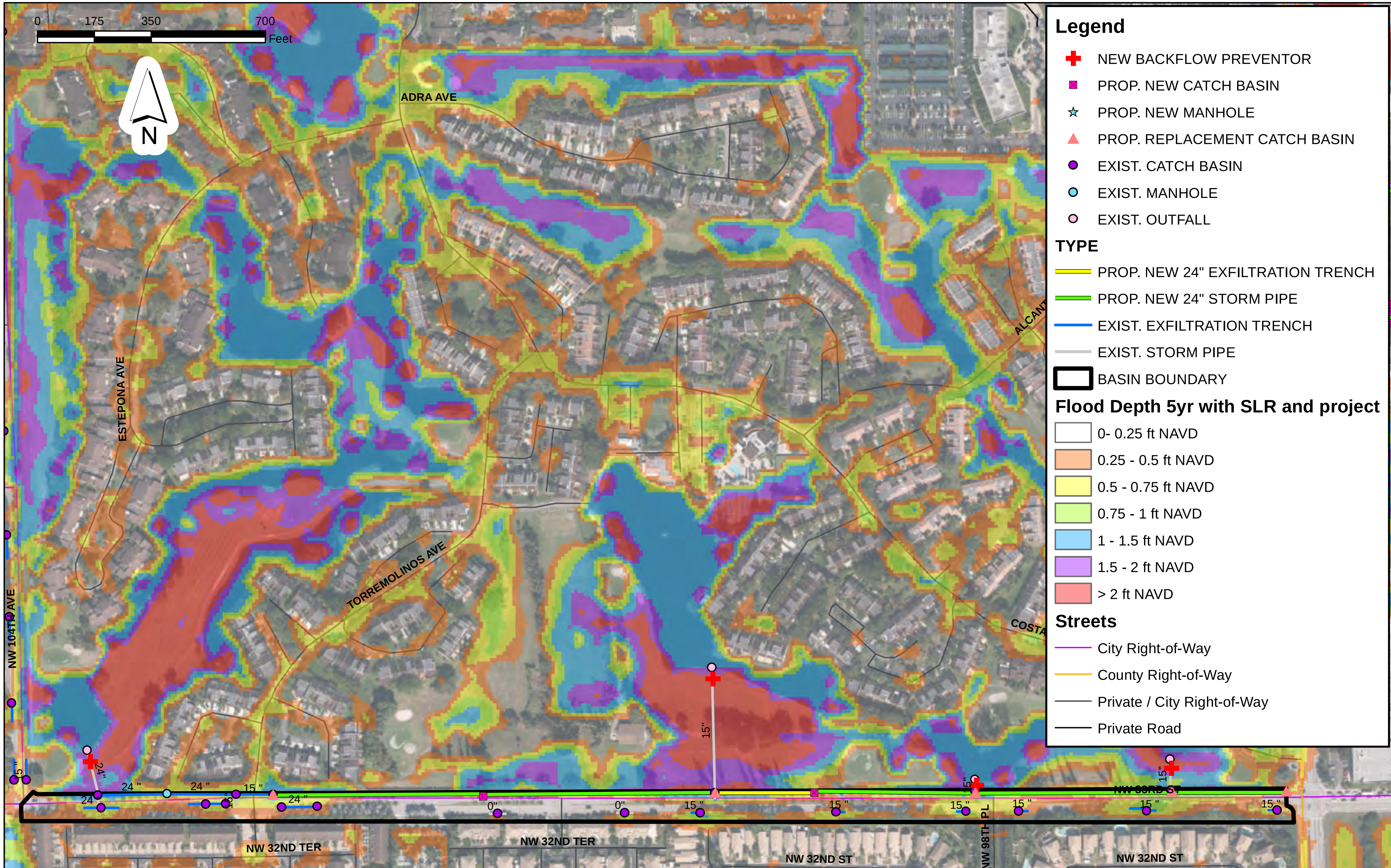
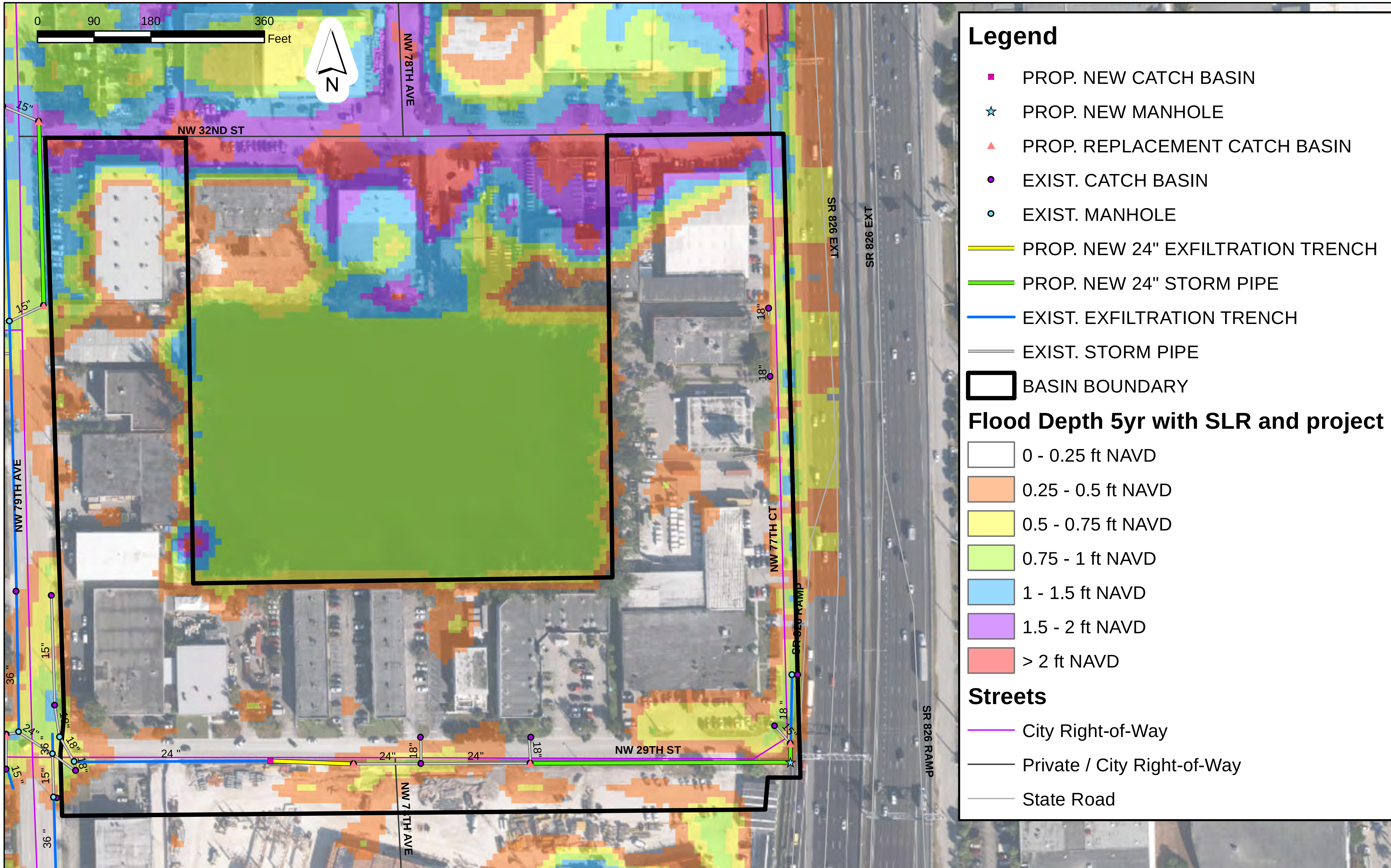
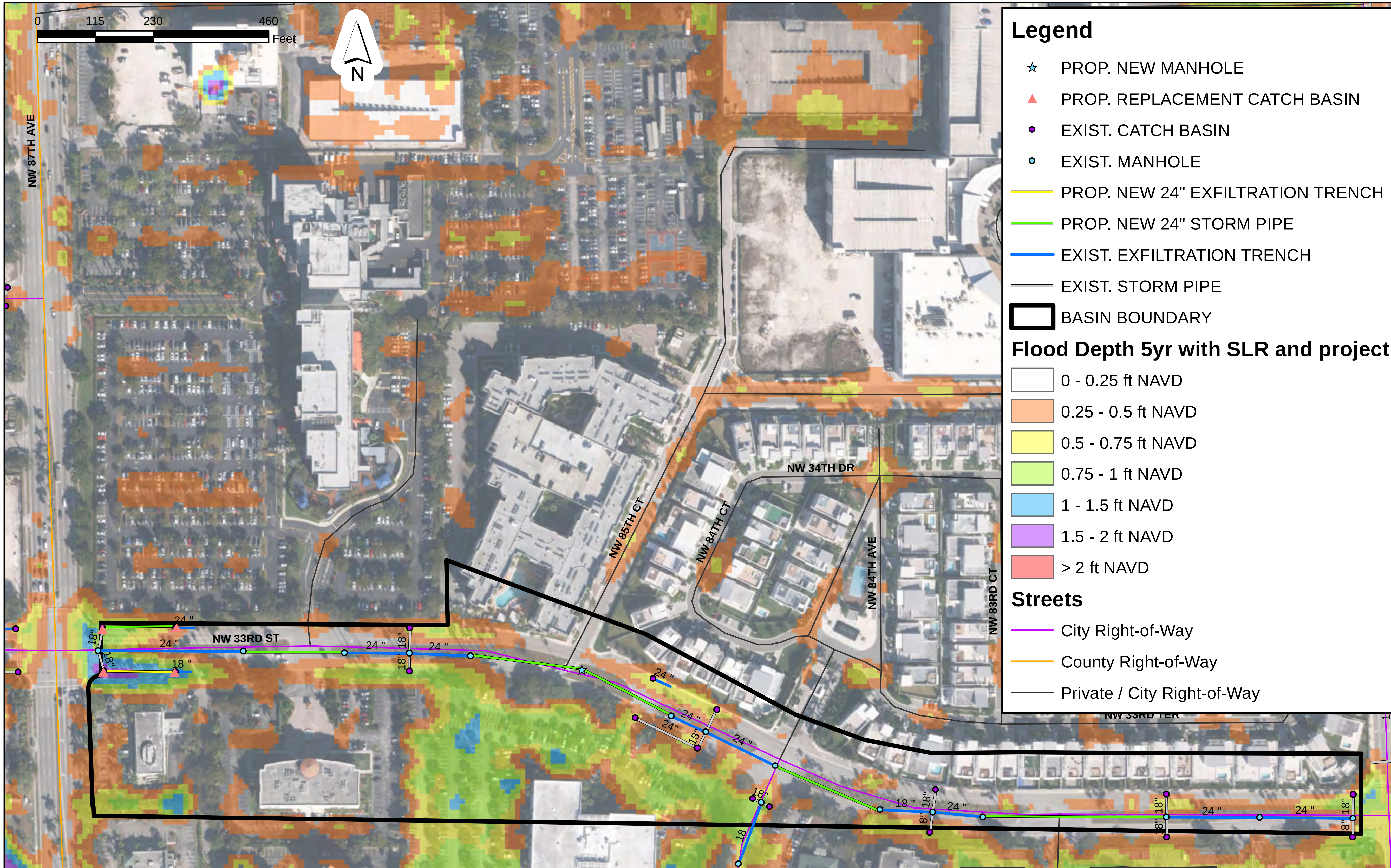


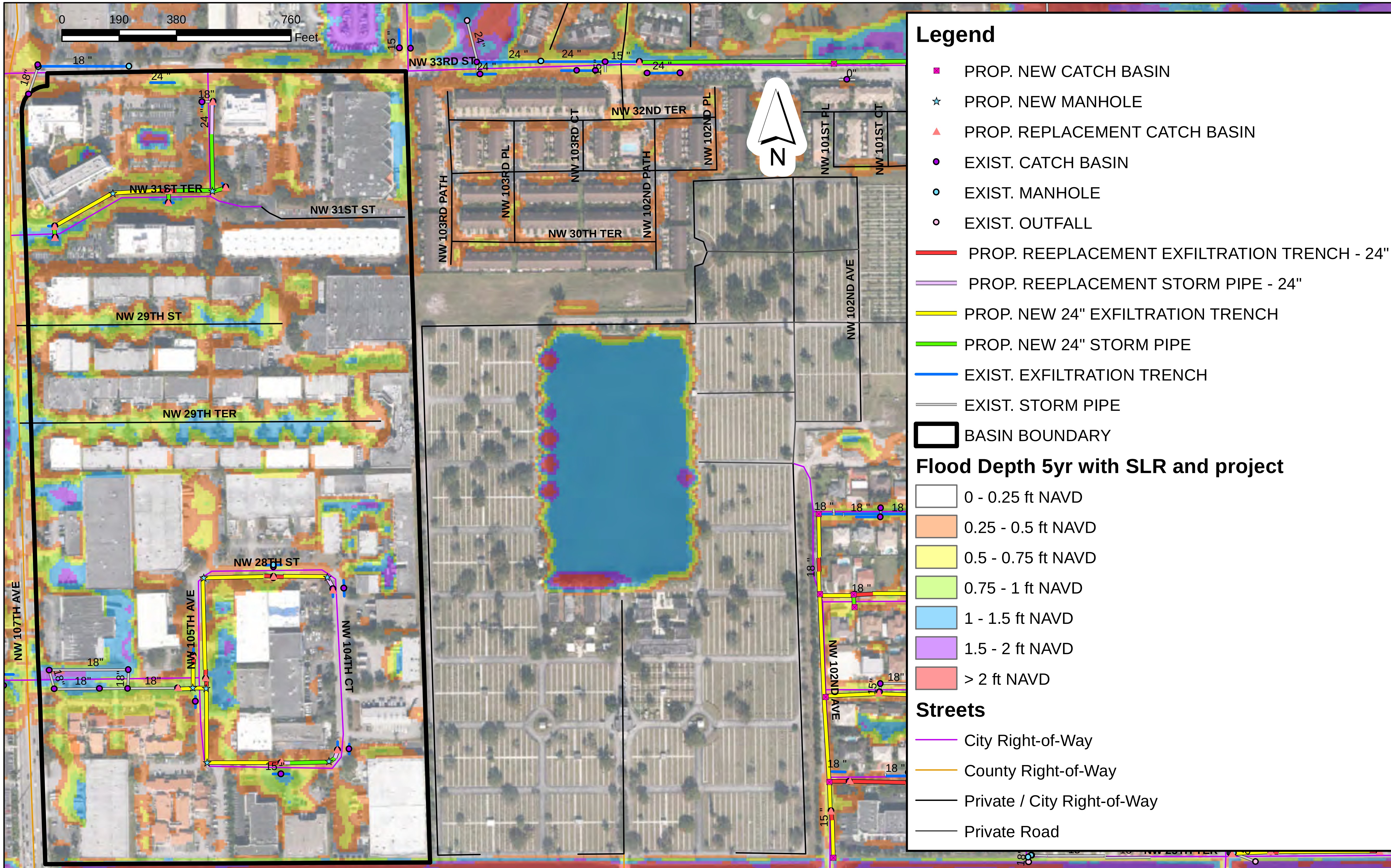
City of Doral Stormwater Management Master Plan
Proposed Stormwater Projects
Basin NW 33 ST
(Basin Rank 7)
Cost Rank 9 - $823,837.44



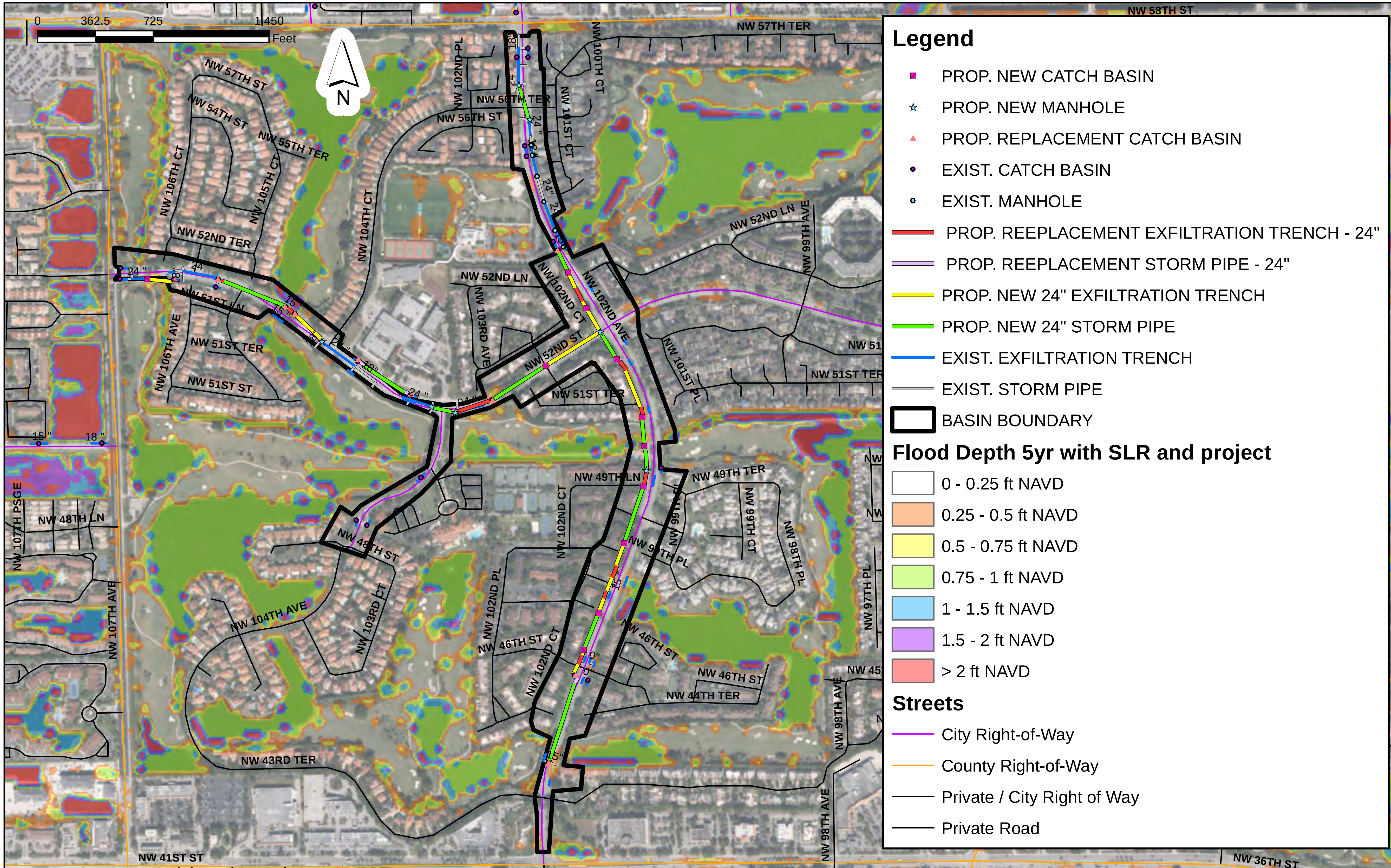
City of Doral Stormwater Management Master Plan
Proposed Stormwater Projects
Basin D-1-1
(Basin Rank 8)
Cost Rank 2 - $165,360.97



City of Doral Stormwater Management Master Plan
Proposed Stormwater Projects
Basin NW 33 ST W
(Basin Rank 9)
Cost Rank 1 - $301,645.14



City of Doral Stormwater Management Master Plan
Proposed Stormwater Projects
Basin F5
(Basin Rank 10)
Cost Rank 12 - $826,550.60



City of Doral Stormwater Management Master Plan
Proposed Stormwater Projects
Basin NW 52 ST W
(Basin Rank 11)
Cost Rank 13 - $1,488,362.73

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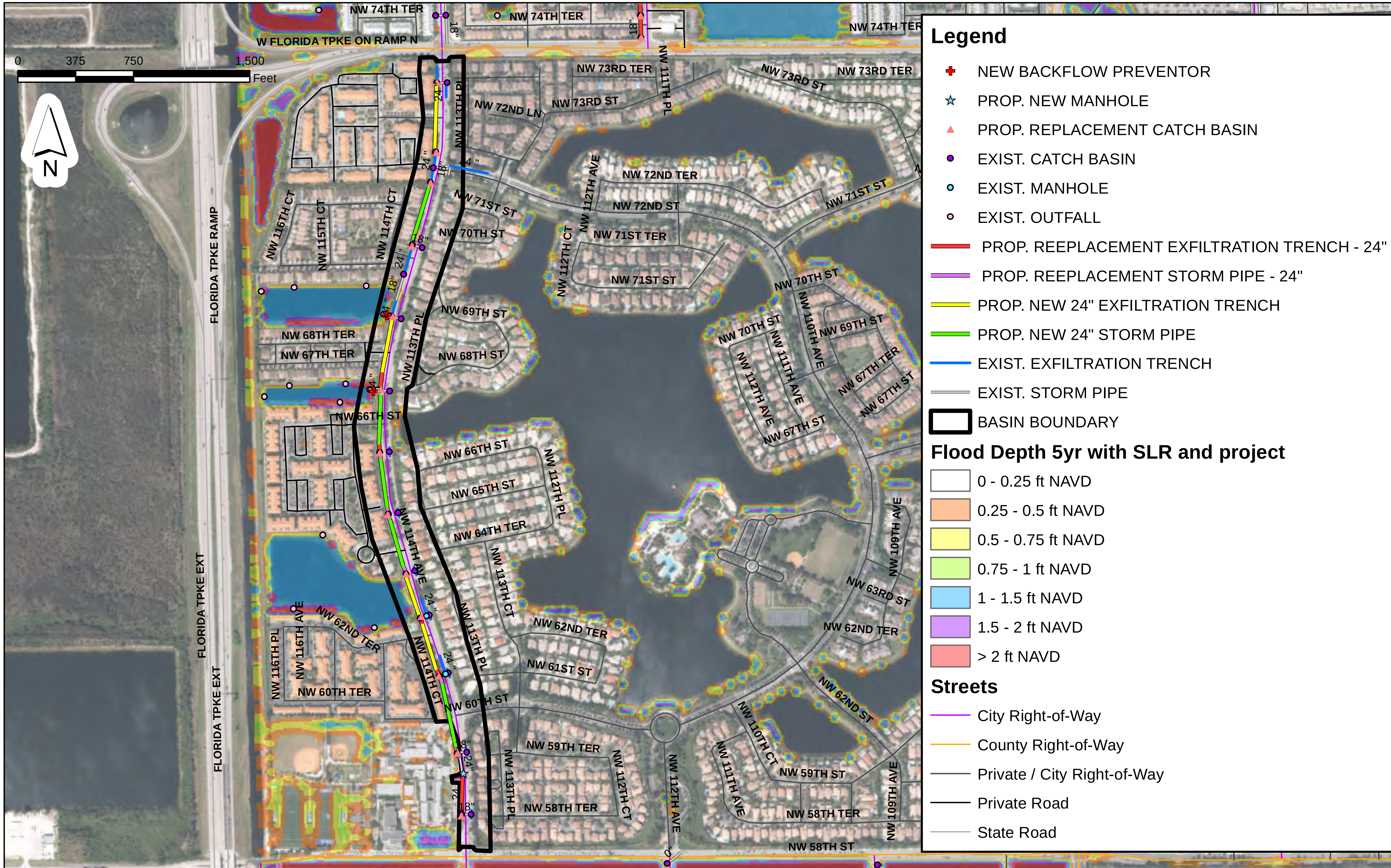

City of Doral Stormwater Management Master Plan
Proposed Stormwater Projects
Basin NW 114 AVE
(Basin Rank 12)
Cost Rank 14 - $1,107,908.26

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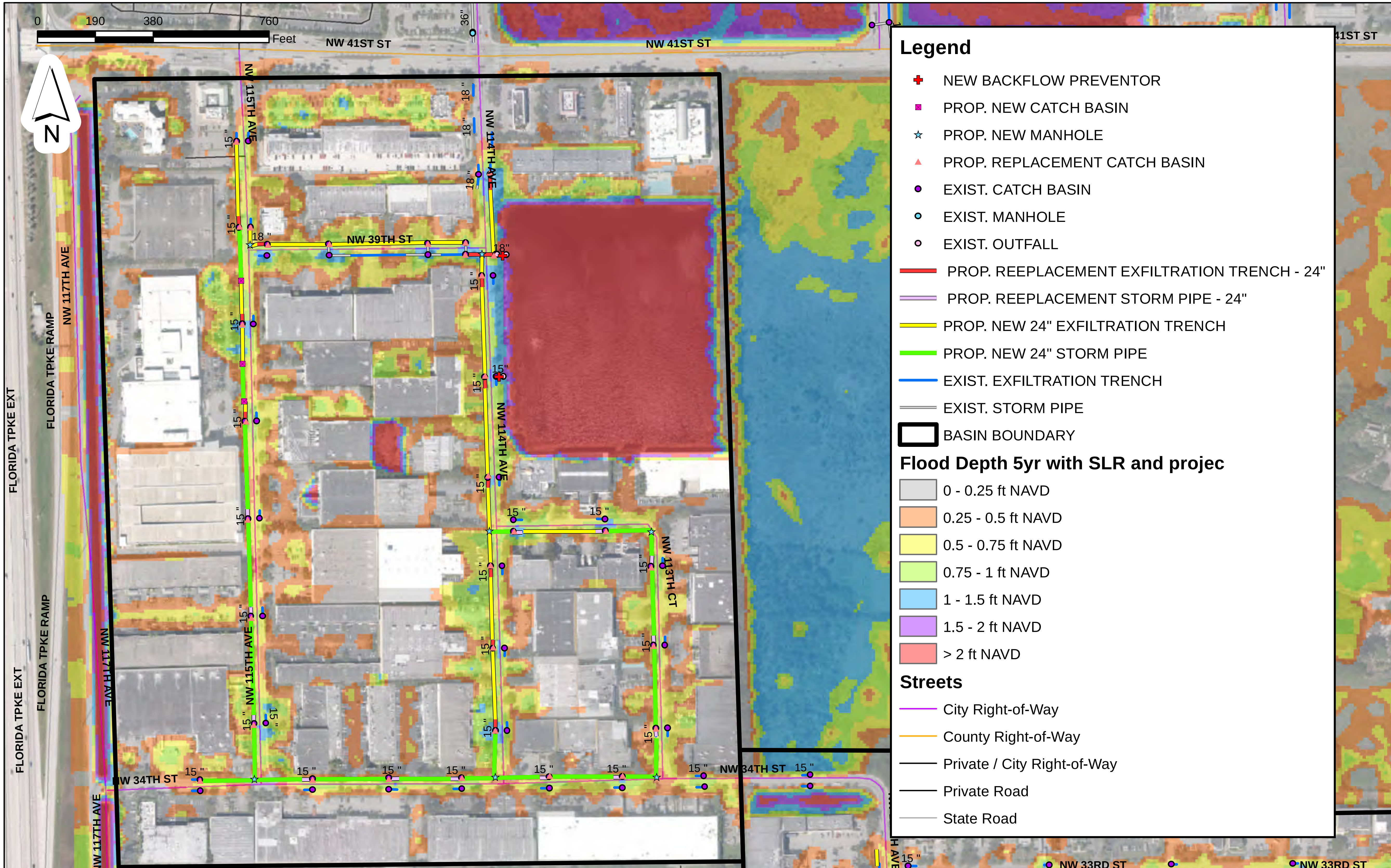

City of Doral Stormwater Management Master Plan
Proposed Stormwater Projects
Basin G4
(Basin Rank 13)
Cost Rank 15 - $2,095,009.55

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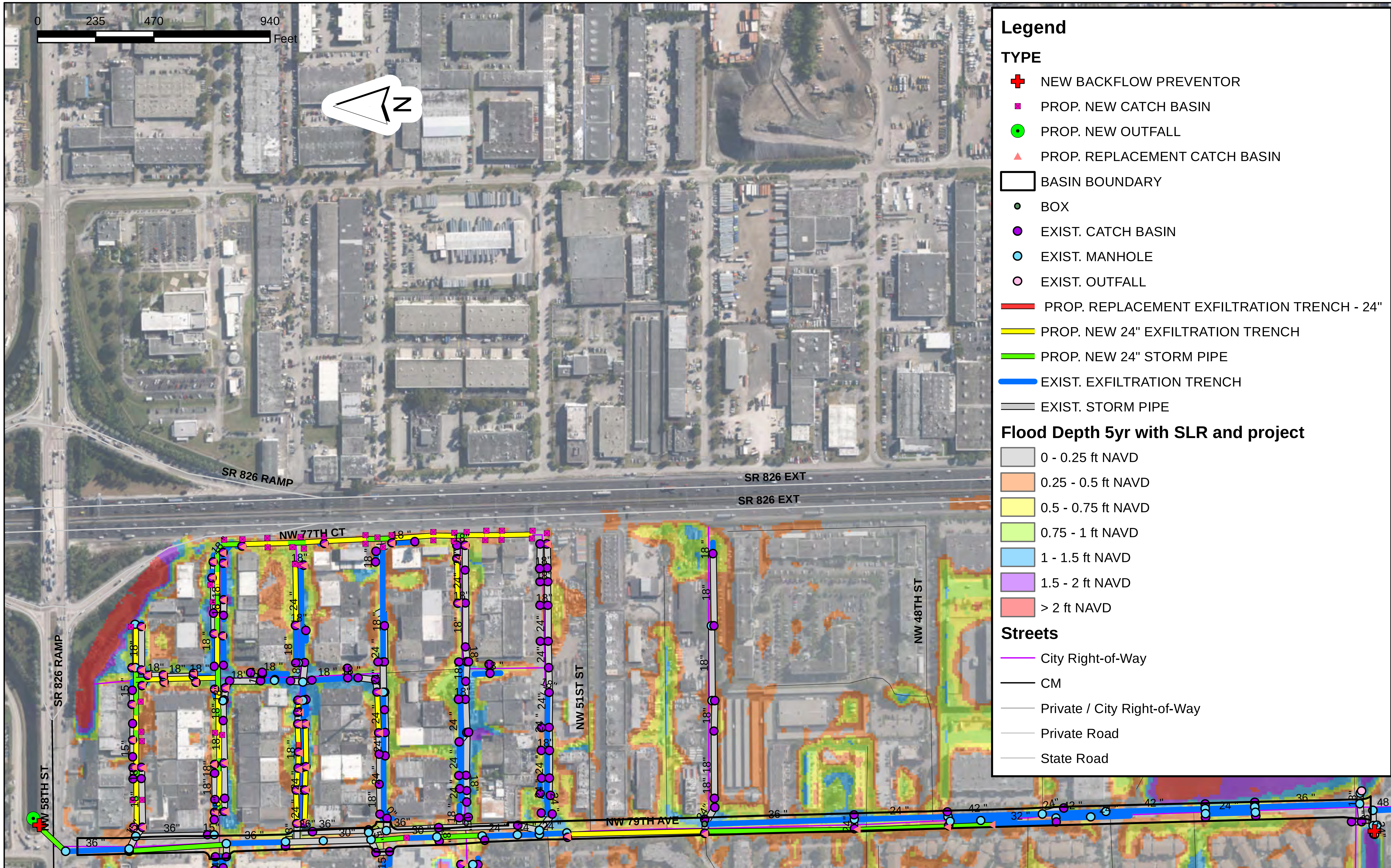
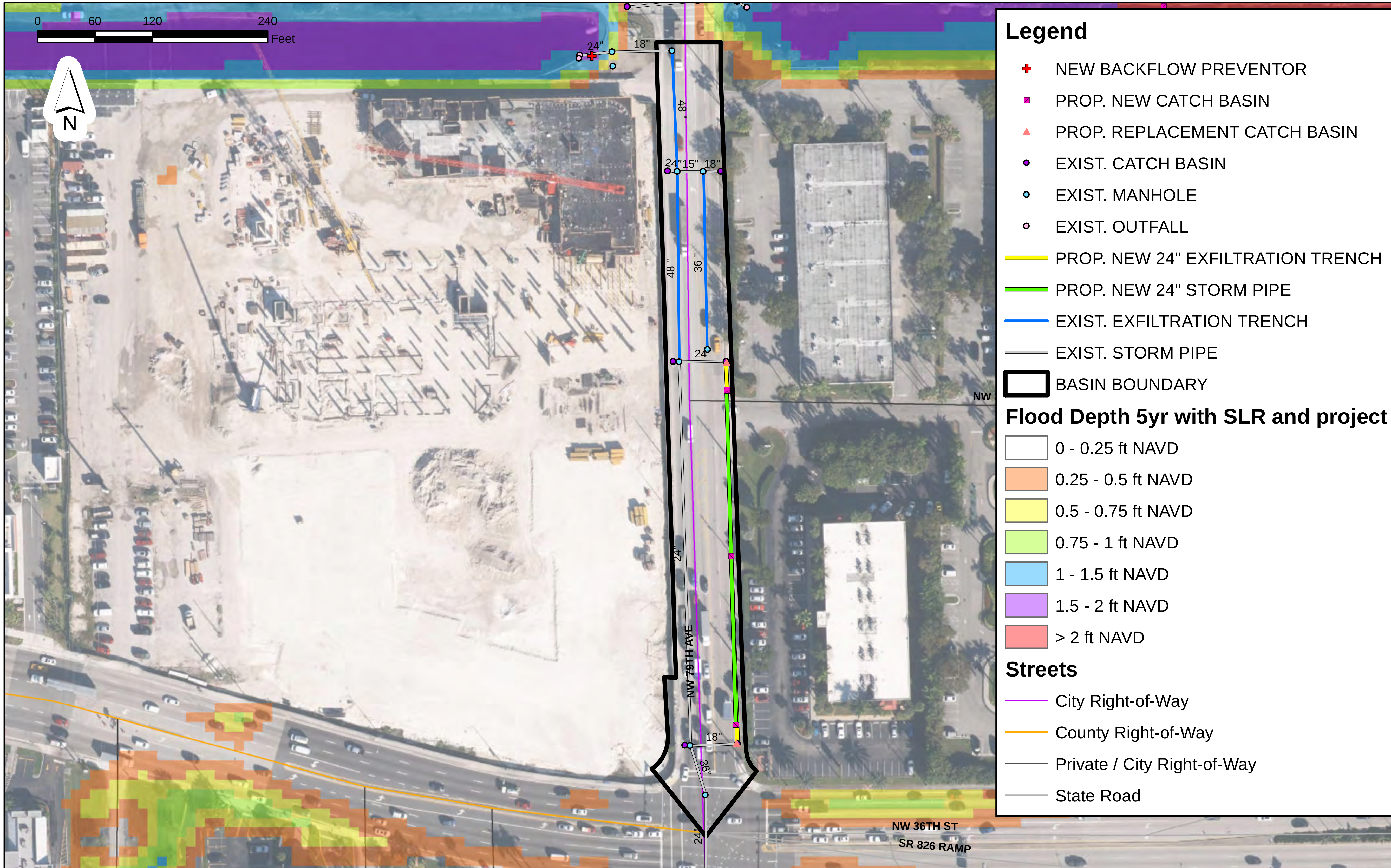
City of Doral Stormwater Management Master Plan
Proposed Stormwater Projects
Basin G1
(Basin Rank 14)
Cost Rank 19 - $3,692,714.23

bcc engineering



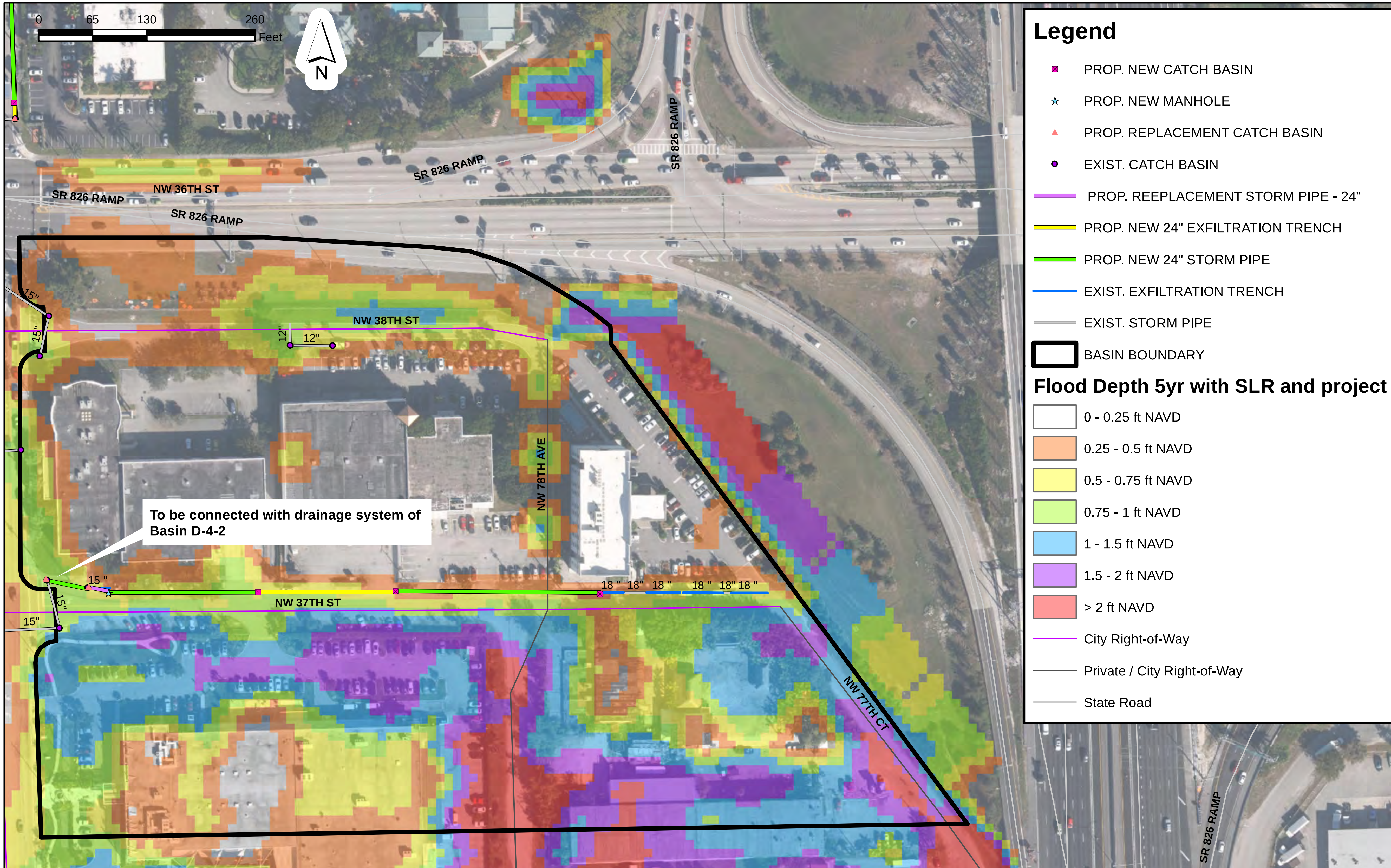
City of Doral Stormwater Management Master Plan
Proposed Stormwater Projects
Basin H-79AVE-N
(Basin Rank 15)
Cost Rank 17 - $417,610.88



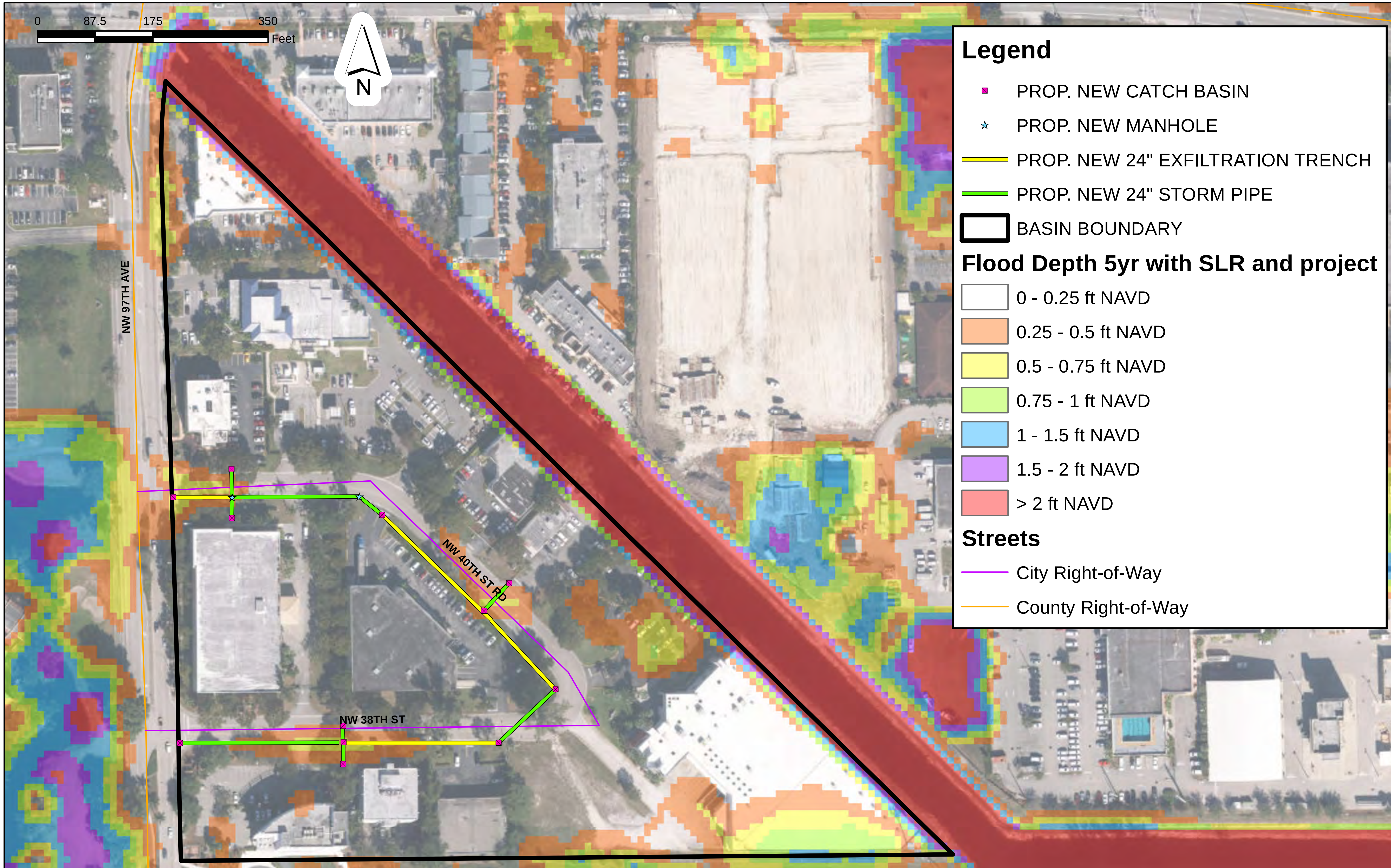
CITY OF DORAL

City of Doral Stormwater Management Master Plan
Proposed Stormwater Projects
Basin H 79 AVE S
(Basin Rank 16)
Cost Rank - $253,849.67

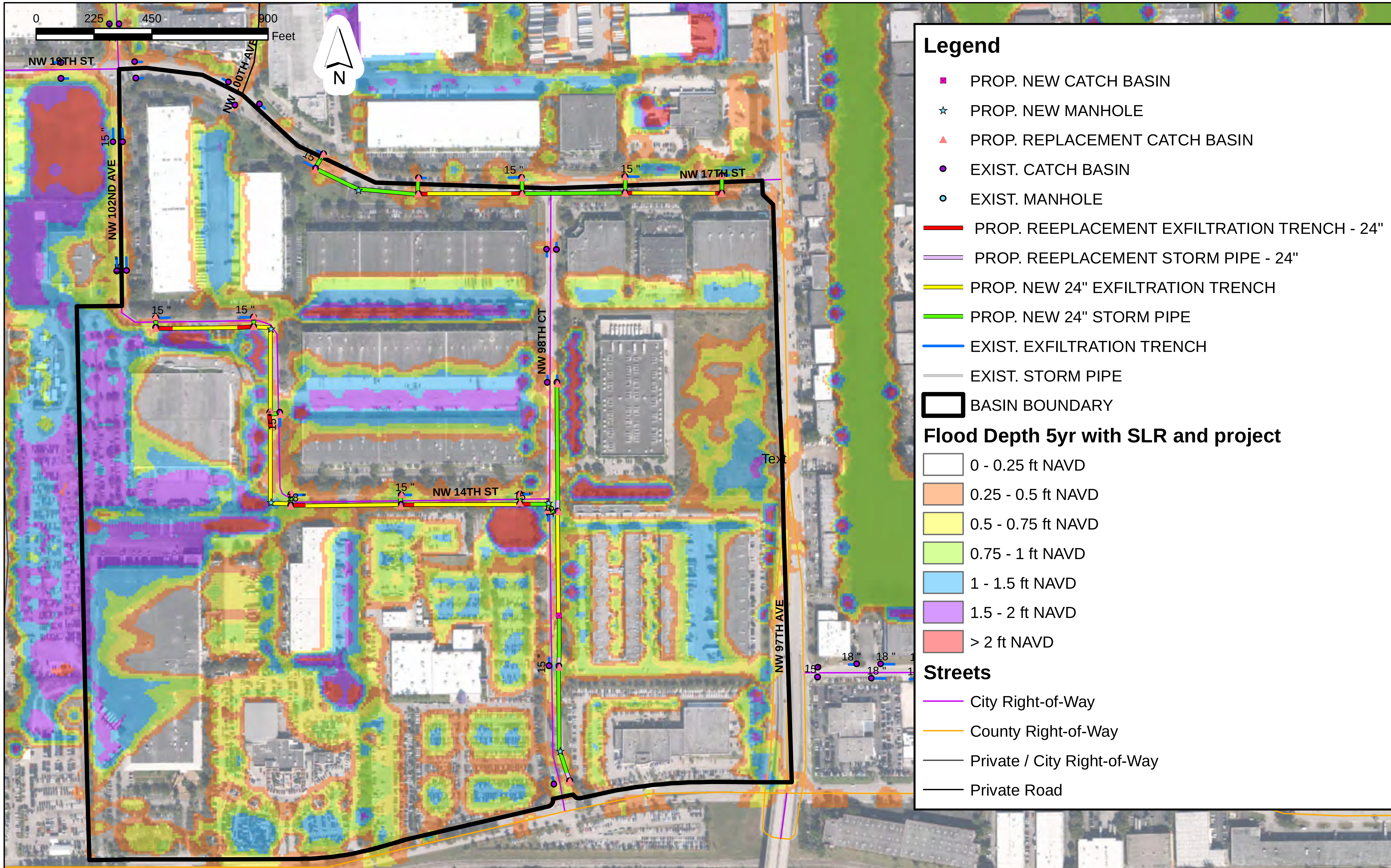
bc engineering



City of Doral Stormwater Management Master Plan
Proposed Stormwater Projects
Basin D-2-1
(Basin Rank 17)
Cost Rank 4 - $204,138.38



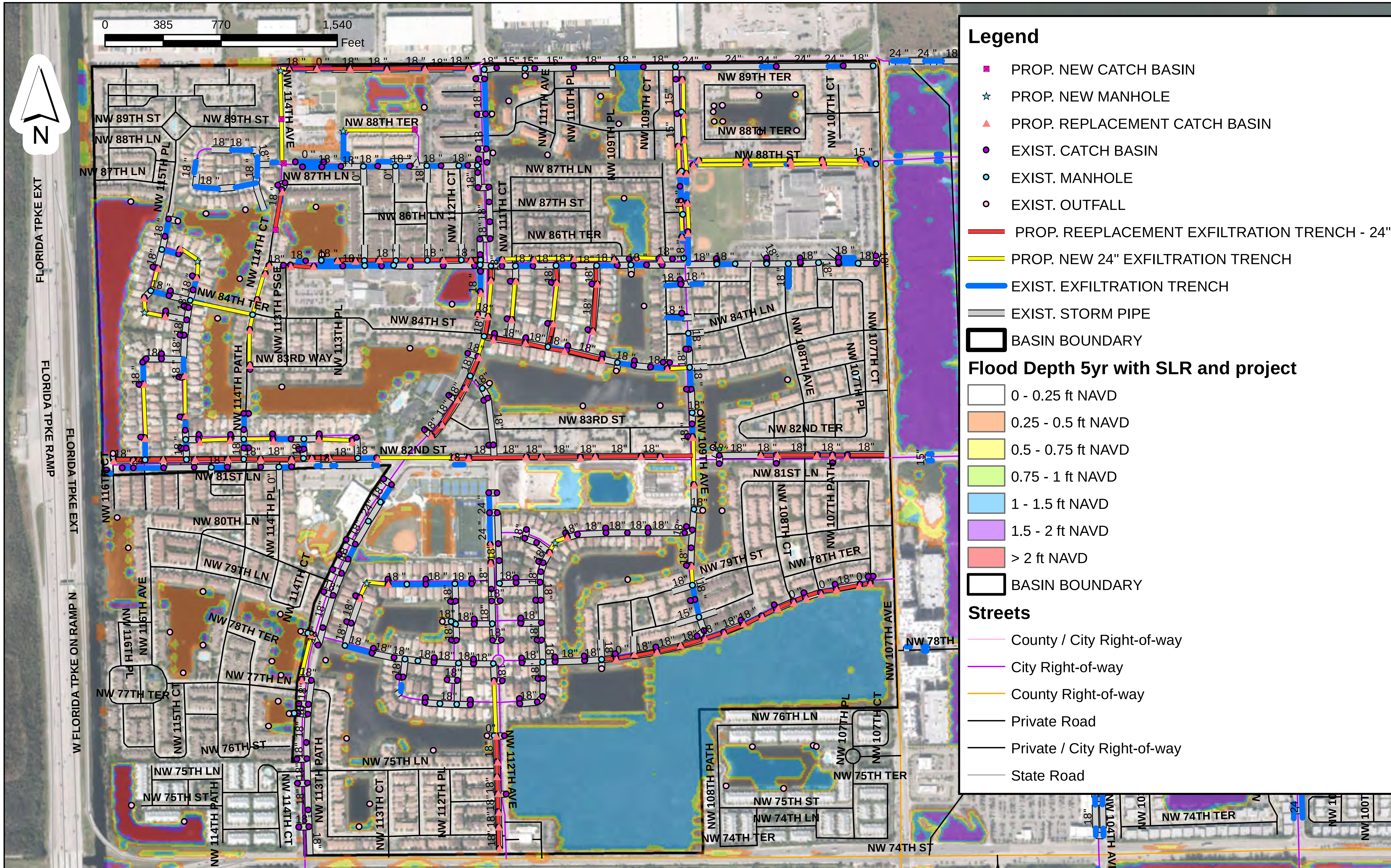
City of Doral Stormwater Management Master Plan
Proposed Stormwater Projects
Basin E7
(Basin Rank 18)
Cost Rank 3 - $515,181.63



CITY OF DORAL

City of Doral Stormwater Management Master Plan
Proposed Stormwater Projects
Basin C5
(Basin Rank 19)
Cost Rank 10 - $1,570,433.93

bc engineering



City of Doral Stormwater Management Master Plan
Proposed Stormwater Projects
Basin O-1
(Basin Rank 20)
Cost Rank 20 - $12,011,203.06

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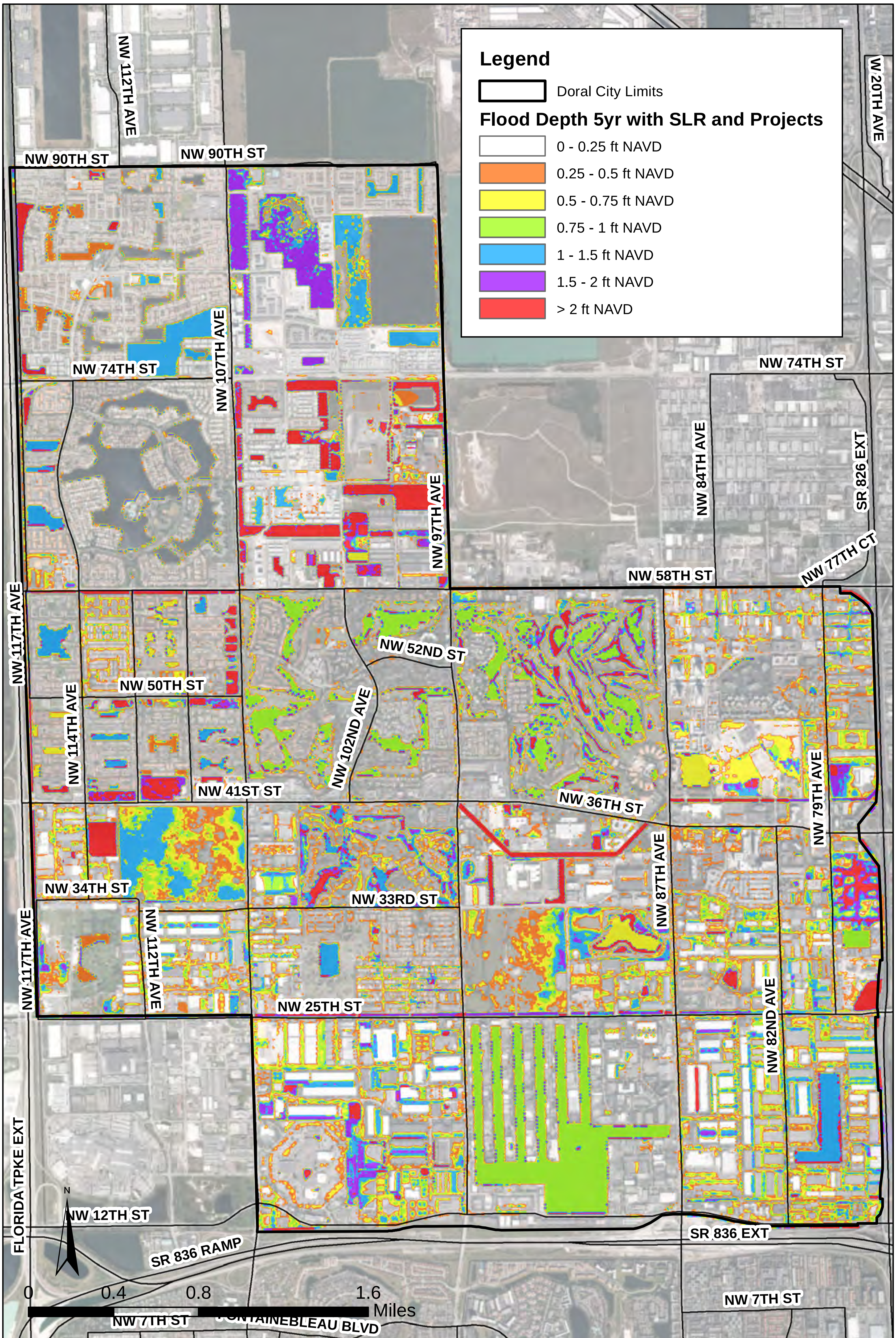
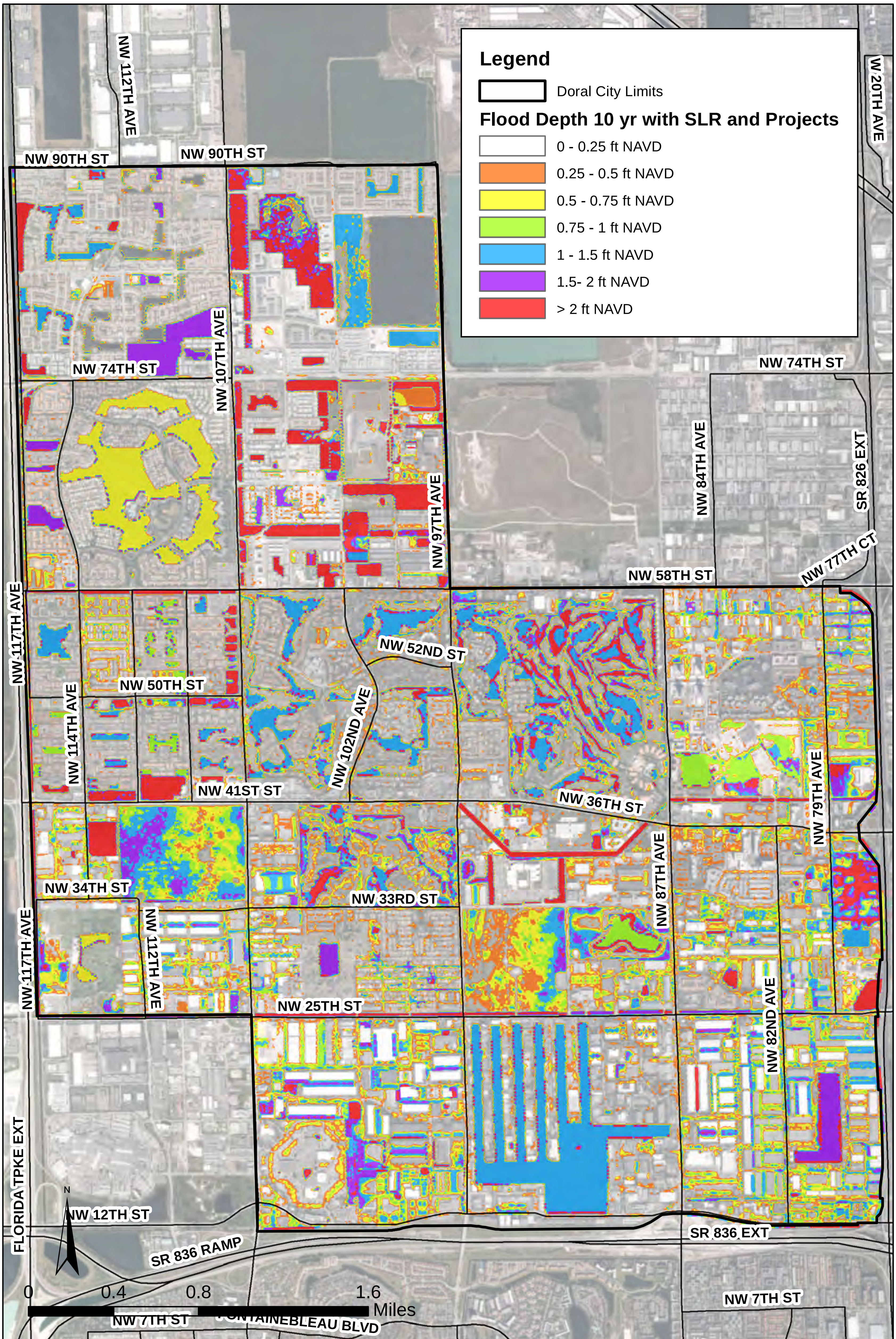
For all the right reasons!

bc engineering

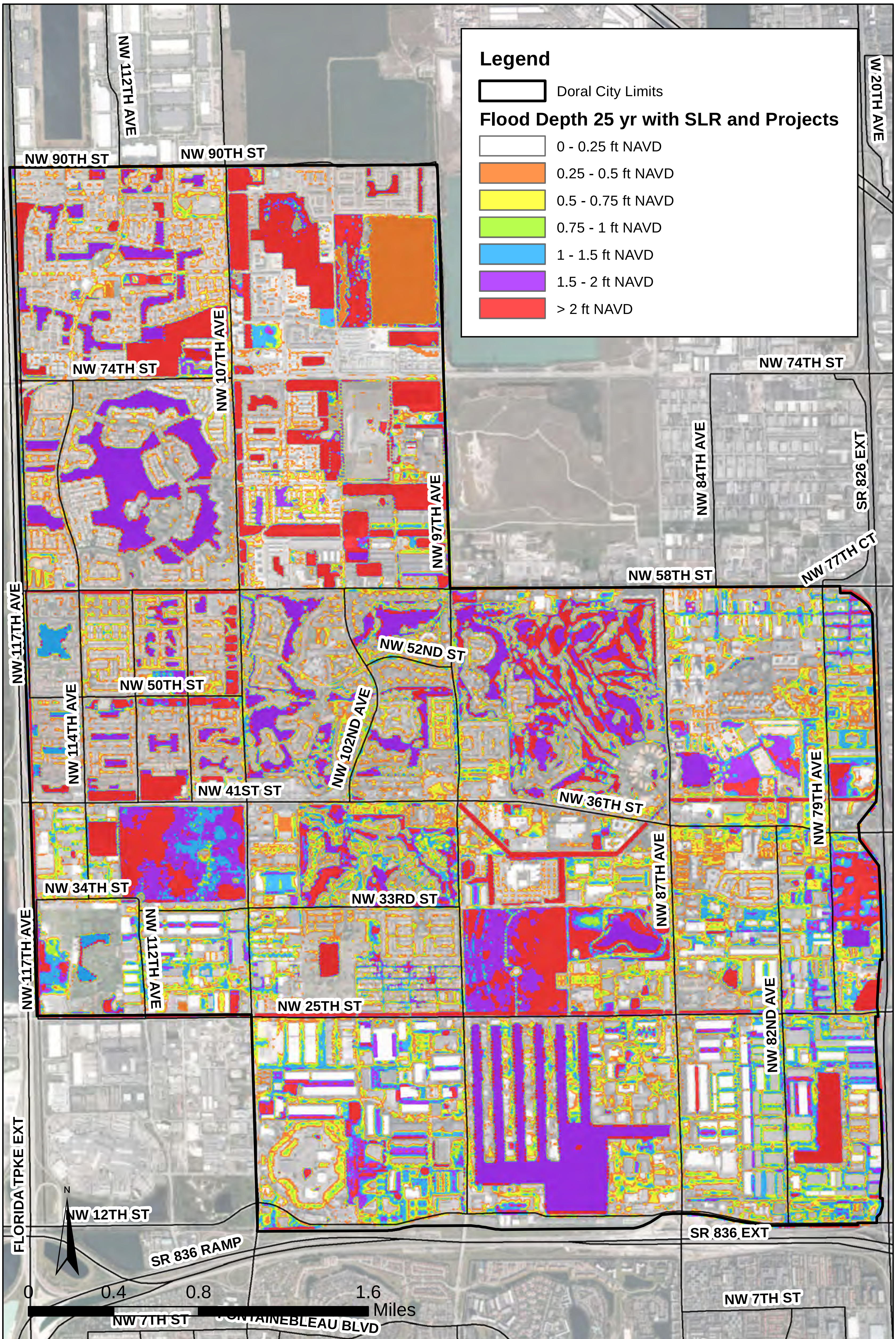
APPENDIX U. FLOOD PLAIN MAPS FOR THE TOP 20 RANKED SUB-BASINS



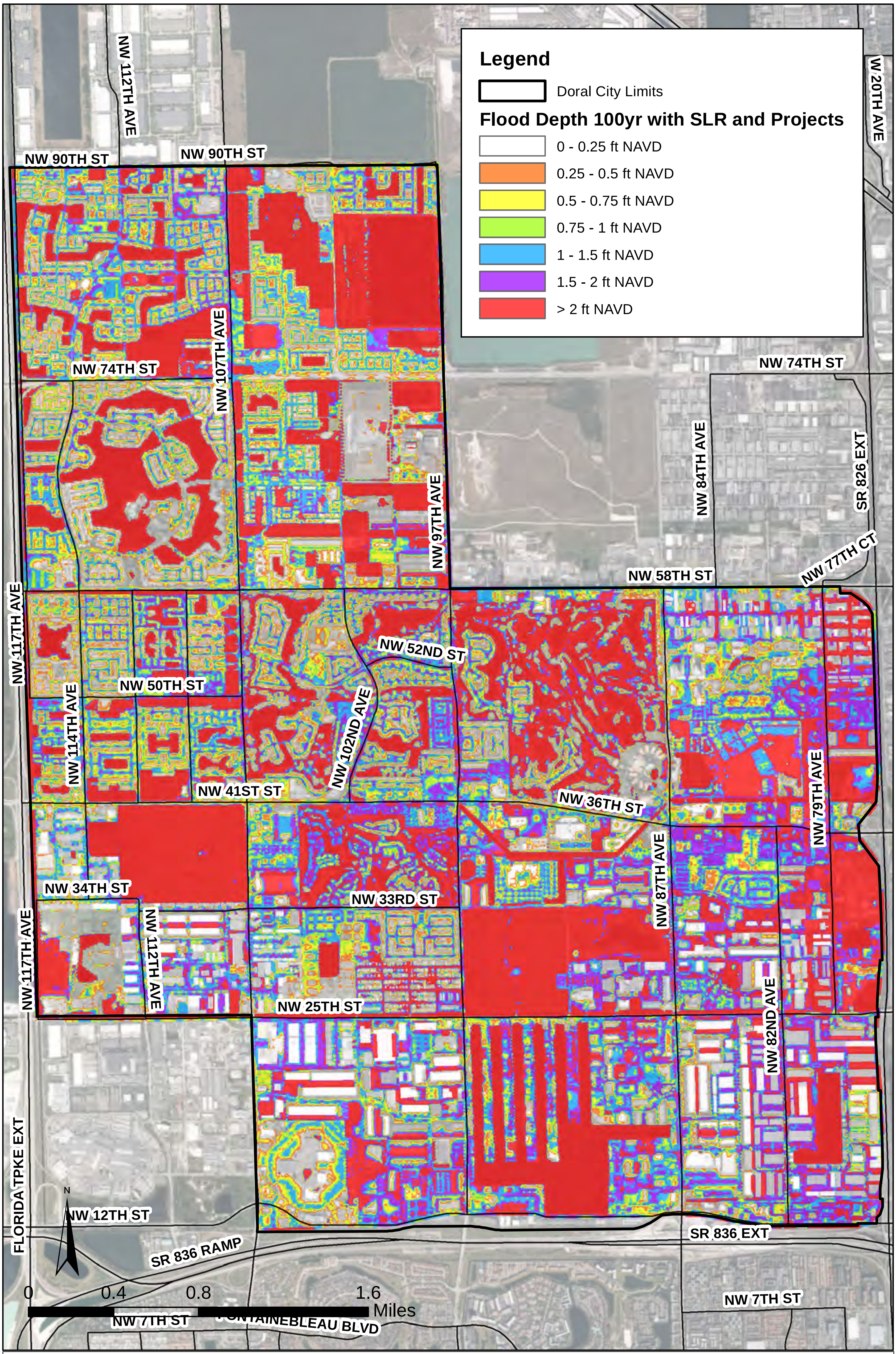
City of Doral Stormwater Management Master Plan
Design Storm Inundation Flood Map with SLR and Improvement projects
5 yr 24 hr event



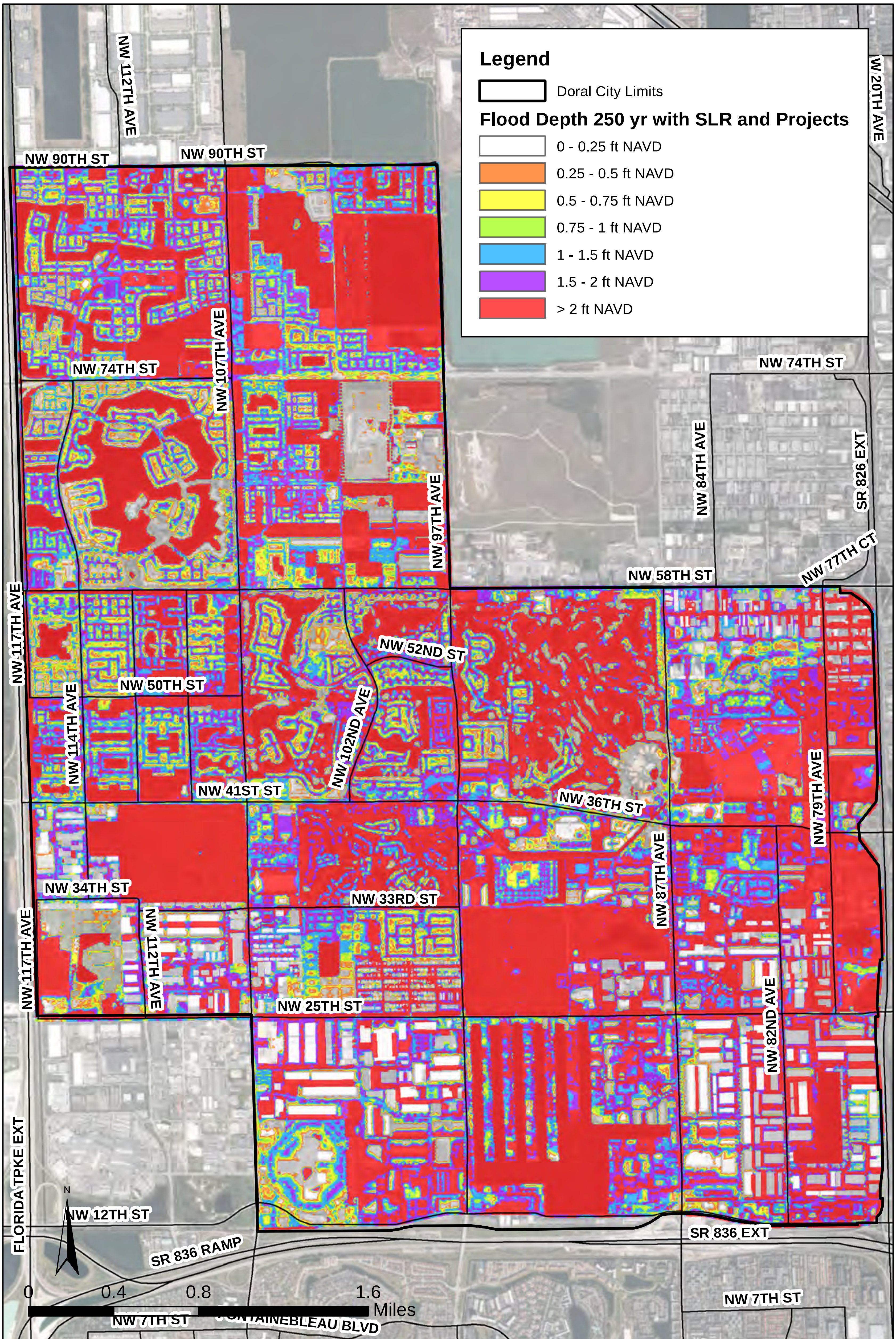
City of Doral Stormwater Management Master Plan
Design Storm Inundation Flood Map with SLR and Improvement projects
10 yr 24 hr event



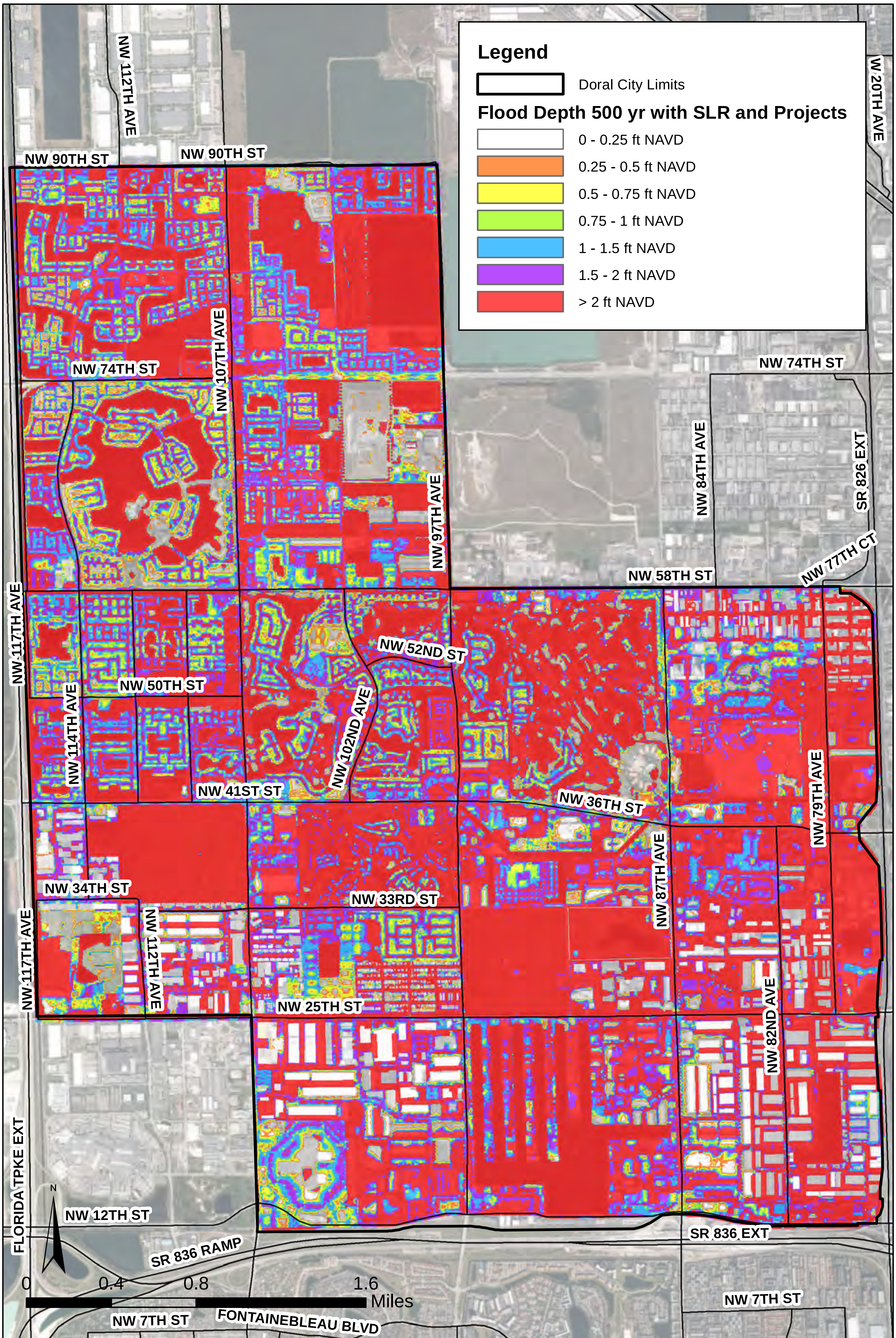
City of Doral Stormwater Management Master Plan
Design Storm Inundation Flood Map with SLR and Improvement projects
25 yr 72 hr event



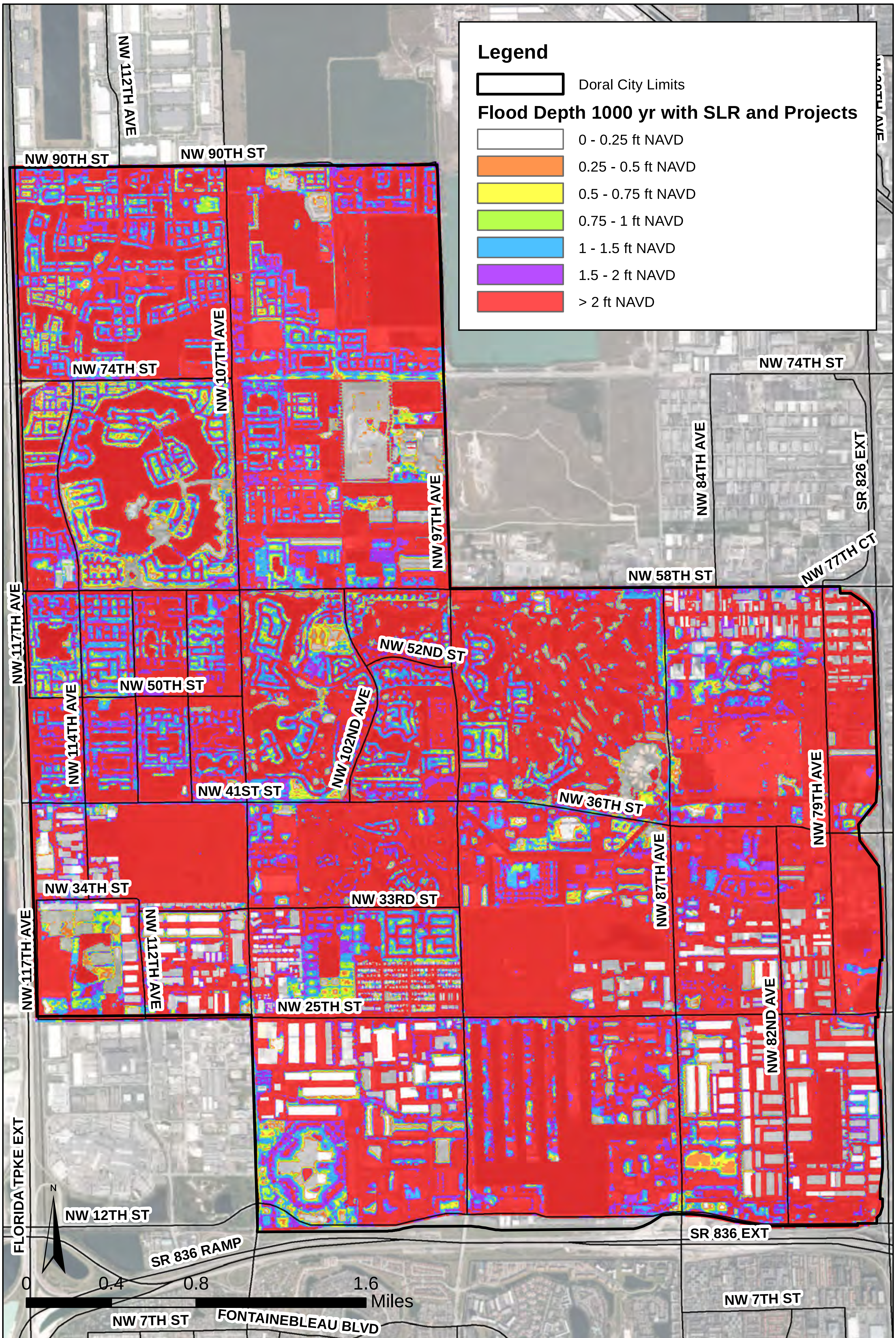
City of Doral Stormwater Management Master Plan
Design Storm Inundation Flood Map with SLR and Improvement projects
100 yr 72 hr event



City of Doral Stormwater Management Master Plan
Design Storm Inundation Flood Map with SLR and Improvement projects
250 yr 72 hr event



City of Doral Stormwater Management Master Plan
Design Storm Inundation Flood Map with SLR and Improvement projects
500 yr 72 hr event



City of Doral Stormwater Management Master Plan
Design Storm Inundation Flood Map with SLR and Improvement projects
1000 yr 72 hr event

APPENDIX V. EXFILTRATION TRENCH CALCULATIONS

DATE	5/1/2014
PROJECT No.:	0
Designed By:	AV
Checked By:	

Project Name: SWMP Update Doral
TEST PROJECT

Catch Basin ID H5

Project Location

DRAINAGE AREAS

		SQ. FT.	ACRES
Impervious Area	(A_i)	2,545,646	58.44
Pervious Area	(A_p)	542,758	12.46
Total Drainage Area	(A_t)	3,088,404	70.90

SFWMD RETENTION REQUIREMENTS

Percent Impervious =	82.4%	
1" of Runoff =	70.90	(ac-in)
2.5 inches X Percent Impervious =	146.10	(ac-in)
Volume of WQ Treatment Volume required (V_{wq}) =	232.50	(ac-in)
	3.28	(inches)
Additional WQ Volume (V_{add}) =	0.00	(ac-in)
	0.00	(inches)
Total Volume Treated by Trench = V_{wq} + V_{add} =	3.28	(inches)
(Max allowed 3.28 inches)		
Safety Factor (SF) =	2.0	(Minimum 2.0)
Percent Water Quality Reduction (%WQ) =	50%	
(50% for wet or dry retention)		

SFWMD EXFILTRATION TRENCH EQUATIONS AND TRENCH LENGTH

If $D_u > D_S$ or $W < 2(D_u + D_s)$ then Eq 1 Applies. If not, Eq 2 Applies.

$$Equation1: \quad L_1 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(H_2 W + 2H_2 D_u - D_u^2 + 2H_2 D_s\right) + (1.39E-04)W D_u}$$

Trench Length Required for Eq 1 = L_1 1,286.8 (feet)

$$Equation\ 2: \quad L_2 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(2H_2 D_u - D_u^2 + 2H_2 D_s\right) + (1.39E-04)W D_u}$$

Trench Length Required for Eq 2 = L_2 1,501.3 (feet)

Trench Length Required = L_{REQ} 1,286.8 (feet)

Trench Length Provided = L_{PRO} 1,467.0 (feet)

Safety Factor Provided = SF_{PRO} 2.28

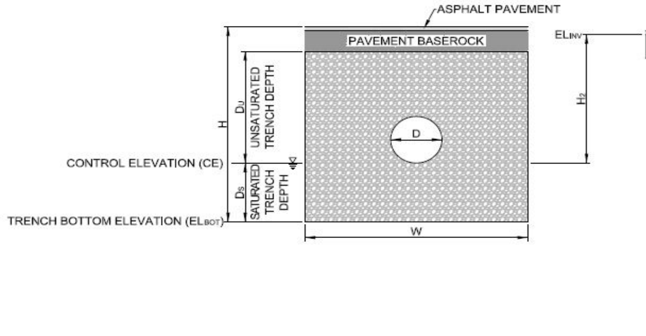
TRENCH DATA - SELFCONTAINED SYSTEM

Trench Width	W	5.0	(feet)		
Hydraulic Conductivity	K	2.95E-03	(cfs/ft2-ft head)		
Control Elevation	CE	2.75	(ft-NGVD)	DHW	
Invert Elevation of Lowest Inlet	EL_{inv}	4.50	(ft-NGVD)	Lowest Inlet Elevation	
Top Elevation of Trench	EL_{top}	3.00	(ft-NGVD)	Average El	3.00
Bottom Elevation of Trench	EL_{bot}	-12.00	(ft-NGVD)	Average Bottom El	-12.00
Pipe Diameter	D	24	(inches)		
Pipe Invert	P_{inv}	-0.50	(ft-NGVD)		-0.50
Head on Saturated Surface = El_{inv} - CE =	H_2	1.75	(feet)		
Unsaturated Trench Depth = EL_{top} - CE =	D_u	0.25	(feet)		
Saturated Trench Depth = CE - EL_{bot} =	D_S	14.75	(feet)		

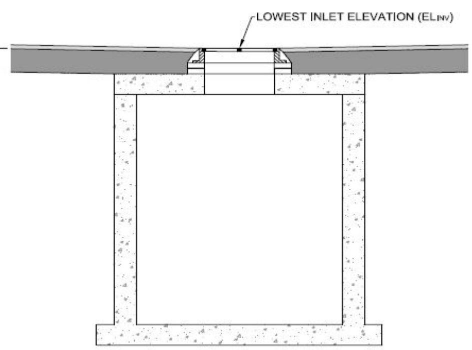
Is Du > Ds	NO
Is W < 2*(Du + Ds)	YES

NOTES: Gray Cells is where data is required, and blue Cells is where data is calculated.

SELF CONTAINED EXFILTRATION TRENCH



TRENCH SECTION



LOWEST INLET

SHEET NO.	1 of 2
DATE	5/1/2014
PROJECT No.:	0
Designed By:	AV
Checked By:	

Project Name: SWMP Update Doral
TEST PROJECT

Catch Basin ID F1

Project Location

DRAINAGE AREAS

		SQ. FT.	ACRES
Impervious Area	(A_i)	2,185,841	50.18
Pervious Area	(A_p)	1,215,760	27.91
Total Drainage Area	(A_t)	3,401,600	78.09

SFWMD RETENTION REQUIREMENTS

Percent Impervious =	64.3%	
1" of Runoff =	78.09	(ac-in)
2.5 inches X Percent Impervious =	125.45	(ac-in)
Volume of WQ Treatment Volume required (V_{wq}) =	40.00	(ac-in)
	0.51	(inches)
Additional WQ Volume (V_{add}) =	0.00	(ac-in)
	0.00	(inches)
Total Volume Treated by Trench = V_{wq} + V_{add} =	0.51	(inches)
(Max allowed 3.28 inches)		
Safety Factor (SF) =	2.0	(Minimum 2.0)
Percent Water Quality Reduction (%WQ) =	50%	
(50% for wet or dry retention)		

TRENCH DATA - SELFCONTAINED SYSTEM

Trench Width	W	5.0	(feet)		
Hydraulic Conductivity	K	1.54E-04	(cfs/ft2-ft head)		
Control Elevation	CE	2.75	(ft-NGVD)	DHW	
Invert Elevation of Lowest Inlet	EL_{inv}	4.50	(ft-NGVD)	Lowest Inlet Elevation	
Top Elevation of Trench	EL_{top}	3.00	(ft-NGVD)	Average El	3.00
Bottom Elevation of Trench	EL_{bot}	-12.00	(ft-NGVD)	Average Bottom El	-12.00
Pipe Diameter	D	24	(inches)		
Pipe Invert	P_{inv}	-0.50	(ft-NGVD)		-0.50
Head on Saturated Surface = El_{inv} - CE =	H_2	1.75	(feet)		
Unsaturated Trench Depth = EL_{top} - CE =	D_u	0.25	(feet)		
Saturated Trench Depth = CE - EL_{bot} =	D_S	14.75	(feet)		

Is Du > Ds	NO
Is W < 2*(Du + Ds)	YES

NOTES: Gray Cells is where data is required, and blue Cells is where data is calculated.

SFWMD EXFILTRATION TRENCH EQUATIONS AND TRENCH LENGTH

If $D_u > D_S$ or $W < 2(D_u + D_s)$ then Eq 1 Applies. If not, Eq 2 Applies.

$$Equation1: \quad L_1 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(H_2W + 2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 1 = L_1 4,168.1 (feet)

$$Equation\ 2: \quad L_2 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 2 = L_2 4,849.0 (feet)

Trench Length Required = L_{REQ} 4,168.1 (feet)

Trench Length Provided = L_{PRO} 4,460.0 (feet)

Safety Factor Provided = SF_{PRO} 2.14

SHEET NO.	1 of 2
DATE	5/1/2014
PROJECT No.:	0
Designed By:	AV
Checked By:	

Project Name: SWMP Update Doral
TEST PROJECT

Catch Basin ID H7

Project Location

DRAINAGE AREAS

		SQ. FT.	ACRES
Impervious Area	(A_i)	3,672,979	84.32
Pervious Area	(A_p)	1,102,939	25.32
Total Drainage Area	(A_t)	4,775,918	109.64

SFWMD RETENTION REQUIREMENTS

Percent Impervious =	76.9%	
1" of Runoff =	109.64	(ac-in)
2.5 inches X Percent Impervious =	210.80	(ac-in)
Volume of WQ Treatment Volume required (V_{wq}) =	360.00	(ac-in)
	3.28	(inches)
Additional WQ Volume (V_{add}) =	0.00	(ac-in)
	0.00	(inches)
Total Volume Treated by Trench = V_{wq} + V_{add} =	3.28	(inches)
(Max allowed 3.28 inches)		
Safety Factor (SF) =	2.0	(Minimum 2.0)
Percent Water Quality Reduction (%WQ) =	50%	
(50% for wet or dry retention)		

SFWMD EXFILTRATION TRENCH EQUATIONS AND TRENCH LENGTH

If $D_u > D_S$ or $W < 2(D_u + D_s)$ then Eq 1 Applies. If not, Eq 2 Applies.

$$Equation 1: \quad L_1 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(H_2 W + 2H_2 D_u - D_u^2 + 2H_2 D_s\right) + (1.39E-04) W D_u}$$

Trench Length Required for Eq 1 = L_1 5,339.8 (feet)

$$Equation\ 2: \quad L_2 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(2H_2 D_u - D_u^2 + 2H_2 D_s\right) + (1.39E-04) W D_u}$$

Trench Length Required for Eq 2 = L_2 6,228.1 (feet)

Trench Length Required = L_{REQ} 5,339.8 (feet)

Trench Length Provided = L_{PRO} 5,626.0 (feet)

Safety Factor Provided = SF_{PRO} 2.11

TRENCH DATA - SELFCONTAINED SYSTEM

Trench Width	W	5.0	(feet)		
Hydraulic Conductivity	K	1.10E-03	(cfs/ft2-ft head)		
Control Elevation	CE	2.75	(ft-NGVD)	DHW	
Invert Elevation of Lowest Inlet	EL_{inv}	4.50	(ft-NGVD)	Lowest Inlet Elevation	
Top Elevation of Trench	EL_{top}	3.00	(ft-NGVD)	Average El	3.00
Bottom Elevation of Trench	EL_{bot}	-12.00	(ft-NGVD)	Average Bottom El	-12.00
Pipe Diameter	D	24	(inches)		
Pipe Invert	P_{inv}	-0.50	(ft-NGVD)		-0.50
Head on Saturated Surface = El_{inv} - CE =	H_2	1.75	(feet)		
Unsaturated Trench Depth = EL_{top} - CE =	D_u	0.25	(feet)		
Saturated Trench Depth = CE - EL_{bot} =	D_S	14.75	(feet)		

Is Du > Ds	NO
Is W < 2*(Du + Ds)	YES

SHEET NO.	1 of 2
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PROJECT No.:	0
Designed By:	AV
Checked By:	

Project Name: SWMP Update Doral
TEST PROJECT

Catch Basin ID H8

Project Location

DRAINAGE AREAS

		SQ. FT.	ACRES
Impervious Area	(A_i)	4,330,735	99.42
Pervious Area	(A_p)	1,003,622	23.04
Total Drainage Area	(A_t)	5,334,358	122.46

SFWMD RETENTION REQUIREMENTS

Percent Impervious =	81.2%	
1" of Runoff =	122.46	(ac-in)
2.5 inches X Percent Impervious =	248.55	(ac-in)
Volume of WQ Treatment Volume required (V_{wq}) =	402.00	(ac-in)
	3.28	(inches)
Additional WQ Volume (V_{add}) =	0.00	(ac-in)
	0.00	(inches)
Total Volume Treated by Trench = V_{wq} + V_{add} =	3.28	(inches)
(Max allowed 3.28 inches)		
Safety Factor (SF) =	2.0	(Minimum 2.0)
Percent Water Quality Reduction (%WQ) =	50%	
(50% for wet or dry retention)		

SFWMD EXFILTRATION TRENCH EQUATIONS AND TRENCH LENGTH

If $D_u > D_S$ or $W < 2(D_u + D_s)$ then Eq 1 Applies. If not, Eq 2 Applies.

$$Equation1: \quad L_1 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(H_2W + 2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 1 = L_1 5,962.7 (feet)

$$Equation\ 2: \quad L_2 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 2 = L_2 6,954.7 (feet)

Trench Length Required = L_{REQ} 5,962.7 (feet)

Trench Length Provided = L_{PRO} 6,084.0 (feet)

Safety Factor Provided = SF_{PRO} 2.04

TRENCH DATA - SELFCONTAINED SYSTEM

Trench Width	W	5.0	(feet)		
Hydraulic Conductivity	K	1.10E-03	(cfs/ft2-ft head)		
Control Elevation	CE	2.75	(ft-NGVD)	DHW	
Invert Elevation of Lowest Inlet	EL_{inv}	4.50	(ft-NGVD)	Lowest Inlet Elevation	
Top Elevation of Trench	EL_{top}	3.00	(ft-NGVD)	Average El	3.00
Bottom Elevation of Trench	EL_{bot}	-12.00	(ft-NGVD)	Average Bottom El	-12.00
Pipe Diameter	D	24	(inches)		
Pipe Invert	P_{inv}	-0.50	(ft-NGVD)		-0.50
Head on Saturated Surface = El_{inv} - CE =	H_2	1.75	(feet)		
Unsaturated Trench Depth = EL_{top} - CE =	D_u	0.25	(feet)		
Saturated Trench Depth = CE - EL_{bot} =	D_S	14.75	(feet)		

Is Du > Ds	NO
Is W < 2*(Du + Ds)	YES

SHEET NO.	1 of 2
DATE	5/1/2014
PROJECT No.:	0
Designed By:	AV
Checked By:	

Project Name: SWMP Update Doral
TEST PROJECT

Catch Basin ID D-3-1

Project Location

DRAINAGE AREAS

		SQ. FT.	ACRES
Impervious Area	(A_i)	701,316	16.10
Pervious Area	(A_p)	100,624	2.31
Total Drainage Area	(A_t)	801,940	18.41

SFWMD RETENTION REQUIREMENTS

Percent Impervious =	87.5%	
1" of Runoff =	18.41	(ac-in)
2.5 inches X Percent Impervious =	40.25	(ac-in)
Volume of WQ Treatment Volume required (V_{wq}) =	40.25	(ac-in)
	2.19	(inches)
Additional WQ Volume (V_{add}) =	20.13	(ac-in)
	1.09	(inches)
Total Volume Treated by Trench = V_{wq} + V_{add} =	3.28	(inches)
(Max allowed 3.28 inches)		
Safety Factor (SF) =	2.0	(Minimum 2.0)
Percent Water Quality Reduction (%WQ) =	50%	
(50% for wet or dry retention)		

SFWMD EXFILTRATION TRENCH EQUATIONS AND TRENCH LENGTH

If $D_u > D_S$ or $W < 2(D_u + D_s)$ then Eq 1 Applies. If not, Eq 2 Applies.

$$Equation 1: \quad L_1 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(H_2 W + 2H_2 D_u - D_u^2 + 2H_2 D_s\right) + (1.39E-04)W D_u}$$

Trench Length Required for Eq 1 = L_1 236.6 (feet)

$$Equation 2: \quad L_2 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(2H_2 D_u - D_u^2 + 2H_2 D_s\right) + (1.39E-04)W D_u}$$

Trench Length Required for Eq 2 = L_2 276.0 (feet)

Trench Length Required = L_{REQ} 236.6 (feet)

Trench Length Provided = L_{PRO} 358.0 (feet)

Safety Factor Provided = SF_{PRO} 3.03

TRENCH DATA - SELFCONTAINED SYSTEM

Trench Width	W	5.0	(feet)		
Hydraulic Conductivity	K	5.56E-03	(cfs/ft2-ft head)		
Control Elevation	CE	2.75	(ft-NGVD)	DHW	
Invert Elevation of Lowest Inlet	EL_{inv}	4.50	(ft-NGVD)	Lowest Inlet Elevation	
Top Elevation of Trench	EL_{top}	3.00	(ft-NGVD)	Average El	3.00
Bottom Elevation of Trench	EL_{bot}	-12.00	(ft-NGVD)	Average Bottom El	-12.00
Pipe Diameter	D	24	(inches)		
Pipe Invert	P_{inv}	-0.50	(ft-NGVD)		-0.50
Head on Saturated Surface = El_{inv} - CE =	H_2	1.75	(feet)		
Unsaturated Trench Depth = EL_{top} - CE =	D_u	0.25	(feet)		
Saturated Trench Depth = CE - EL_{bot} =	D_S	14.75	(feet)		

Is Du > Ds	NO
Is W < 2*(Du + Ds)	YES

NOTES: Gray Cells is where data is required, and blue Cells is where data is calculated.

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Designed By:	AV
Checked By:	

Project Name: SWMP Update Doral
TEST PROJECT

Catch Basin ID D-4-2

Project Location

DRAINAGE AREAS

		SQ. FT.	ACRES
Impervious Area	(A_i)	1,780,733	40.88
Pervious Area	(A_p)	320,166	7.35
Total Drainage Area	(A_t)	2,100,899	48.23

SFWMD RETENTION REQUIREMENTS

Percent Impervious =	84.8%	
1" of Runoff =	48.23	(ac-in)
2.5 inches X Percent Impervious =	102.20	(ac-in)
Volume of WQ Treatment Volume required (V_{wq}) =	102.20	(ac-in)
	2.12	(inches)
Additional WQ Volume (V_{add}) =	55.99	(ac-in)
	1.16	(inches)
Total Volume Treated by Trench = V_{wq} + V_{add} =	3.28	(inches)
(Max allowed 3.28 inches)		
Safety Factor (SF) =	2.0	(Minimum 2.0)
Percent Water Quality Reduction (%WQ) =	50%	
(50% for wet or dry retention)		

SFWMD EXFILTRATION TRENCH EQUATIONS AND TRENCH LENGTH

If $D_u > D_S$ or $W < 2(D_u + D_s)$ then Eq 1 Applies. If not, Eq 2 Applies.

$$Equation 1: \quad L_1 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(H_2W + 2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 1 = L_1 629.3 (feet)

$$Equation\ 2: \quad L_2 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 2 = L_2 734.2 (feet)

Trench Length Required = L_{REQ} 629.3 (feet)

Trench Length Provided = L_{PRO} 671.0 (feet)

Safety Factor Provided = SF_{PRO} 2.13

TRENCH DATA - SELFCONTAINED SYSTEM

Trench Width	W	5.0	(feet)		
Hydraulic Conductivity	K	5.56E-03	(cfs/ft2-ft head)		
Control Elevation	CE	2.75	(ft-NGVD)	DHW	
Invert Elevation of Lowest Inlet	EL_{inv}	4.50	(ft-NGVD)	Lowest Inlet Elevation	
Top Elevation of Trench	EL_{top}	3.00	(ft-NGVD)	Average El	3.00
Bottom Elevation of Trench	EL_{bot}	-12.00	(ft-NGVD)	Average Bottom El	-12.00
Pipe Diameter	D	24	(inches)		
Pipe Invert	P_{inv}	-0.50	(ft-NGVD)		-0.50
Head on Saturated Surface = El_{inv} - CE =	H_2	1.75	(feet)		
Unsaturated Trench Depth = EL_{top} - CE =	D_u	0.25	(feet)		
Saturated Trench Depth = CE - EL_{bot} =	D_S	14.75	(feet)		

Is Du > Ds	NO
Is W < 2*(Du + Ds)	YES

NOTES: Gray Cells is where data is required, and blue Cells is where data is calculated.

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Checked By:	

Project Name: SWMP Update Doral
TEST PROJECT

Catch Basin ID NW33ST

Project Location

DRAINAGE AREAS

		SQ. FT.	ACRES
Impervious Area	(A_i)	234,353	5.38
Pervious Area	(A_p)	145,490	3.34
Total Drainage Area	(A_t)	379,843	8.72

SFWMD RETENTION REQUIREMENTS

Percent Impervious =	61.7%	
1" of Runoff =	8.72	(ac-in)
2.5 inches X Percent Impervious =	13.45	(ac-in)
Volume of WQ Treatment Volume required (V_{wq}) =	13.45	(ac-in)
	1.54	(inches)
Additional WQ Volume (V_{add}) =	15.15	(ac-in)
	1.74	(inches)
Total Volume Treated by Trench = $V_{wq} + V_{add}$ =	3.28	(inches)
(Max allowed 3.28 inches)		
Safety Factor (SF) =	2.0	(Minimum 2.0)
Percent Water Quality Reduction (%WQ) =	50%	
(50% for wet or dry retention)		

SFWMD EXFILTRATION TRENCH EQUATIONS AND TRENCH LENGTH

If $D_u > D_S$ or $W < 2(D_u + D_s)$ then Eq 1 Applies. If not, Eq 2 Applies.

$$Equation1: \quad L_1 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(H_2W + 2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 1 = L_1 304.6 (feet)

$$Equation\ 2: \quad L_2 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 2 = L_2 355.3 (feet)

Trench Length Required = L_{REQ} 304.6 (feet)

Trench Length Provided = L_{PRO} 305.0 (feet)

Safety Factor Provided = SF_{PRO} 2.00

TRENCH DATA - SELFCONTAINED SYSTEM

Trench Width	W	5.0	(feet)		
Hydraulic Conductivity	K	2.35E-03	(cfs/ft2-ft head)		
Control Elevation	CE	2.75	(ft-NGVD)	DHW	
Invert Elevation of Lowest Inlet	EL_{inv}	4.50	(ft-NGVD)	Lowest Inlet Elevation	
Top Elevation of Trench	EL_{top}	3.00	(ft-NGVD)	Average El	3.00
Bottom Elevation of Trench	EL_{bot}	-12.00	(ft-NGVD)	Average Bottom El	-12.00
Pipe Diameter	D	24	(inches)		
Pipe Invert	P_{inv}	-0.50	(ft-NGVD)		-0.50
Head on Saturated Surface = El_{inv} - CE =	H_2	1.75	(feet)		
Unsaturated Trench Depth = EL_{top} - CE =	D_u	0.25	(feet)		
Saturated Trench Depth = CE - EL_{bot} =	D_S	14.75	(feet)		

Is Du > Ds	NO
Is W < 2*(Du + Ds)	YES

SHEET NO.	1 of 2
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Designed By:	AV
Checked By:	

Project Name: **SWMP Update Doral**
TEST PROJECT

Catch Basin ID D-2-1, D-1-1

Project Location

DRAINAGE AREAS

		SQ. FT.	ACRES
Impervious Area	(A_i)	412,078	9.46
Pervious Area	(A_p)	77,972	1.79
Total Drainage Area	(A_t)	490,050	11.25

SFWMD RETENTION REQUIREMENTS

Percent Impervious = 84.1%

1" of Runoff = 11.25 (ac-in)
2.5 inches X Percent Impervious = 23.65 (ac-in)

Volume of WQ Treatment Volume required (V_{wq}) = 23.65 (ac-in)
2.10 (inches)

Additional WQ Volume (V_{add}) = 13.25 (ac-in)
1.18 (inches)

Total Volume Treated by Trench = V_{wq} + V_{add} = 3.28 (inches)
(Max allowed 3.28 inches)

Safety Factor (SF) = 2.0 (Minimum 2.0)

Percent Water Quality Reduction (%WQ) = 50%
(50% for wet or dry retention)

TRENCH DATA - SELFCONTAINED SYSTEM

Trench Width	W	5.0	(feet)		
Hydraulic Conductivity	K	6.73E-03	(cfs/ft2-ft head)		
Control Elevation	CE	2.75	(ft-NGVD)	DHW	
Invert Elevation of Lowest Inlet	EL_{inv}	4.50	(ft-NGVD)	Lowest Inlet Elevation	
Top Elevation of Trench	EL_{top}	3.00	(ft-NGVD)	Average El	3.00
Bottom Elevation of Trench	EL_{bot}	-12.00	(ft-NGVD)	Average Bottom El	-12.00
Pipe Diameter	D	24	(inches)		
Pipe Invert	P_{inv}	-0.50	(ft-NGVD)		-0.50
Head on Saturated Surface = El_{inv} - CE =	H_2	1.75	(feet)		
Unsaturated Trench Depth = EL_{top} - CE =	D_u	0.25	(feet)		
Saturated Trench Depth = CE - EL_{bot} =	D_S	14.75	(feet)		

Is Du > Ds NO
Is W < 2*(Du + Ds) YES

SFWMD EXFILTRATION TRENCH EQUATIONS AND TRENCH LENGTH

If $D_u > D_S$ or $W < 2(D_u + D_s)$ then Eq 1 Applies. If not, Eq 2 Applies.

$$Equation 1: \quad L_1 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(H_2W + 2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 1 = L_1 121.7 (feet)

$$Equation 2: \quad L_2 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 2 = L_2 142.0 (feet)

Trench Length Required = L_{REQ} 121.7 (feet)

Trench Length Provided = L_{PRO} 129.0 (feet)

Safety Factor Provided = SF_{PRO} 2.12

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Project Name: SWMP Update Doral
TEST PROJECT

Catch Basin ID NW33ST W

Project Location

DRAINAGE AREAS

		SQ. FT.	ACRES
Impervious Area	(A_i)	239,144	5.49
Pervious Area	(A_p)	14,375	0.33
Total Drainage Area	(A_t)	253,519	5.82

SFWMD RETENTION REQUIREMENTS

Percent Impervious =	94.3%	
1" of Runoff =	5.82	(ac-in)
2.5 inches X Percent Impervious =	13.73	(ac-in)
Volume of WQ Treatment Volume required (V_{wq}) =	13.73	(ac-in)
	2.36	(inches)
Additional WQ Volume (V_{add}) =	5.36	(ac-in)
	0.92	(inches)
Total Volume Treated by Trench = V_{wq} + V_{add} =	3.28	(inches)
(Max allowed 3.28 inches)		
Safety Factor (SF) =	2.0	(Minimum 2.0)
Percent Water Quality Reduction (%WQ) =	50%	
(50% for wet or dry retention)		

SFWMD EXFILTRATION TRENCH EQUATIONS AND TRENCH LENGTH

If $D_u > D_S$ or $W < 2(D_u + D_s)$ then Eq 1 Applies. If not, Eq 2 Applies.

$$Equation1: \quad L_1 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(H_2W + 2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 1 = L_1 137.2 (feet)

$$Equation\ 2: \quad L_2 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 2 = L_2 160.0 (feet)

Trench Length Required = L_{REQ} 137.2 (feet)

Trench Length Provided = L_{PRO} 145.0 (feet)

Safety Factor Provided = SF_{PRO} 2.11

TRENCH DATA - SELFCONTAINED SYSTEM

Trench Width	W	5.0	(feet)		
Hydraulic Conductivity	K	2.91E-03	(cfs/ft2-ft head)		
Control Elevation	CE	2.75	(ft-NGVD)	DHW	
Invert Elevation of Lowest Inlet	EL_{inv}	4.50	(ft-NGVD)	Lowest Inlet Elevation	
Top Elevation of Trench	EL_{top}	3.00	(ft-NGVD)	Average El	3.00
Bottom Elevation of Trench	EL_{bot}	-12.00	(ft-NGVD)	Average Bottom El	-12.00
Pipe Diameter	D	24	(inches)		
Pipe Invert	P_{inv}	-0.50	(ft-NGVD)		-0.50
Head on Saturated Surface = El_{inv} - CE =	H_2	1.75	(feet)		
Unsaturated Trench Depth = EL_{top} - CE =	D_u	0.25	(feet)		
Saturated Trench Depth = CE - EL_{bot} =	D_S	14.75	(feet)		

Is Du > Ds	NO
Is W < 2*(Du + Ds)	YES

SHEET NO.	1 of 2
DATE	5/1/2014
PROJECT No.:	0
Designed By:	AV
Checked By:	

Project Name: SWMP Update Doral
TEST PROJECT

Catch Basin ID F5

Project Location

DRAINAGE AREAS

		SQ. FT.	ACRES
Impervious Area	(A_i)	1,441,836	33.10
Pervious Area	(A_p)	597,208	13.71
Total Drainage Area	**(A_t)**	2,039,044	46.81

SFWMD RETENTION REQUIREMENTS

Percent Impervious =	70.7%	
1" of Runoff =	46.81	(ac-in)
2.5 inches X Percent Impervious =	82.75	(ac-in)
Volume of WQ Treatment Volume required (V_{wq}) =	82.75	(ac-in)
	1.77	(inches)
Additional WQ Volume (V_{add}) =	70.79	(ac-in)
	1.51	(inches)
Total Volume Treated by Trench = V_{wq} + V_{add} =	3.28	(inches)
(Max allowed 3.28 inches)		
Safety Factor (SF) =	2.0	(Minimum 2.0)
Percent Water Quality Reduction (%WQ) =	50%	
(50% for wet or dry retention)		

TRENCH DATA - SELFCONTAINED SYSTEM

Trench Width	W	5.0	(feet)		
Hydraulic Conductivity	K	2.35E-03	(cfs/ft2-ft head)		
Control Elevation	CE	2.75	(ft-NGVD)	DHW	
Invert Elevation of Lowest Inlet	EL_{inv}	4.31	(ft-NGVD)	Lowest Inlet Elevation	
Top Elevation of Trench	EL_{top}	2.81	(ft-NGVD)	Average El	2.81
Bottom Elevation of Trench	EL_{bot}	-12.19	(ft-NGVD)	Average Bottom El	-12.19
Pipe Diameter	D	24	(inches)		
Pipe Invert	P_{inv}	-0.69	(ft-NGVD)		-0.69
Head on Saturated Surface = El_{inv} - CE =	H_2	1.56	(feet)		
Unsaturated Trench Depth = EL_{top} - CE =	D_u	0.06	(feet)		
Saturated Trench Depth = CE - EL_{bot} =	D_S	14.94	(feet)		

Is Du > Ds	NO
Is W < 2*(Du + Ds)	YES

NOTES: Gray Cells is where data is required, and blue Cells is where data is calculated.

SFWMD EXFILTRATION TRENCH EQUATIONS AND TRENCH LENGTH

If $D_u > D_S$ or $W < 2(D_u + D_s)$ then Eq 1 Applies. If not, Eq 2 Applies.

$$Equation 1: \quad L_1 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(H_2W + 2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 1 = L_1 1,751.6 (feet)

$$Equation 2: \quad L_2 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 2 = L_2 2,043.4 (feet)

Trench Length Required = L_{REQ} 1,751.6 (feet)

Trench Length Provided = L_{PRO} 1,755.0 (feet)

Safety Factor Provided = SF_{PRO} 2.00

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Designed By:	AV
Checked By:	

Project Name: SWMP Update Doral
TEST PROJECT

Catch Basin ID NW 52ST W

Project Location

DRAINAGE AREAS

		SQ. FT.	ACRES
Impervious Area	(A_i)	1,447,063	33.22
Pervious Area	(A_p)	770,576	17.69
Total Drainage Area	(A_t)	2,217,640	50.91

SFWMD RETENTION REQUIREMENTS

Percent Impervious = 65.3%

1" of Runoff = 50.91 (ac-in)
2.5 inches X Percent Impervious = 83.05 (ac-in)

Volume of WQ Treatment Volume required (V_{wq}) = 83.05 (ac-in)
1.63 (inches)

Additional WQ Volume (V_{add}) = 83.93 (ac-in)
1.65 (inches)

Total Volume Treated by Trench = V_{wq} + V_{add} = 3.28 (inches)
(Max allowed 3.28 inches)

Safety Factor (SF) = 2.0 (Minimum 2.0)

Percent Water Quality Reduction (%WQ) = 50%
(50% for wet or dry retention)

SFWMD EXFILTRATION TRENCH EQUATIONS AND TRENCH LENGTH

If $D_u > D_S$ or $W < 2(D_u + D_s)$ then Eq 1 Applies. If not, Eq 2 Applies.

$$Equation 1: \quad L_1 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(H_2 W + 2H_2 D_u - D_u^2 + 2H_2 D_s\right) + (1.39E-04) W D_u}$$

Trench Length Required for Eq 1 = L_1 2,419.1 (feet)

$$Equation 2: \quad L_2 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(2H_2 D_u - D_u^2 + 2H_2 D_s\right) + (1.39E-04) W D_u}$$

Trench Length Required for Eq 2 = L_2 2,850.8 (feet)

Trench Length Required = L_{REQ} 2,419.1 (feet)

Trench Length Provided = L_{PRO} 2,420.0 (feet)

Safety Factor Provided = SF_{PRO} 2.00

TRENCH DATA - SELFCONTAINED SYSTEM

Trench Width	W	5.0	(feet)		
Hydraulic Conductivity	K	1.80E-03	(cfs/ft2-ft head)		
Control Elevation	CE	2.75	(ft-NGVD)	DHW	
Invert Elevation of Lowest Inlet	EL_{inv}	4.50	(ft-NGVD)	Lowest Inlet Elevation	
Top Elevation of Trench	EL_{top}	3.00	(ft-NGVD)	Average El	3.00
Bottom Elevation of Trench	EL_{bot}	-11.00	(ft-NGVD)	Average Bottom El	-12.00
Pipe Diameter	D	24	(inches)		
Pipe Invert	P_{inv}	-0.50	(ft-NGVD)		-0.50
Head on Saturated Surface = El_{inv} - CE =	H_2	1.75	(feet)		
Unsaturated Trench Depth = EL_{top} - CE =	D_u	0.25	(feet)		
Saturated Trench Depth = CE - EL_{bot} =	D_S	13.75	(feet)		

Is Du > Ds	NO
Is W < 2*(Du + Ds)	YES

DATE	5/1/2014
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Checked By:	

Project Name: SWMP Update Doral
TEST PROJECT

Project Location

Catch Basin ID NW114AVE

DRAINAGE AREAS

		SQ. FT.	ACRES
Impervious Area	(A_i)	1,076,368	24.71
Pervious Area	(A_p)	711,335	16.33
Total Drainage Area	(A_t)	1,787,702	41.04

SFWMD RETENTION REQUIREMENTS

Percent Impervious =	60.2%	
1" of Runoff =	41.04	(ac-in)
2.5 inches X Percent Impervious =	61.78	(ac-in)
Volume of WQ Treatment Volume required (V_{wq}) =	61.78	(ac-in)
	1.51	(inches)
Additional WQ Volume (V_{add}) =	72.84	(ac-in)
	1.77	(inches)
Total Volume Treated by Trench = V_{wq} + V_{add} =	3.28	(inches)
(Max allowed 3.28 inches)		
Safety Factor (SF) =	2.0	(Minimum 2.0)
Percent Water Quality Reduction (%WQ) =	50%	
(50% for wet or dry retention)		

SFWMD EXFILTRATION TRENCH EQUATIONS AND TRENCH LENGTH

If $D_u > D_S$ or $W < 2(D_u + D_s)$ then Eq 1 Applies. If not, Eq 2 Applies.

$$Equation 1: \quad L_1 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(H_2W + 2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 1 = L_1 1,434.9 (feet)

$$Equation\ 2: \quad L_2 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 2 = L_2 1,674.0 (feet)

Trench Length Required = L_{REQ} 1,434.9 (feet)

Trench Length Provided = L_{PRO} 1,450.0 (feet)

Safety Factor Provided = SF_{PRO} 2.02

TRENCH DATA - SELFCONTAINED SYSTEM

Trench Width	W	5.0	(feet)		
Hydraulic Conductivity	K	2.36E-03	(cfs/ft2-ft head)		
Control Elevation	CE	2.75	(ft-NGVD)	DHW	
Invert Elevation of Lowest Inlet	EL_{inv}	4.50	(ft-NGVD)	Lowest Inlet Elevation	
Top Elevation of Trench	EL_{top}	3.00	(ft-NGVD)	Average El	3.00
Bottom Elevation of Trench	EL_{bot}	-12.00	(ft-NGVD)	Average Bottom El	-12.00
Pipe Diameter	D	24	(inches)		
Pipe Invert	P_{inv}	-0.50	(ft-NGVD)		-0.50
Head on Saturated Surface = El_{inv} - CE =	H_2	1.75	(feet)		
Unsaturated Trench Depth = EL_{top} - CE =	D_u	0.25	(feet)		
Saturated Trench Depth = CE - EL_{bot} =	D_S	14.75	(feet)		

Is Du > Ds	NO
Is W < 2*(Du + Ds)	YES

NOTES: Gray Cells is where data is required, and blue Cells is where data is calculated.

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Designed By:	AV
Checked By:	

Project Name: **SWMP Update Doral**
TEST PROJECT

Catch Basin ID G4

Project Location

DRAINAGE AREAS

		SQ. FT.	ACRES
Impervious Area	(A_i)	3,520,955	80.83
Pervious Area	(A_p)	906,048	20.80
Total Drainage Area	(A_t)	4,427,003	101.63

SFWMD RETENTION REQUIREMENTS

Percent Impervious =	79.5%	
1" of Runoff =	101.63	(ac-in)
2.5 inches X Percent Impervious =	202.08	(ac-in)
Volume of WQ Treatment Volume required (V_{wq}) =	202.08	(ac-in)
	1.99	(inches)
Additional WQ Volume (V_{add}) =	131.27	(ac-in)
	1.29	(inches)
Total Volume Treated by Trench = $V_{wq} + V_{add}$ =	3.28	(inches)
(Max allowed 3.28 inches)		
Safety Factor (SF) =	2.0	(Minimum 2.0)
Percent Water Quality Reduction (%WQ) =	50%	
(50% for wet or dry retention)		

TRENCH DATA - SELFCONTAINED SYSTEM

Trench Width	W	5.0	(feet)		
Hydraulic Conductivity	K	2.20E-03	(cfs/ft2-ft head)		
Control Elevation	CE	2.75	(ft-NGVD)	DHW	
Invert Elevation of Lowest Inlet	EL_{inv}	4.50	(ft-NGVD)	Lowest Inlet Elevation	
Top Elevation of Trench	EL_{top}	3.00	(ft-NGVD)	Average El	3.00
Bottom Elevation of Trench	EL_{bot}	-12.00	(ft-NGVD)	Average Bottom El	-12.00
Pipe Diameter	D	24	(inches)		
Pipe Invert	P_{inv}	-0.50	(ft-NGVD)		-0.50
Head on Saturated Surface = El_{inv} - CE =	H_2	1.75	(feet)		
Unsaturated Trench Depth = EL_{top} - CE =	D_u	0.25	(feet)		
Saturated Trench Depth = CE - EL_{bot} =	D_S	14.75	(feet)		

Is Du > Ds	NO
Is W < 2*(Du + Ds)	YES

SFWMD EXFILTRATION TRENCH EQUATIONS AND TRENCH LENGTH

If $D_u > D_S$ or $W < 2(D_u + D_s)$ then Eq 1 Applies. If not, Eq 2 Applies.

$$Equation1: \quad L_1 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(H_2W + 2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 1 = L_1 3,450.2 (feet)

$$Equation\ 2: \quad L_2 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 2 = L_2 4,025.1 (feet)

Trench Length Required = L_{REQ} 3,450.2 (feet)

Trench Length Provided = L_{PRO} 3,545.0 (feet)

Safety Factor Provided = SF_{PRO} 2.05

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Checked By:	

Project Name: SWMP Update Doral
TEST PROJECT

Catch Basin ID G1

Project Location

DRAINAGE AREAS

		SQ. FT.	ACRES
Impervious Area	(A_i)	5,582,650	128.16
Pervious Area	(A_p)	1,596,474	36.65
Total Drainage Area	(A_t)	7,179,124	164.81

SFWMD RETENTION REQUIREMENTS

Percent Impervious =	77.8%	
1" of Runoff =	164.81	(ac-in)
2.5 inches X Percent Impervious =	320.40	(ac-in)
Volume of WQ Treatment Volume required (V_{wq}) =	320.40	(ac-in)
	1.94	(inches)
Additional WQ Volume (V_{add}) =	220.18	(ac-in)
	1.34	(inches)
Total Volume Treated by Trench = V_{wq} + V_{add} =	3.28	(inches)
(Max allowed 3.28 inches)		
Safety Factor (SF) =	2.0	(Minimum 2.0)
Percent Water Quality Reduction (%WQ) =	50%	
(50% for wet or dry retention)		

SFWMD EXFILTRATION TRENCH EQUATIONS AND TRENCH LENGTH

If $D_u > D_S$ or $W < 2(D_u + D_s)$ then Eq 1 Applies. If not, Eq 2 Applies.

$$Equation 1: \quad L_1 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(H_2 W + 2H_2 D_u - D_u^2 + 2H_2 D_s\right) + (1.39E-04)W D_u}$$

Trench Length Required for Eq 1 = L_1 **4,449.7** (feet)

$$Equation 2: \quad L_2 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(2H_2 D_u - D_u^2 + 2H_2 D_s\right) + (1.39E-04)W D_u}$$

Trench Length Required for Eq 2 = L_2 **5,191.8** (feet)

Trench Length Required = L_{REQ} **4,449.7** (feet)

Trench Length Provided = L_{PRO} **4,450.0** (feet)

Safety Factor Provided = SF_{PRO} **2.00**

TRENCH DATA - SELFCONTAINED SYSTEM

Trench Width	W	5.0	(feet)		
Hydraulic Conductivity	K	2.60E-03	(cfs/ft2-ft head)		
Control Elevation	CE	2.75	(ft-NGVD)	DHW	
Invert Elevation of Lowest Inlet	EL_{inv}	4.63	(ft-NGVD)	Lowest Inlet Elevation	
Top Elevation of Trench	EL_{top}	3.13	(ft-NGVD)	Average El	3.13
Bottom Elevation of Trench	EL_{bot}	-11.87	(ft-NGVD)	Average Bottom El	-11.87
Pipe Diameter	D	24	(inches)		
Pipe Invert	P_{inv}	-0.37	(ft-NGVD)		-0.37
Head on Saturated Surface = El_{inv} - CE =	H_2	1.88	(feet)		
Unsaturated Trench Depth = EL_{top} - CE =	D_u	0.38	(feet)		
Saturated Trench Depth = CE - EL_{bot} =	D_S	14.62	(feet)		

Is Du > Ds NO
Is W < 2*(Du + Ds) YES

NOTES: Gray Cells is where data is required, and blue Cells is where data is calculated.

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Checked By:	

Project Name: SWMP Update Doral
TEST PROJECT

Catch Basin ID H-79AVE-N

Project Location

DRAINAGE AREAS

		SQ. FT.	ACRES
Impervious Area	(A_i)	355,450	8.16
Pervious Area	(A_p)	18,731	0.43
Total Drainage Area	(A_t)	374,180	8.59

SFWMD RETENTION REQUIREMENTS

Percent Impervious =	95.0%	
1" of Runoff =	8.59	(ac-in)
2.5 inches X Percent Impervious =	20.40	(ac-in)
Volume of WQ Treatment Volume required (V_{wq}) =	20.40	(ac-in)
	2.37	(inches)
Additional WQ Volume (V_{add}) =	7.78	(ac-in)
	0.91	(inches)
Total Volume Treated by Trench = V_{wq} + V_{add} =	3.28	(inches)
(Max allowed 3.28 inches)		
Safety Factor (SF) =	2.0	(Minimum 2.0)
Percent Water Quality Reduction (%WQ) =	50%	
(50% for wet or dry retention)		

SFWMD EXFILTRATION TRENCH EQUATIONS AND TRENCH LENGTH

If $D_u > D_S$ or $W < 2(D_u + D_s)$ then Eq 1 Applies. If not, Eq 2 Applies.

$$Equation 1: \quad L_1 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(H_2W + 2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 1 = L_1 350.8 (feet)

$$Equation 2: \quad L_2 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 2 = L_2 409.2 (feet)

Trench Length Required = L_{REQ} 350.8 (feet)

Trench Length Provided = L_{PRO} 559.0 (feet)

Safety Factor Provided = SF_{PRO} 3.19

TRENCH DATA - SELFCONTAINED SYSTEM

Trench Width	W	5.0	(feet)		
Hydraulic Conductivity	K	1.58E-03	(cfs/ft2-ft head)		
Control Elevation	CE	2.75	(ft-NGVD)	DHW	
Invert Elevation of Lowest Inlet	EL_{inv}	4.60	(ft-NGVD)	Lowest Inlet Elevation	
Top Elevation of Trench	EL_{top}	3.10	(ft-NGVD)	Average El	3.10
Bottom Elevation of Trench	EL_{bot}	-11.90	(ft-NGVD)	Average Bottom El	-11.90
Pipe Diameter	D	24	(inches)		
Pipe Invert	P_{inv}	-0.40	(ft-NGVD)		-0.40
Head on Saturated Surface = El_{inv} - CE =	H_2	1.85	(feet)		
Unsaturated Trench Depth = EL_{top} - CE =	D_u	0.35	(feet)		
Saturated Trench Depth = CE - EL_{bot} =	D_S	14.65	(feet)		

Is Du > Ds	NO
Is W < 2*(Du + Ds)	YES

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Designed By:	AV
Checked By:	

Project Name: SWMP Update Doral
TEST PROJECT

Project Location

Catch Basin ID H-79AVE-S

DRAINAGE AREAS

		SQ. FT.	ACRES
Impervious Area	(A_i)	54,450	1.25
Pervious Area	(A_p)	3,049	0.07
Total Drainage Area	(A_t)	57,499	1.32

SFWMD RETENTION REQUIREMENTS

Percent Impervious =	94.7%	
1" of Runoff =	1.32	(ac-in)
2.5 inches X Percent Impervious =	3.13	(ac-in)
Volume of WQ Treatment Volume required (V_{wq}) =	3.13	(ac-in)
	2.37	(inches)
Additional WQ Volume (V_{add}) =	1.20	(ac-in)
	0.91	(inches)
Total Volume Treated by Trench = V_{wq} + V_{add} =	3.28	(inches)
(Max allowed 3.28 inches)		
Safety Factor (SF) =	2.0	(Minimum 2.0)
Percent Water Quality Reduction (%WQ) =	50%	
(50% for wet or dry retention)		

SFWMD EXFILTRATION TRENCH EQUATIONS AND TRENCH LENGTH

If $D_u > D_S$ or $W < 2(D_u + D_s)$ then Eq 1 Applies. If not, Eq 2 Applies.

$$Equation 1: \quad L_1 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(H_2W + 2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 1 = L_1 30.2 (feet)

$$Equation 2: \quad L_2 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 2 = L_2 35.2 (feet)

Trench Length Required = L_{REQ} 30.2 (feet)

Trench Length Provided = L_{PRO} 55.0 (feet)

Safety Factor Provided = SF_{PRO} 3.65

TRENCH DATA - SELFCONTAINED SYSTEM

Trench Width	W	5.0	(feet)		
Hydraulic Conductivity	K	2.84E-03	(cfs/ft2-ft head)		
Control Elevation	CE	2.75	(ft-NGVD)	DHW	
Invert Elevation of Lowest Inlet	EL_{inv}	4.60	(ft-NGVD)	Lowest Inlet Elevation	
Top Elevation of Trench	EL_{top}	3.10	(ft-NGVD)	Average El	3.10
Bottom Elevation of Trench	EL_{bot}	-11.90	(ft-NGVD)	Average Bottom El	-11.90
Pipe Diameter	D	24	(inches)		
Pipe Invert	P_{inv}	-0.40	(ft-NGVD)		-0.40
Head on Saturated Surface = El_{inv} - CE =	H_2	1.85	(feet)		
Unsaturated Trench Depth = EL_{top} - CE =	D_u	0.35	(feet)		
Saturated Trench Depth = CE - EL_{bot} =	D_S	14.65	(feet)		

Is Du > Ds	NO
Is W < 2*(Du + Ds)	YES

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Designed By:	AV
Checked By:	

Project Name: SWMP Update Doral
TEST PROJECT

Catch Basin ID D-2-1

Project Location

DRAINAGE AREAS

		SQ. FT.	ACRES
Impervious Area	(A_i)	474,804	10.90
Pervious Area	(A_p)	146,797	3.37
Total Drainage Area	(A_t)	621,601	14.27

SFWMD RETENTION REQUIREMENTS

Percent Impervious =	76.4%	
1" of Runoff =	14.27	(ac-in)
2.5 inches X Percent Impervious =	27.25	(ac-in)
Volume of WQ Treatment Volume required (V_{wq}) =	27.25	(ac-in)
	1.91	(inches)
Additional WQ Volume (V_{add}) =	19.56	(ac-in)
	1.37	(inches)
Total Volume Treated by Trench = V_{wq} + V_{add} =	3.28	(inches)
(Max allowed 3.28 inches)		
Safety Factor (SF) =	2.0	(Minimum 2.0)
Percent Water Quality Reduction (%WQ) =	50%	
(50% for wet or dry retention)		

SFWMD EXFILTRATION TRENCH EQUATIONS AND TRENCH LENGTH

If $D_u > D_S$ or $W < 2(D_u + D_s)$ then Eq 1 Applies. If not, Eq 2 Applies.

$$Equation1: \quad L_1 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(H_2W + 2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 1 = L_1 161.1 (feet)

$$Equation\ 2: \quad L_2 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 2 = L_2 188.0 (feet)

Trench Length Required = L_{REQ} 161.1 (feet)

Trench Length Provided = L_{PRO} 167.0 (feet)

Safety Factor Provided = SF_{PRO} 2.07

TRENCH DATA - SELFCONTAINED SYSTEM

Trench Width	W	5.0	(feet)		
Hydraulic Conductivity	K	6.73E-03	(cfs/ft2-ft head)		
Control Elevation	CE	2.75	(ft-NGVD)	DHW	
Invert Elevation of Lowest Inlet	EL_{inv}	4.50	(ft-NGVD)	Lowest Inlet Elevation	
Top Elevation of Trench	EL_{top}	3.00	(ft-NGVD)	Average El	3.00
Bottom Elevation of Trench	EL_{bot}	-12.00	(ft-NGVD)	Average Bottom El	-12.00
Pipe Diameter	D	24	(inches)		
Pipe Invert	P_{inv}	-0.50	(ft-NGVD)		-0.50
Head on Saturated Surface = El_{inv} - CE =	H_2	1.75	(feet)		
Unsaturated Trench Depth = EL_{top} - CE =	D_u	0.25	(feet)		
Saturated Trench Depth = CE - EL_{bot} =	D_S	14.75	(feet)		

Is Du > Ds	NO
Is W < 2*(Du + Ds)	YES

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Designed By:	AV
Checked By:	

Project Name: SWMP Update Doral
TEST PROJECT

Catch Basin ID E7

Project Location

DRAINAGE AREAS

		SQ. FT.	ACRES
Impervious Area	(A_i)	532,303	12.22
Pervious Area	(A_p)	165,964	3.81
Total Drainage Area	(A_t)	698,267	16.03

SFWMD RETENTION REQUIREMENTS

Percent Impervious =	76.2%	
1" of Runoff =	16.03	(ac-in)
2.5 inches X Percent Impervious =	30.55	(ac-in)
Volume of WQ Treatment Volume required (V_{wq}) =	30.55	(ac-in)
	1.91	(inches)
Additional WQ Volume (V_{add}) =	22.03	(ac-in)
	1.37	(inches)
Total Volume Treated by Trench = V_{wq} + V_{add} =	3.28	(inches)
(Max allowed 3.28 inches)		
Safety Factor (SF) =	2.0	(Minimum 2.0)
Percent Water Quality Reduction (%WQ) =	50%	
(50% for wet or dry retention)		

SFWMD EXFILTRATION TRENCH EQUATIONS AND TRENCH LENGTH

If $D_u > D_S$ or $W < 2(D_u + D_s)$ then Eq 1 Applies. If not, Eq 2 Applies.

$$Equation 1: \quad L_1 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(H_2 W + 2H_2 D_u - D_u^2 + 2H_2 D_s\right) + (1.39E-04)W D_u}$$

Trench Length Required for Eq 1 = L_1 665.8 (feet)

$$Equation\ 2: \quad L_2 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(2H_2 D_u - D_u^2 + 2H_2 D_s\right) + (1.39E-04)W D_u}$$

Trench Length Required for Eq 2 = L_2 776.7 (feet)

Trench Length Required = L_{REQ} 665.8 (feet)

Trench Length Provided = L_{PRO} 719.0 (feet)

Safety Factor Provided = SF_{PRO} 2.16

TRENCH DATA - SELFCONTAINED SYSTEM

Trench Width	W	5.0	(feet)		
Hydraulic Conductivity	K	1.81E-03	(cfs/ft2-ft head)		
Control Elevation	CE	2.75	(ft-NGVD)	DHW	
Invert Elevation of Lowest Inlet	EL_{inv}	4.52	(ft-NGVD)	Lowest Inlet Elevation	
Top Elevation of Trench	EL_{top}	3.02	(ft-NGVD)	Average El	3.02
Bottom Elevation of Trench	EL_{bot}	-11.98	(ft-NGVD)	Average Bottom El	-11.98
Pipe Diameter	D	24	(inches)		
Pipe Invert	P_{inv}	-0.48	(ft-NGVD)		-0.48
Head on Saturated Surface = El_{inv} - CE =	H_2	1.77	(feet)		
Unsaturated Trench Depth = EL_{top} - CE =	D_u	0.27	(feet)		
Saturated Trench Depth = CE - EL_{bot} =	D_S	14.73	(feet)		

Is Du > Ds	NO
Is W < 2*(Du + Ds)	YES

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PROJECT No.:	0
Designed By:	AV
Checked By:	

Project Name: SWMP Update Doral
TEST PROJECT

Catch Basin ID C-5

Project Location

DRAINAGE AREAS

		SQ. FT.	ACRES
Impervious Area	(A_i)	3,102,779	71.23
Pervious Area	(A_p)	852,034	19.56
Total Drainage Area	(A_t)	3,954,812	90.79

SFWMD RETENTION REQUIREMENTS

Percent Impervious =	78.5%	
1" of Runoff =	90.79	(ac-in)
2.5 inches X Percent Impervious =	178.08	(ac-in)
Volume of WQ Treatment Volume required (V_{wq}) =	178.08	(ac-in)
	1.96	(inches)
Additional WQ Volume (V_{add}) =	119.72	(ac-in)
	1.32	(inches)
Total Volume Treated by Trench = V_{wq} + V_{add} =	3.28	(inches)
(Max allowed 3.28 inches)		
Safety Factor (SF) =	2.0	(Minimum 2.0)
Percent Water Quality Reduction (%WQ) =	50%	
(50% for wet or dry retention)		

SFWMD EXFILTRATION TRENCH EQUATIONS AND TRENCH LENGTH

If $D_u > D_S$ or $W < 2(D_u + D_s)$ then Eq 1 Applies. If not, Eq 2 Applies.

$$Equation 1: \quad L_1 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(H_2 W + 2H_2 D_u - D_u^2 + 2H_2 D_s\right) + (1.39E-04)W D_u}$$

Trench Length Required for Eq 1 = L_1 3,182.7 (feet)

$$Equation 2: \quad L_2 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(2H_2 D_u - D_u^2 + 2H_2 D_s\right) + (1.39E-04)W D_u}$$

Trench Length Required for Eq 2 = L_2 3,713.3 (feet)

Trench Length Required = L_{REQ} 3,182.7 (feet)

Trench Length Provided = L_{PRO} 3,333 (feet)

Safety Factor Provided = SF_{PRO} 2.09

TRENCH DATA - SELFCONTAINED SYSTEM

Trench Width	W	5.0	(feet)		
Hydraulic Conductivity	K	1.96E-03	(cfs/ft2-ft head)		
Control Elevation	CE	2.75	(ft-NGVD)	DHW	
Invert Elevation of Lowest Inlet	EL_{inv}	4.66	(ft-NGVD)	Lowest Inlet Elevation	
Top Elevation of Trench	EL_{top}	3.16	(ft-NGVD)	Average El	3.16
Bottom Elevation of Trench	EL_{bot}	-11.84	(ft-NGVD)	Average Bottom El	-11.84
Pipe Diameter	D	24	(inches)		
Pipe Invert	P_{inv}	-0.34	(ft-NGVD)		-0.34
Head on Saturated Surface = El_{inv} - CE =	H_2	1.91	(feet)		
Unsaturated Trench Depth = EL_{top} - CE =	D_u	0.41	(feet)		
Saturated Trench Depth = CE - EL_{bot} =	D_S	14.59	(feet)		

Is Du > Ds	NO
Is W < 2*(Du + Ds)	YES

NOTES: Gray Cells is where data is required, and blue Cells is where data is calculated.

SHEET NO.	1 of 2
DATE	5/1/2014
PROJECT No.:	0
Designed By:	AV
Checked By:	

Project Name: SWMP Update Doral
TEST PROJECT

Catch Basin ID. O-1

Project Location

DRAINAGE AREAS

		SQ. FT.	ACRES
Impervious Area	(A_i)	485,694	11.15
Pervious Area	(A_p)	19,713,514	452.56
Total Drainage Area	(A_t)	20,199,208	463.71

SFWMD RETENTION REQUIREMENTS

Percent Impervious =	2.4%	
1" of Runoff =	463.71	(ac-in)
2.5 inches X Percent Impervious =	27.88	(ac-in)
Volume of WQ Treatment Volume required (V_{wq}) =	463.71	(ac-in)
	1.00	(inches)
Additional WQ Volume (V_{add}) =	1057.26	(ac-in)
	2.28	(inches)
Total Volume Treated by Trench = V_{wq} + V_{add} =	3.28	(inches)
(Max allowed 3.28 inches)		
Safety Factor (SF) =	2.0	(Minimum 2.0)
Percent Water Quality Reduction (%WQ) =	50%	
(50% for wet or dry retention)		

SFWMD EXFILTRATION TRENCH EQUATIONS AND TRENCH LENGTH

If $D_u > D_S$ or $W < 2(D_u + D_s)$ then Eq 1 Applies. If not, Eq 2 Applies.

$$Equation 1: \quad L_1 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(H_2W + 2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 1 = L_1 24,274.4 (feet)

$$Equation\ 2: \quad L_2 = \frac{FS\left[(\%WQ)(V_{wq}) + V_{add}\right]}{K\left(2H_2D_u - D_u^2 + 2H_2D_s\right) + (1.39E-04)WD_u}$$

Trench Length Required for Eq 2 = L_2 28,317.3 (feet)

Trench Length Required = L_{REQ} 24,274.4 (feet)

Trench Length Provided = L_{PRO} 24,390 (feet)

Safety Factor Provided = SF_{PRO} 2.01

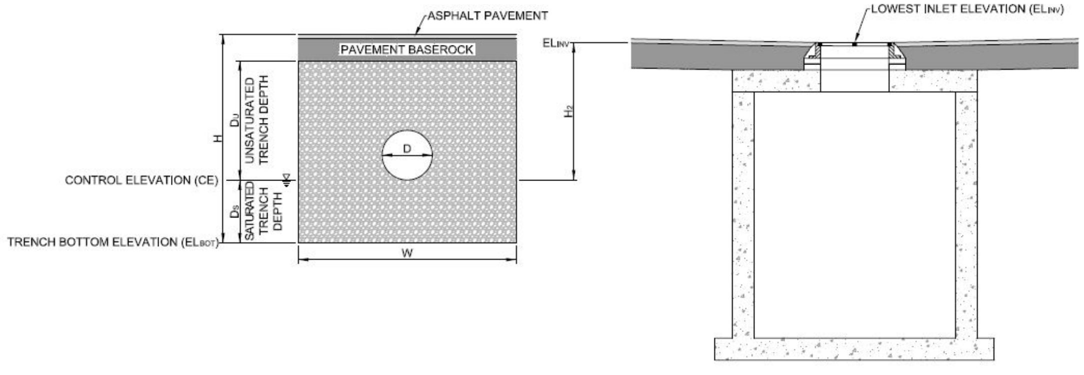
TRENCH DATA - SELFCONTAINED SYSTEM

Trench Width	W	5.0	(feet)		
Hydraulic Conductivity	K	1.73E-03	(cfs/ft2-ft head)		
Control Elevation	CE	2.75	(ft-NGVD)	DHW	
Invert Elevation of Lowest Inlet	EL_{inv}	4.50	(ft-NGVD)	Lowest Inlet Elevation	
Top Elevation of Trench	EL_{top}	3.00	(ft-NGVD)	Average El	3.00
Bottom Elevation of Trench	EL_{bot}	-12.00	(ft-NGVD)	Average Bottom El	-12.00
Pipe Diameter	D	24	(inches)		
Pipe Invert	P_{inv}	-0.50	(ft-NGVD)		-0.50
Head on Saturated Surface = El_{inv} - CE =	H_2	1.75	(feet)		
Unsaturated Trench Depth = EL_{top} - CE =	D_u	0.25	(feet)		
Saturated Trench Depth = CE - EL_{bot} =	D_S	14.75	(feet)		

Is Du > Ds	NO
Is W < 2*(Du + Ds)	YES

NOTES: Gray Cells is where data is required, and blue Cells is where data is calculated.

SELF CONTAINED EXFILTRATION TRENCH



TRENCH SECTION   LOWEST INLET

APPENDIX W. PLANNING LEVEL COST ESTIMATE FOR THE TOP 20 RANKED SUB-BASINS

					O-1		G-1		F-5		NW 114 AVE		F-1 with PS		F-1 No PS		C-5	
ITEM	PAY ITEM	DESCRIPTION	UNITS	AVERAGE UNIT COST	QUANTITY	TOTAL AMOUNT	QUANTITY	TOTAL AMOUNT	QUANTITY	TOTAL AMOUNT	QUANTITY	TOTAL AMOUNT	QUANTITY	TOTAL AMOUNT	QUANTITY	TOTAL AMOUNT	QUANTITY	TOTAL AMOUNT
ROADWAY PAY ITEMS																		
1	110-1-1	CLEARING AND GRUBBING	AC	$ 52,260.38	0.212015231	$ 11,080.00	0.298897536	$ 15,620.50	0	$ -	0	$ -	0.674423098	$ 35,245.61	0.674423098	$ 35,245.61	0	$ -
2	327-70-1	MILLING EXISTING ASPHALT (1" AVG. DEPTH) (INCLUDES REWORKED BASE AREAS)	SY	$ 5.00	11578.01006	$ 57,890.05	6226.990822	$ 31,134.95	1452.544772	$ 7,262.72	1851.028511	$ 9,255.14	359.6637146	$ 1,798.32	359.6637146	$ 1,798.32	3096.24696	$ 15,481.23
3	331-2-1	TYPE S-I ASPHALTIC CONCRETE (1") (110 LBS/SY)	TN	$ 200.00	636.7905533	$ 127,358.11	342.4844952	$ 68,496.90	79.88996245	$ 15,977.99	101.8065681	$ 20,361.31	19.7815043	$ 3,956.30	19.7815043	$ 3,956.30	170.2935828	$ 34,058.72
4	522-2	CONCRETE SIDEWALK / DRIVEWAY (6" THICK)	SY	$ 52.65	9812.6183	$ 516,634.35	7091.181523	$ 373,350.71	372.8516	$ 19,630.64	1684.712904	$ 88,700.13	299.9937359	$ 15,794.67	299.9937359	$ 15,794.67	42.218	$ 2,222.78
5	570-1-2	PERFORMANCE TURF (SOD)	SY	$ 3.67	1025.1294	$ 3,762.22	1445.22	$ 5,303.96	0	$ -	0	$ -	3260.949431	$ 11,967.68	3260.949431	$ 11,967.68	0	$ -
		SUBTOTAL			**$**	**716,724.74**	**$**	**493,907.02**	**$**	**42,871.35**	**$**	**118,316.59**	**$**	**68,762.58**	**$**	**68,762.58**	**$**	**51,762.73**
ITEM	**PAY ITEM**	**DESCRIPTION**	**UNITS**	**AVERAGE UNIT COST**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**
DRAINAGE ITEMS																		
6	425-1-901	CATCH BASINS <10'	EA	$ 10,000.00	142	$ 1,420,000.00	43	$ 430,000.00	13	$ 130,000.00	13	$ 130,000.00	50	$ 500,000.00	50	$ 500,000.00	28	$ 280,000.00
7		BACKFLOW PREVENTOR	EA	$ 45,000.00	0	$ -	0	$ -	0	$ -	2	$ 90,000.00	0	$ -	0	$ -	0	$ -
8	425-2-41	MANHOLE <10'	EA	$ 6,000.00	6	$ 36,000.00	6	$ 36,000.00	8	$ 48,000.00	1	$ 6,000.00	2	$ 12,000.00	2	$ 12,000.00	5	$ 30,000.00
9	430-94-1	DESILTING PIPE, 0-24"	LF	$ 8.08	26381.05493	$ 213,158.92	916.5025595	$ 7,405.34	267.7566339	$ 2,163.47	925	$ 7,473.42	7664.057968	$ 61,925.59	7664.057968	$ 61,925.59	515	$ 4,161.20
10	430-175-115	PIPE CULVERT, OPTIONAL MATERIAL, ROUND, 18" SD	LF	$ 101.25	22,569.05	$ 2,285,116.81	-	$ -	-	$ -	-	$ -	103.09	$ 10,437.90	103.09	$ 10,437.90	-	$ -
11	443-70-4	FRENCH DRAIN, 24"	LF	$ 143.50	24,389.45	$ 3,499,885.97	4,831.53	$ 693,324.24	1,916.58	$ 275,029.25	1,498.77	$ 215,073.99	6,463.57	$ 927,522.16	6,463.57	$ 927,522.16	3,333.42	$ 478,346.47
12		PIPE CULVERT, OPTIONAL MATERIAL, ROUND, 24" SD	LF	$ 81.50	-	$ -	10,446.80	$ 851,413.90	787.92	$ 64,215.24	2,292.21	$ 186,815.09	183.87	$ 14,985.79	183.87	$ 14,985.79	2,749.10	$ 224,052.00
13		2-20,000 gpm pump station/CDS/Panel	EA	$ 4,000,000.00		$ -		$ -		$ -		$ -	1.00	$ 4,000,000.00	-	$ -		$ -
		SUBTOTAL			**$**	**7,454,161.70**	**$**	**2,018,143.48**	**$**	**519,407.97**	**$**	**635,362.50**	**$**	**5,526,871.43**	**$**	**1,526,871.43**	**$**	**1,016,559.67**
14	102-1	MAINTENANCE OF TRAFFIC (10%) (ESTIMATED 120 DAYS)	LS		$	817,088.64	$	251,205.05	$	56,227.93	$	75,367.91	$	559,563.40	$	159,563.40	$	106,832.24
15	101-1	MOBILIZATION (10%)	LS		$	817,088.64	$	251,205.05	$	56,227.93	$	75,367.91	$	559,563.40	$	159,563.40	$	106,832.24
16		PERMIT (2%)	LS		$	163,417.73	$	50,241.01	$	11,245.59	$	15,073.58	$	111,912.68	$	31,912.68	$	21,366.45
17		CONTINGENCY (25%)	LS		$	2,042,721.61	$	628,012.62	$	140,569.83	$	188,419.77	$	1,398,908.50	$	398,908.50	$	267,080.60
		TOTAL			**$**	**12,011,203.06**	**$**	**3,692,714.23**	**$**	**826,550.60**	**$**	**1,107,908.26**	**$**	**8,225,582.00**	**$**	**2,345,582.00**	**$**	**1,570,433.93**

					D-3-1		D-4-2		E-7		G-4		NW 33 ST W		D-2-1		D-1-1	
ITEM	**PAY ITEM**	**DESCRIPTION**	**UNITS**	**AVERAGE UNIT COST**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**
ROADWAY PAY ITEMS																		
1	110-1-1	CLEARING AND GRUBBING	AC	$ 52,260.38	0.002479334	$ 129.57	0	$ -	0.039427845	$ 2,060.51	0	$ -	0.132588778	$ 6,929.14	0	$ -	0	$ -
2	327-70-1	MILLING EXISTING ASPHALT (1" AVG. DEPTH) (INCLUDES REWORKED BASE AREAS)	SY	$ 5.00	776.2518294	$ 3,881.26	1685.730712	$ 8,428.65	836.6576981	$ 4,183.29	3961.7924	$ 19,808.96	167.86086	$ 839.30	368.6656884	$ 1,843.33	316.1445621	$ 1,580.72
3	331-2-1	TYPE S-I ASPHALTIC CONCRETE (1") (110 LBS/SY)	TN	$ 200.00	42.69385062	$ 8,538.77	92.71518917	$ 18,543.04	46.0161734	$ 9,203.23	217.898582	$ 43,579.72	9.2323473	$ 1,846.47	20.27661286	$ 4,055.32	17.38795091	$ 3,477.59
4	522-2	CONCRETE SIDEWALK / DRIVEWAY (6" THICK)	SY	$ 52.65	270.377404	$ 14,235.37	527.5028	$ 27,773.02	0	$ -	451.9548	$ 23,795.42	67.406592	$ 3,548.96	60.8828	$ 3,205.48	0	$ -
5	570-1-2	PERFORMANCE TURF (SOD)	SY	$ 3.67	11.988	$ 44.00	0	$ -	190.64028	$ 699.65	0	$ -	641.0891029	$ 2,352.80	0	$ -	0	$ -
		SUBTOTAL			**$**	**26,828.97**	**$**	**54,744.71**	**$**	**16,146.69**	**$**	**87,184.10**	**$**	**15,516.67**	**$**	**9,104.13**	**$**	**5,058.31**
ITEM	**PAY ITEM**	**DESCRIPTION**	**UNITS**	**AVERAGE UNIT COST**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**
DRAINAGE ITEMS																		
6	425-1-901	CATCH BASINS <10'	EA	$ 10,000.00	9	$ 90,000.00	26	$ 260,000.00	12	$ 120,000.00	35	$ 350,000.00	4	$ 40,000.00	5	$ 50,000.00	4	$ 40,000.00
7		BACKFLOW PREVENTOR	EA	$ 45,000.00	0	$ -	0	$ -	0	$ -	2	$ 90,000.00	0	$ -	0	$ -	0	$ -
8	425-2-41	MANHOLE <10'	EA	$ 6,000.00	5	$ 30,000.00	2	$ 12,000.00	2	$ 12,000.00	7	$ 42,000.00	1	$ 6,000.00	1	$ 6,000.00	1	$ 6,000.00
9	430-94-1	DESILTING PIPE, 0-24"	LF	$ 8.08	1810.62834	$ 14,629.88	2711.384342	$ 21,907.99	0	$ -	175.8369426	$ 1,420.76	1563.950944	$ 12,636.72	176.47	$ 1,425.88	795.028	$ 6,423.83
10	430-175-115	PIPE CULVERT, OPTIONAL MATERIAL, ROUND, 18" SD	LF	$ 101.25	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -
11	443-70-4	FRENCH DRAIN, 24"	LF	$ 143.50	358.47	$ 51,440.81	671.33	$ 96,335.67	718.62	$ 103,122.51	3,544.71	$ 508,665.38	144.58	$ 20,747.23	167.00	$ 23,964.50	128.71	$ 18,469.31
12		PIPE CULVERT, OPTIONAL MATERIAL, ROUND, 24" SD	LF	$ 81.50	903.71	$ 73,652.55	2,369.36	$ 193,103.01	1,217.11	$ 99,194.50	4,244.25	$ 345,906.32	1,353.38	$ 110,300.16	593.56	$ 48,375.14	448.33	$ 36,539.00
13		2-20,000 gpm pump station/CDS/Panel	EA	$ 4,000,000.00		$ -		$ -		$ -		$ -		$ -		$ -		$ -
		SUBTOTAL			**$**	**259,723.24**	**$**	**583,346.66**	**$**	**334,317.01**	**$**	**1,337,992.47**	**$**	**189,684.11**	**$**	**129,765.52**	**$**	**107,432.14**
14	102-1	MAINTENANCE OF TRAFFIC (10%) (ESTIMATED 120 DAYS)	LS		$	28,655.22	$	63,809.14	$	35,046.37	$	142,517.66	$	20,520.08	$	13,886.96	$	11,249.05
15	101-1	MOBILIZATION (10%)	LS		$	28,655.22	$	63,809.14	$	35,046.37	$	142,517.66	$	20,520.08	$	13,886.96	$	11,249.05
16		PERMIT (2%)	LS		$	5,731.04	$	12,761.83	$	7,009.27	$	28,503.53	$	4,104.02	$	2,777.39	$	2,249.81
17		CONTINGENCY (25%)	LS		$	71,638.05	$	159,522.84	$	87,615.92	$	356,294.14	$	51,300.19	$	34,717.41	$	28,122.61
		TOTAL			**$**	**421,231.74**	**$**	**937,994.33**	**$**	**515,181.63**	**$**	**2,095,009.55**	**$**	**301,645.14**	**$**	**204,138.38**	**$**	**165,360.97**

					H-79AVE-S		NW 52 ST W		H-5		H-79AVE-N		H-7		H-8		NW 33 ST	
ITEM	**PAY ITEM**	**DESCRIPTION**	**UNITS**	**AVERAGE UNIT COST**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**
ROADWAY PAY ITEMS																		
1	110-1-1	CLEARING AND GRUBBING	AC	$ 52,260.38	0	$ -	0	$ -	0.013406771	$ 700.64	0	$ -	0	$ -	0	$ -	0.28759938	$ 15,030.05
2	327-70-1	MILLING EXISTING ASPHALT (1" AVG. DEPTH) (INCLUDES REWORKED BASE AREAS)	SY	$ 5.00	334.5808434	$ 1,672.90	2847.676449	$ 14,238.38	790.1763833	$ 3,950.88	1159.873743	$ 5,799.37	4899.562192	$ 24,497.81	3499.691424	$ 17,498.46	108.78	$ 543.90
3	331-2-1	TYPE S-I ASPHALTIC CONCRETE (1") (110 LBS/SY)	TN	$ 200.00	18.40194638	$ 3,680.39	156.6222047	$ 31,324.44	43.45970108	$ 8,691.94	63.79305584	$ 12,758.61	269.4759206	$ 53,895.18	192.4830283	$ 38,496.61	5.9829	$ 1,196.58
4	522-2	CONCRETE SIDEWALK / DRIVEWAY (6" THICK)	SY	$ 52.65	274.8882675	$ 14,472.87	1746.57319	$ 91,957.08	0	$ -	968.9378739	$ 51,014.58	4064.949012	$ 214,019.57	404.8484	$ 21,315.27	24.8864	$ 1,310.27
5	570-1-2	PERFORMANCE TURF (SOD)	SY	$ 3.67	0	$ -	0	$ -	64.824	$ 237.90	0	$ -	0	$ -	0	$ -	1390.591509	$ 5,103.47
		SUBTOTAL			**$**	**19,826.16**	**$**	**137,519.90**	**$**	**13,581.37**	**$**	**69,572.56**	**$**	**292,412.56**	**$**	**77,310.33**	**$**	**23,184.27**
ITEM	**PAY ITEM**	**DESCRIPTION**	**UNITS**	**AVERAGE UNIT COST**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**	**QUANTITY**	**TOTAL AMOUNT**
DRAINAGE ITEMS																		
6	425-1-901	CATCH BASINS <10'	EA	$ 10,000.00	5	$ 50,000.00	18	$ 180,000.00	17	$ 170,000.00	6	$ 60,000.00	31	$ 310,000.00	60	$ 600,000.00	7	$ 70,000.00
7		BACKFLOW PREVENTOR	EA	$ 45,000.00	1	$ 45,000.00	0	$ -	1	$ 45,000.00	0	$ -	0	$ -	0	$ -	4	$ 180,000.00
8	425-2-41	MANHOLE <10'	EA	$ 6,000.00	0	$ -	7	$ 42,000.00	0	$ -	0	$ -	18	$ 108,000.00	2	$ 12,000.00	0	$ -
9	430-94-1	DESILTING PIPE, 0-24"	LF	$ 8.08	501.7	$ 4,053.74	3585.959684	$ 28,974.55	0	$ -	1936.285	$ 15,645.18	5108.728056	$ 41,278.52	3023.141	$ 24,426.98	1619.29	$ 13,083.86
10	430-175-115	PIPE CULVERT, OPTIONAL MATERIAL, ROUND, 18" SD	LF	$ 101.25	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -
11	443-70-4	FRENCH DRAIN, 24"	LF	$ 143.50	54.75	$ 7,856.10	2,520.88	$ 361,745.71	1,466.68	$ 210,468.08	558.82	$ 80,190.56	5,626.10	$ 807,345.64	6,084.17	$ 873,078.81	305.01	$ 43,768.72
12		PIPE CULVERT, OPTIONAL MATERIAL, ROUND, 24" SD	LF	$ 81.50	563.81	$ 45,950.85	3,217.81	$ 262,251.49	-	$ -	720.01	$ 58,680.74	4,085.95	$ 333,004.76	124.02	$ 10,107.22	2,826.95	$ 230,396.78
13		2-20,000 gpm pump station/CDS/Panel	EA	$ 4,000,000.00		$ -		$ -		$ -		$ -		$ -		$ -		$ -
		SUBTOTAL			**$**	**152,860.69**	**$**	**874,971.75**	**$**	**425,468.08**	**$**	**214,516.48**	**$**	**1,599,628.92**	**$**	**1,519,613.01**	**$**	**537,249.36**
14	102-1	MAINTENANCE OF TRAFFIC (10%) (ESTIMATED 120 DAYS)	LS		$	17,268.68	$	101,249.17	$	43,904.95	$	28,408.90	$	189,204.15	$	159,692.33	$	56,043.36
15	101-1	MOBILIZATION (10%)	LS		$	17,268.68	$	101,249.17	$	43,904.95	$	28,408.90	$	189,204.15	$	159,692.33	$	56,043.36
16		PERMIT (2%)	LS		$	3,453.74	$	20,249.83	$	8,780.99	$	5,681.78	$	37,840.83	$	31,938.47	$	11,208.67
17		CONTINGENCY (25%)	LS		$	43,171.71	$	253,122.91	$	109,762.36	$	71,022.26	$	473,010.37	$	399,230.84	$	140,108.41
		TOTAL			**$**	**253,849.67**	**$**	**1,488,362.73**	**$**	**645,402.70**	**$**	**417,610.88**	**$**	**2,781,300.98**	**$**	**2,347,477.31**	**$**	**823,837.44**

APPENDIX X. FLOOD REDUCTION BENEFIT AND FPSS SCORE

Sub-Basin	SLR BASIN RANK (CITY Modified)	SLR WEIGHTED FPSS	NEW WEIGHTED FPSS with improvement Projects	Difference	% Change from SLR	Approx. Total Cost Project	Cost per % Reduction FPSS	Cost Ranking*
H-5	1	25.17	25.12	0.05	0.21%	$ 645,402.70	$ 1,346.06	7
F-1 No PS	2	51.95	51.79	0.17	0.32%	$ 2,345,582.00	$ 7,450.86	11
H-7	3	194.96	161.11	33.86	17.37%	$ 2,781,300.98	$ 482,976.03	18
H-8	4	14.39	13.80	0.60	4.14%	$ 2,347,477.31	$ 97,116.88	16
D-3-1	5	21.97	21.96	0.02	0.09%	$ 421,231.74	$ 374.84	6
D-4-2	6	38.19	38.18	0.01	0.03%	$ 937,994.33	$ 248.40	5
NW 33 St	7	1.92	1.91	0.01	0.50%	$ 823,837.44	$ 4,092.63	9
D-1-1	8	29.84	29.83	0.01	0.03%	$ 165,360.97	$ 42.66	2
NW 33 ST W	9	20.50	20.50	0.00	0.01%	$ 301,645.14	$ 20.28	1
F-5	10	28.46	28.14	0.32	1.13%	$ 826,550.60	$ 9,316.15	12
NW 52 ST W	11	56.83	55.41	1.42	2.49%	$ 1,488,362.73	$ 37,115.12	13
NW 114 AVE	12	26.76	25.65	1.11	4.15%	$ 1,107,908.26	$ 46,014.88	14
G-4	13	10.56	10.20	0.37	3.49%	$ 2,095,009.55	$ 73,135.50	15
G-1	14	11.38	9.73	1.65	14.46%	$ 3,692,714.23	$ 533,885.50	19
H-79AVE-N	15	0.64	0.48	0.16	25.49%	$ 417,610.88	$ 106,432.05	17
H-79AVE-S	16	0.38	0.37	0.00	1.22%	$ 253,849.67	$ 3,098.85	8
D-2-1	17	6.61	6.61	0.00	0.04%	$ 204,138.38	$ 76.99	4
E-7	18	9.81	9.81	0.00	0.01%	$ 515,181.63	$ 55.90	3
C-5	19	9.08	9.04	0.04	0.47%	$ 1,570,433.93	$ 7,339.95	10
O-1	20	15.11	14.38	0.73	4.83%	$ 12,011,203.06	$ 580,611.84	20
TOTAL						**$ 34,952,795.52**		
F-1 with PS	2	51.95	51.71	0.24	0.46%	$ 8,225,582.00	$ 38,064.33	
* Cost Ranking in Ascending order of the cost per % reduction of FPSS								

APPENDIX Y. CAPITAL IMPROVEMENT PLAN ALTERNATIVES

Basin Ranking				
Fiscal Year	**SLR Basin Rank**	**Cost Rank**	**Sub-Basin Name**	**Estimated Project Cost**
Year 1	1	7	H-5	$645,402.70
	5	6	D-3-1	$421,231.74
	6	5	D-4-2	$937,994.33
SUBTOTAL YEAR 1				***$2,004,628.76***
Year 2	2	11	F-1 No PS	$2,345,582.00
SUBTOTAL YEAR 2				***$2,345,582.00***
Year 3	4	16	H-8	$2,347,477.31
SUBTOTAL YEAR 3				***$2,347,477.31***
Year 4	7	9	NW 33 St	$823,837.44
	8	2	D-1-1	$165,360.97
	9	1	NW 33 ST W	$301,645.14
	10	12	F-5	$826,550.60
SUBTOTAL YEAR 4				***$2,117,394.15***
Year 5	12	14	NW 114 AVE	$1,107,908.26
	15	17	H-79AVE-N	$417,610.88
	16	8	H-79AVE-S	$253,849.67
	17	4	D-2-1	$204,138.38
SUBTOTAL YEAR 5				***$1,983,507.19***
TOTAL				**$10,798,589.42**

Year 6 to 17				
Fiscal Year	**SLR Basin Rank**	**Cost Rank**	**Sub-Basin Name**	**Estimated Project Cost**
Year 6	3	18	H-7, Phase I	$2,100,000.00
SUBTOTAL YEAR 6				***$2,100,000.00***
Year 7	11	13	NW 52 ST W	$1,488,362.73
	18	3	E-7	$515,181.63
SUBTOTAL YEAR 7				***$2,003,544.36***
Year 8	13	15	G-4	$2,095,009.55
SUBTOTAL YEAR 8				***$2,095,009.55***
Year 9	14	19	G-1, Phase I	$2,000,000.00
SUBTOTAL YEAR 9				***$2,000,000.00***
Year 10	14	19	G-1, Phase II	$1,692,714.23
SUBTOTAL YEAR 10				***$1,692,714.23***
Year 11	19	10	C-5	$1,570,433.93
	3	18	H-7, Phase II	$681,300.98
SUBTOTAL YEAR 11				***$2,251,734.91***
Year 12 to Year 16	20	20	O-1, Phase I - to Phase V	$2,000,000.00
OTAL YEAR 12 to Year 16				***$10,000,000.00***
Year 17	20	20	O-1, Phase VI	$ 2,011,203.06
SUBTOTAL YEAR 17				***$2,011,203.06***
TOTAL				**$24,154,206.11**

Cost Effectiveness				
Cost Effectiveness	**Cost Rank**	**SLR Basin**	**Sub-Basin**	**Estimated Project**
Year 1	1	9	NW 33 ST W	$301,645.14
	2	8	D-1-1	$165,360.97
	3	18	E-7	$515,181.63
	4	17	D-2-1	$204,138.38
	5	6	D-4-2	$937,994.33
SUBTOTAL YEAR 1				***$2,124,320.45***
Year 2	6	5	D-3-1	$421,231.74
	7	1	H-5	$645,402.70
	8	16	H-79AVE-S	$253,849.67
	9	7	NW 33 St	$823,837.44
SUBTOTAL YEAR 2				***$2,144,321.54***
Year 3	10	19	C-5	$1,570,433.93
	17	15	H-79AVE-N	$417,610.88
SUBTOTAL YEAR 3				***$1,988,044.81***
Year 4	11	2	F-1 No PS	$2,345,582.00
SUBTOTAL YEAR 4				***$2,345,582.00***
Year 5	12	10	F-5	$826,550.60
	14	12	NW 114 AVE	$1,107,908.26
SUBTOTAL YEAR 5				***$1,934,458.86***
TOTAL				**$10,536,727.66**
Year 6 to 17				
Fiscal Year	**Cost Rank**	**Rank**	**Name**	**Cost**
Year 6	13	11	NW 52 ST W	$1,488,362.73
	18	3	H-7, Phase II	$681,300.98
SUBTOTAL YEAR 6				***$2,169,663.71***
Year 7	15	13	G-4	$2,095,009.55
SUBTOTAL YEAR 7				***$2,095,009.55***
Year 8	16	4	H-8	$2,347,477.31
SUBTOTAL YEAR 8				***$2,347,477.31***
Year 9	18	3	H-7, Phase I	$2,100,000.00
SUBTOTAL YEAR 9				***$2,100,000.00***
Year 10	19	14	G-1, Phase I	$2,000,000.00
SUBTOTAL YEAR 10				***$2,000,000.00***
Year 11	19	14	G-1, Phase II	$1,692,714.23
SUBTOTAL YEAR 11				***$1,692,714.23***
Year 12 to Year 16	20	20	O-1, Phase I - to Phase V	$2,000,000.00
SUBTOTAL YEAR 12 to Year 16				***$10,000,000.00***
Year 17	20	20	O-1, Phase VI	$ 2,011,203.06
SUBTOTAL YEAR 17				***$2,011,203.06***
TOTAL				**$24,416,067.86**

HYBRID				
Fiscal Year	**SLR Basin**	**Cost Rank**	**Sub-Basin**	**Estimated Project**
Year 1	1	7	H-5	$645,402.70
	5	6	D-3-1	$421,231.74
	9	1	NW 33 ST W	$301,645.14
	8	2	D-1-1	$165,360.97
	15	17	H-79AVE-N	$417,610.88
SUBTOTAL YEAR 1				***$1,951,251.42***
Year 2	6	5	D-4-2	$937,994.33
	7	9	NW 33 St	$823,837.44
	16	8	H-79AVE-S	$253,849.67
SUBTOTAL YEAR 2				***$2,015,681.44***
Year 3	2	11	F-1 No PS	$2,345,582.00
SUBTOTAL YEAR 3				***$2,345,582.00***
Year 4	10	12	F-5	$826,550.60
	12	14	NW 114 AVE	$1,107,908.26
	17	4	D-2-1	$204,138.38
SUBTOTAL YEAR 4				***$2,138,597.24***
Year 5	4	16	H-8	$2,347,477.31
SUBTOTAL YEAR 5				***$2,347,477.31***
TOTAL				**$10,798,589.42**

Year 6 to 17				
Fiscal Year	**Rank**	**Cost Rank**	**Name**	**Cost**
Year 6	3	18	H-7, Phase I	$2,100,000.00
SUBTOTAL YEAR 6				***$2,100,000.00***
Year 7	11	13	NW 52 ST W	$1,488,362.73
	3	18	H-7, Phase II	$681,300.98
SUBTOTAL YEAR 7				***$2,169,663.71***
Year 8	13	15	G-4	$2,095,009.55
SUBTOTAL YEAR 8				***$2,095,009.55***
Year 9	14	19	G-1, Phase I	$2,000,000.00
SUBTOTAL YEAR 9				***$2,000,000.00***
Year 10	14	19	G-1, Phase II	$1,692,714.23
SUBTOTAL YEAR 10				***$1,692,714.23***
Year 11	19	10	C-5	$1,570,433.93
	18	3	E-7	$515,181.63
SUBTOTAL YEAR 11				***$2,085,615.56***
Year 12 to Year 16	20	20	O-1, Phase I - to Phase V	$2,000,000.00
SUBTOTAL YEAR 12 to Year 16				***$10,000,000.00***
Year 17	20	20	O-1, Phase VI	$ 2,011,203.06
SUBTOTAL YEAR 17				***$2,011,203.06***
TOTAL				**$24,154,206.11**