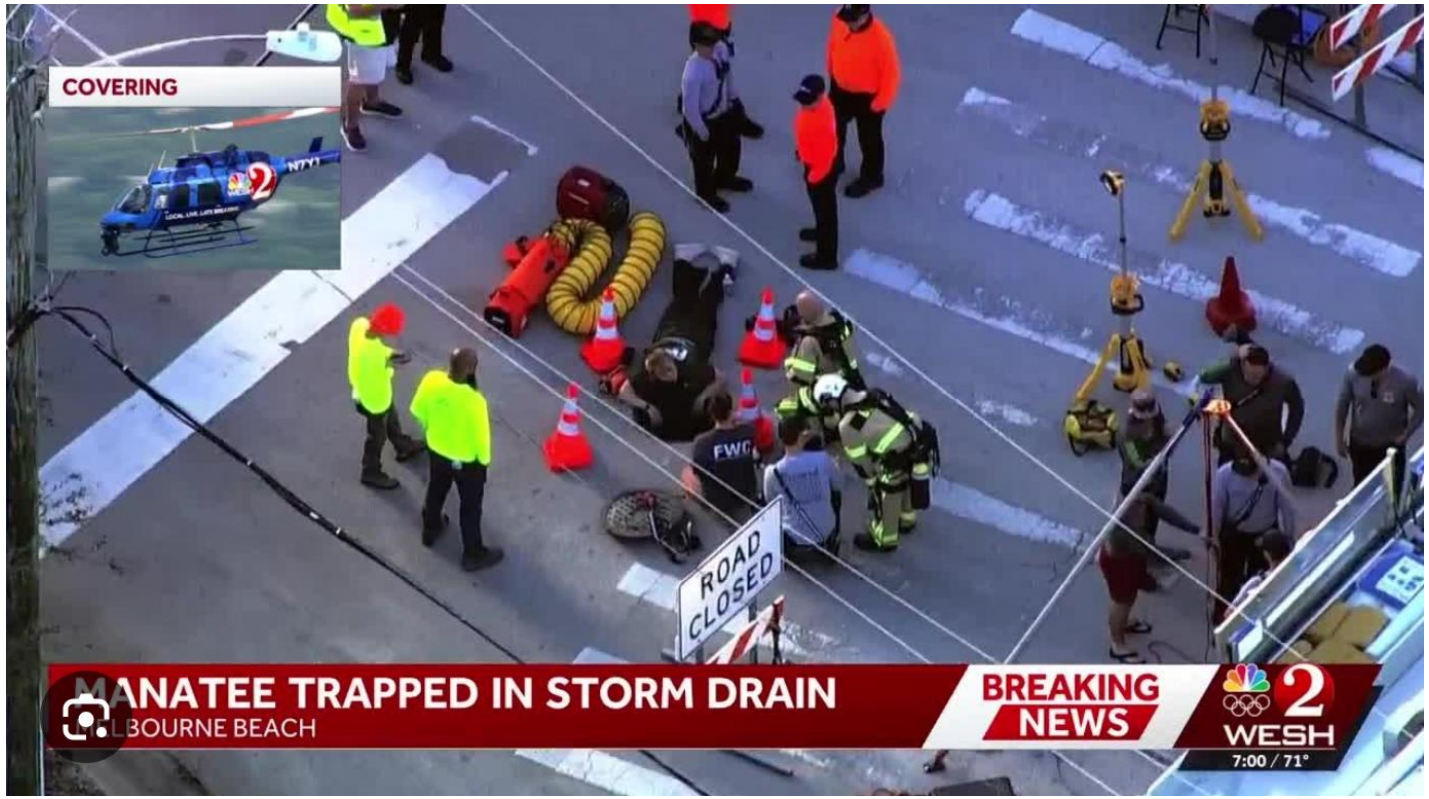
HALEY WARD®

Town of Melbourne Beach Basin 10 Drainage Analysis

Presented by: David C. Baggett, P.E.

May 6, 2026

An Unexpected Rescue…



Professional Background

- David C Baggett, P.E. – Vice President, Melbourne Engineering Manager
- 16 years experience in civil engineering, specializing in stormwater design/permitting
- Past Work Experience as a stormwater engineer for the State of Florida (FDEP)
- Bachelors and Masters in Environmental Engineering from University of Central Florida
- Life long Brevard County resident and Melbourne Beach native

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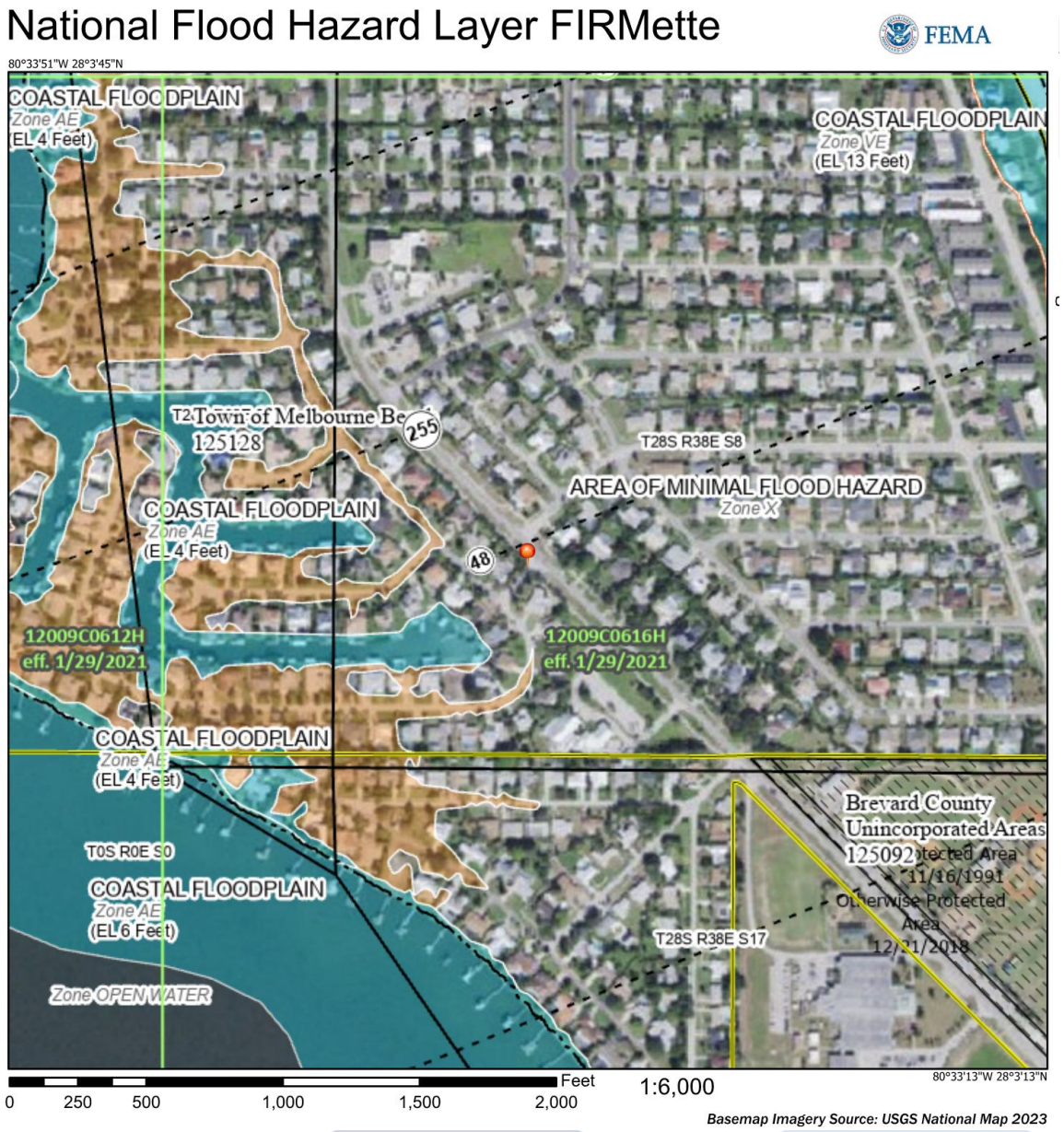
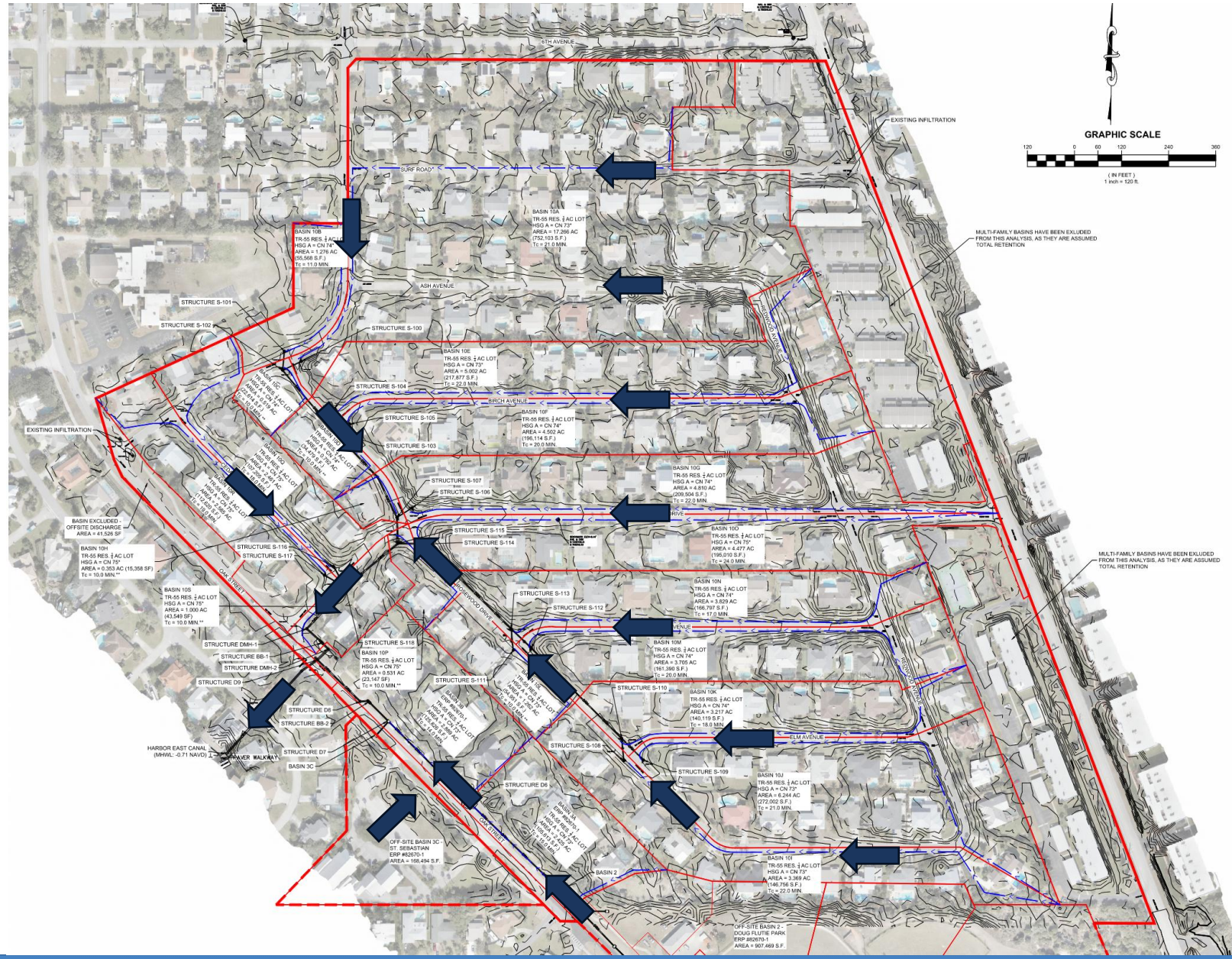
Purpose

- Basin 10 consists of the contributing drainage area located between Oak Street to west, 6th Avenue to the north, the Jimmy Buffett Memorial Highway (A1A) to the east, and the Brevard County Flutie Athletic Complex to the south
- Discharges to Indian River Lagoon via a single outfall pipe through the Harbor East subdivision
- Haley Ward retained to comprehensively analyze Basin 10 drainage system to help identify potential causes of observed flooding and make recommendation for possible improvements to the system

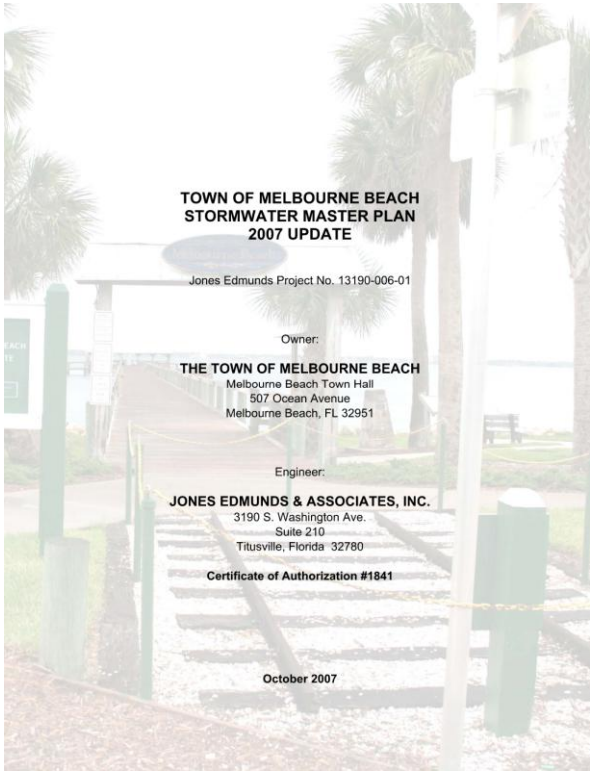
Basin 10 Description

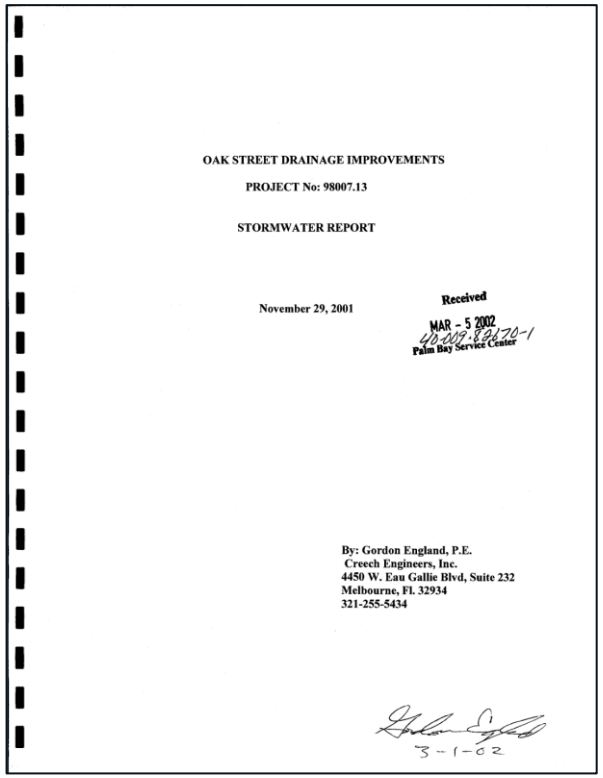
- Majority of land use coverage is ¼ acre residential lots, public roadways. Multi-family fronting Highway A1A
- Not located within a FEMA mapped floodplain
- Drainage patterns are generally east from A1A down the east-west oriented streets to a series of inlets along Rosewood Dr, Cherry Dr, and Cedar Lane.
- A series of inlets and manholes run along Oak Street that collect localized runoff as well as off-site flows from the Flutie Athletic Complex and the St. Sebastian Church.
- Storm sewer confluences at Oak Street and Cherry Drive to a single 42" elliptical outfall pipe.

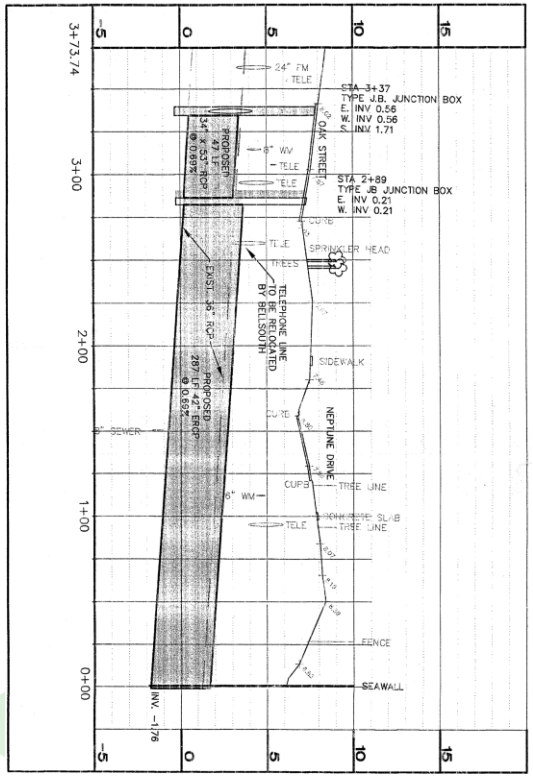



6TH AVENUE
SURF ROAD
ASH AVENUE
BIRCH AVENUE
ELM AVENUE
OAK STREET
HOLLYWOOD DRIVE
HARBOR DRIVE
EXISTING INFILTRATION
MULTI-FAMILY BASINS HAVE BEEN EXLUDED FROM THIS ANALYSIS, AS THEY ARE ASSUMED TOTAL RETENTION
GRAPHIC SCALE
120 0 60 120 240 360
(IN FEET)
1 inch = 120 ft.
BASIN 10A
TR-55 RES. ¼ AC LOT
HSG A = CN 73*
AREA = 17.266 AC
(752,103 S.F.)
Tc = 21.0 MIN.
BASIN 10B
TR-55 RES. ¼ AC LOT
HSG A = CN 74*
AREA = 1.276 AC
(55,568 S.F.)
Tc = 11.0 MIN.
BASIN 10E
TR-55 RES. ¼ AC LOT
HSG A = CN 73*
AREA = 5.002 AC
(217,877 S.F.)
Tc = 22.0 MIN.
BASIN 10F
TR-55 RES. ¼ AC LOT
HSG A = CN 74*
AREA = 4.502 AC
(196,114 S.F.)
Tc = 20.0 MIN.
BASIN 10G
TR-55 RES. ¼ AC LOT
HSG A = CN 74*
AREA = 4.810 AC
(209,504 S.F.)
Tc = 22.0 MIN.
BASIN 10O
TR-55 RES. ¼ AC LOT
HSG A = CN 75*
AREA = 4.477 AC
(195,010 S.F.)
Tc = 24.0 MIN.
BASIN 10N
TR-55 RES. ¼ AC LOT
HSG A = CN 74*
AREA = 3.829 AC
(166,797 S.F.)
Tc = 17.0 MIN.
BASIN 10M
TR-55 RES. ¼ AC LOT
HSG A = CN 74*
AREA = 3.705 AC
(161,390 S.F.)
Tc = 20.0 MIN.
BASIN 10K
TR-55 RES. ¼ AC LOT
HSG A = CN 74*
AREA = 3.217 AC
(140,119 S.F.)
Tc = 18.0 MIN.
BASIN 10J
TR-55 RES. ¼ AC LOT
HSG A = CN 73*
AREA = 6.244 AC
(272,002 S.F.)
Tc = 21.0 MIN.
BASIN 10I
TR-55 RES. ¼ AC LOT
HSG A = CN 73*
AREA = 3.369 AC
(146,756 S.F.)
Tc = 22.0 MIN.
BASIN 10H
TR-55 RES. ¼ AC LOT
HSG A = CN 75*
AREA = 0.353 AC (15,358 SF)
Tc = 10.0 MIN.**
BASIN 10S
TR-55 RES. ¼ AC LOT
HSG A = CN 75*
AREA = 1.000 AC
(43,549 SF)
Tc = 10.0 MIN.**
BASIN 10P
TR-55 RES. ¼ AC LOT
HSG A = CN 75*
AREA = 0.531 AC
(23,147 SF)
Tc = 10.0 MIN.**
BASIN EXCLUDED - OFFSITE DISCHARGE
AREA = 41,526 SF
OFF-SITE BASIN 3C - ST. SEBASTIAN
ERP #02670-1
AREA = 168,494 S.F.
OFF-SITE BASIN 2 - DOUG FLUTIE PARK
ERP #02670-1
AREA = 907,469 S.F.
BASIN 3C
BASIN 2
HARBOR EAST CANAL
(MHWL: -0.71 NAVD)
RIVER WALKWAY
STRUCTURE S-101
STRUCTURE S-102
STRUCTURE S-100
STRUCTURE S-104
STRUCTURE S-105
STRUCTURE S-103
STRUCTURE S-107
STRUCTURE S-106
STRUCTURE S-115
STRUCTURE S-114
STRUCTURE S-116
STRUCTURE S-117
STRUCTURE S-113
STRUCTURE S-112
STRUCTURE S-118
STRUCTURE S-111
STRUCTURE S-110
STRUCTURE S-108
STRUCTURE S-109
STRUCTURE DMH-1
STRUCTURE BB-1
STRUCTURE DMH-2
STRUCTURE D9
STRUCTURE D8
STRUCTURE BB-2
STRUCTURE D7
STRUCTURE D6

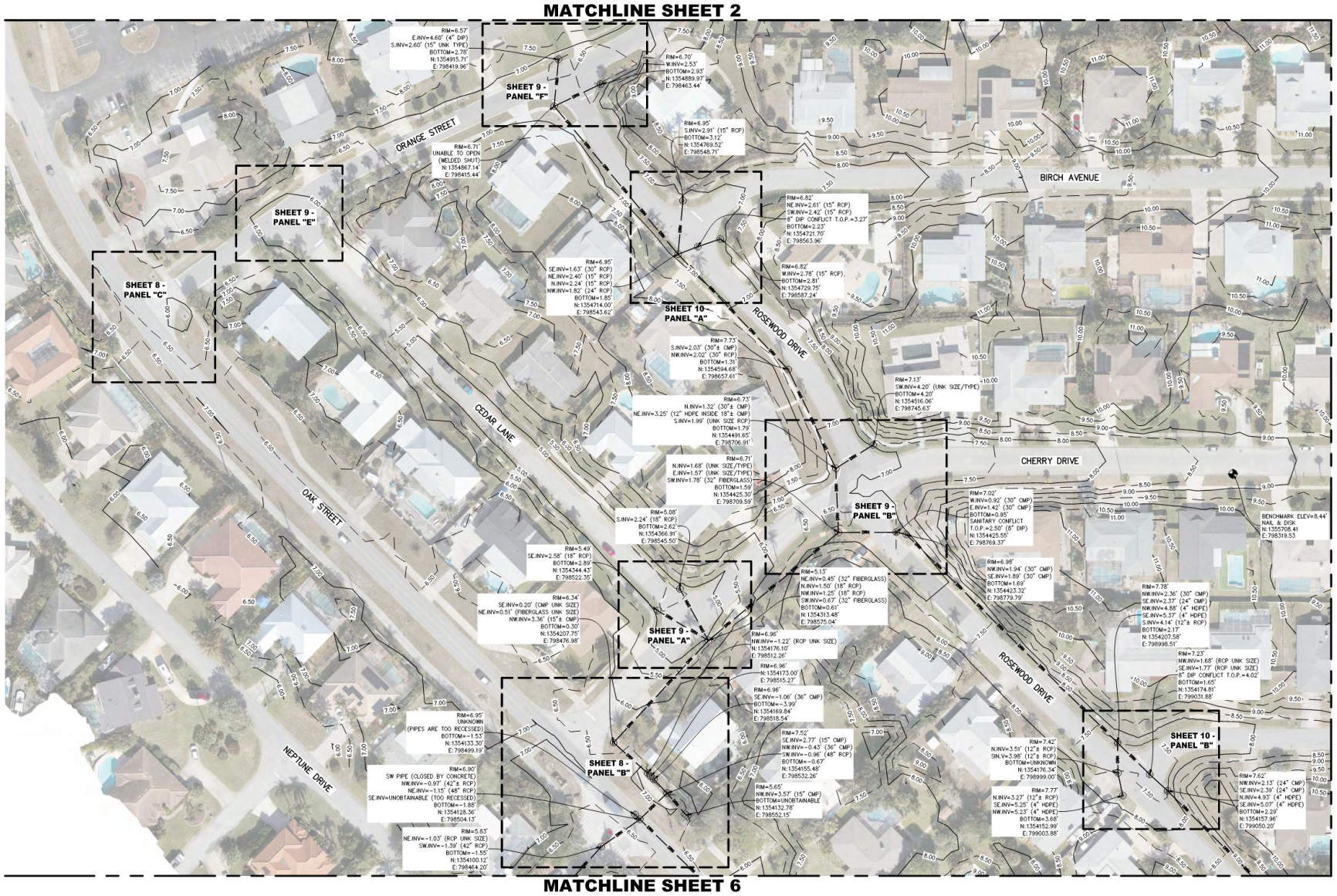
Methodology – Historical Review and Data Collection







Methodology – Updated Survey



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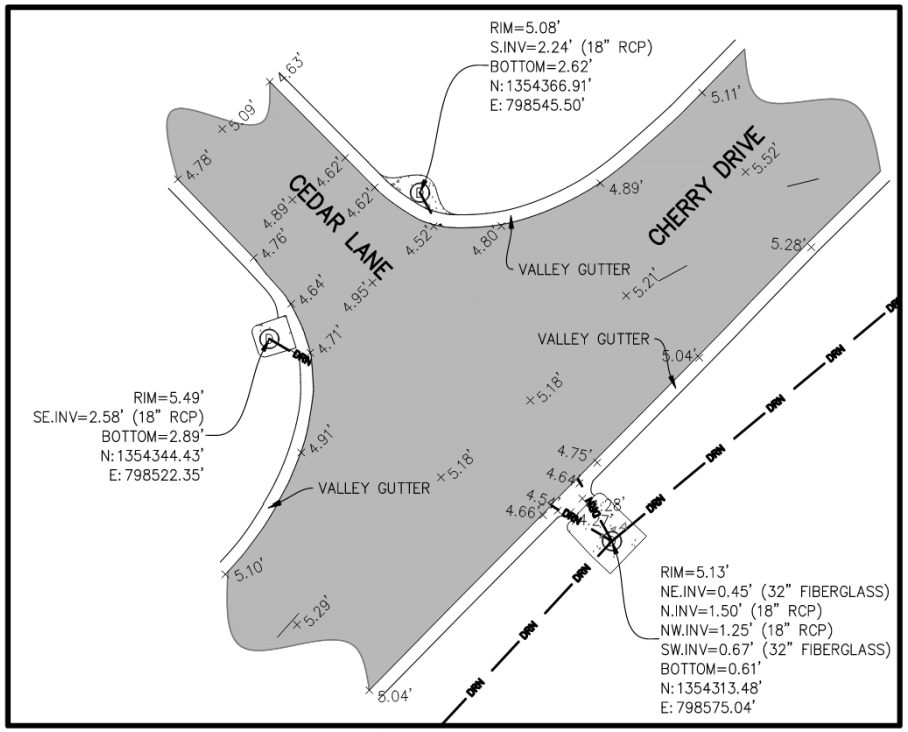
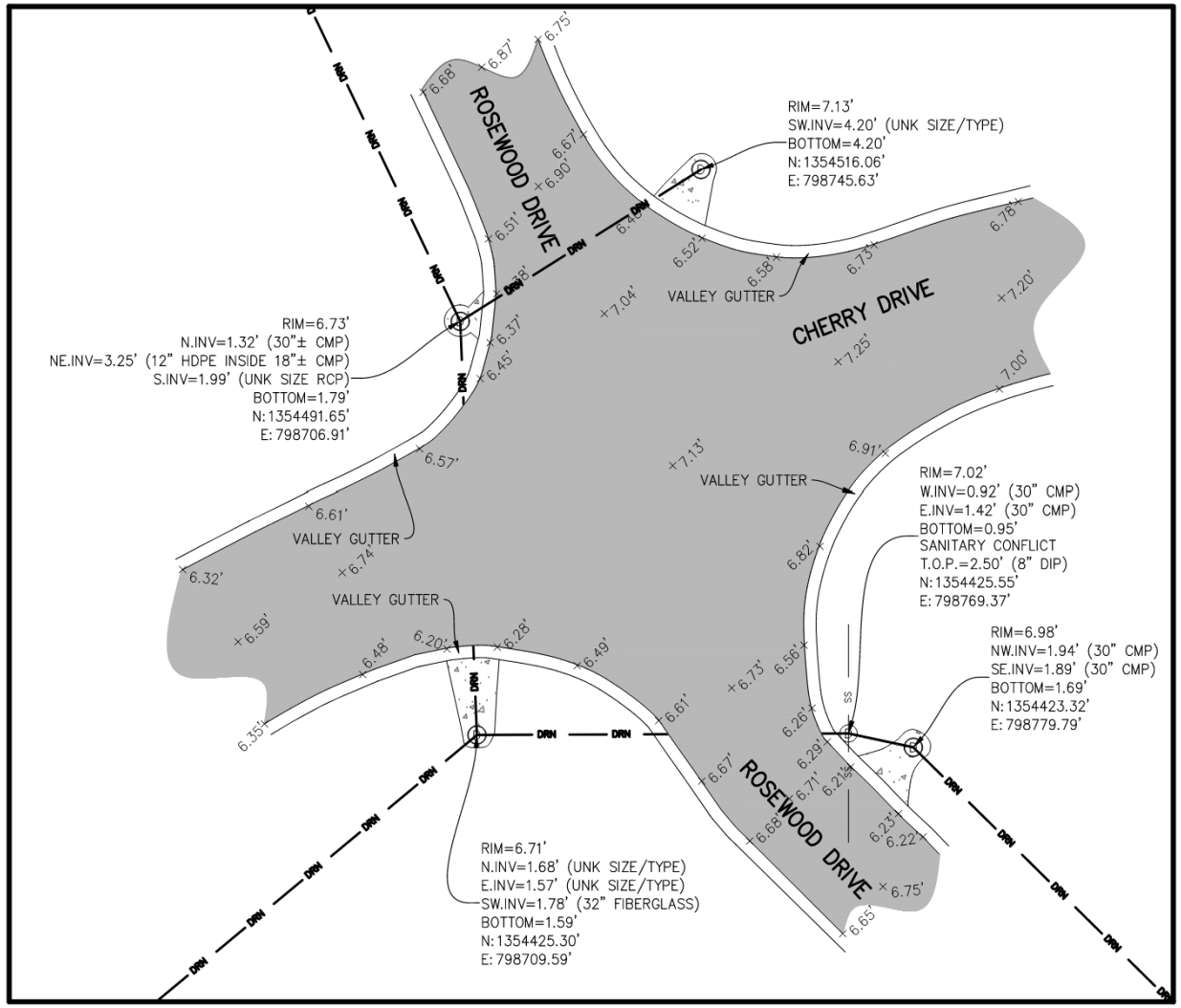
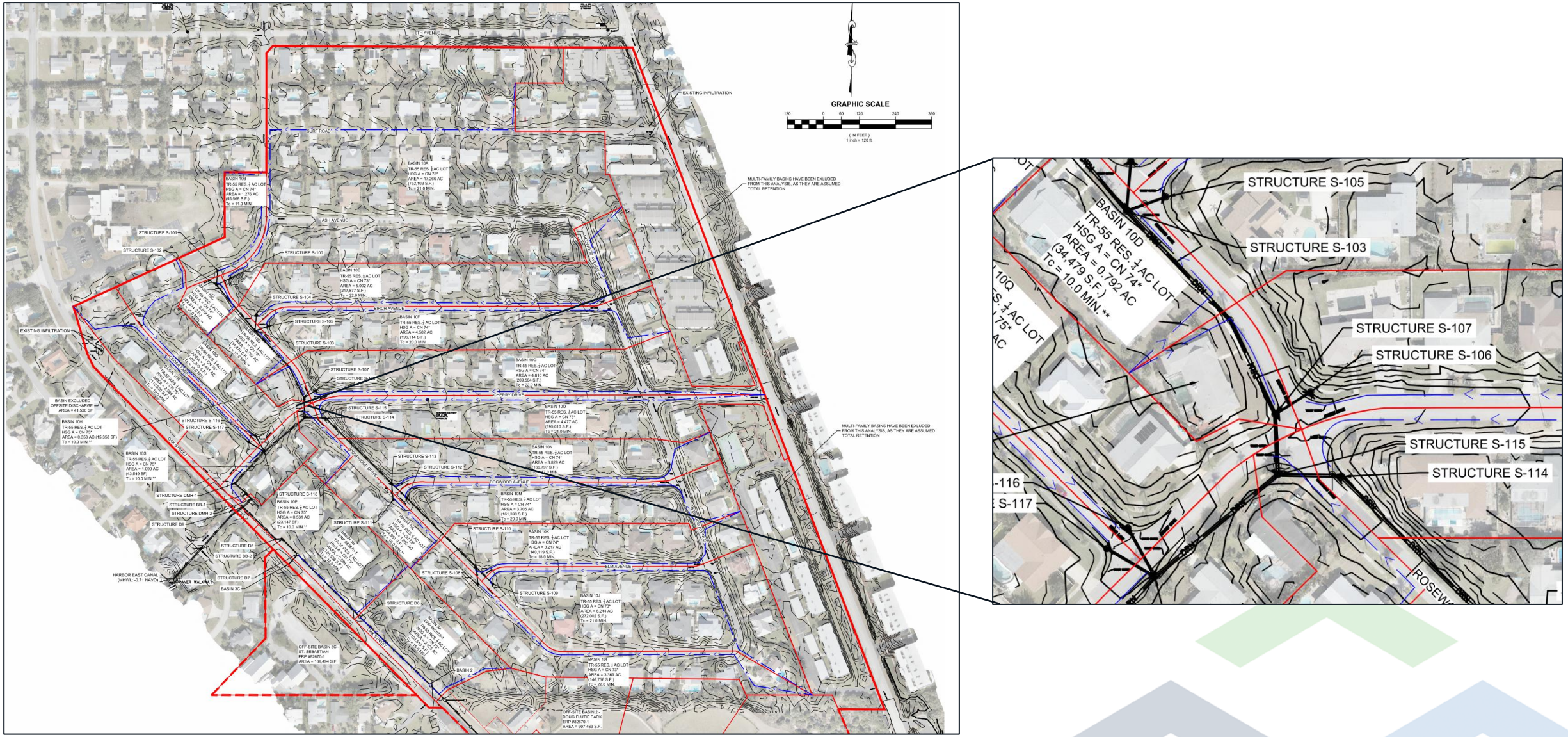


SHEET 9 - PANEL "A"



SHEET 9 - PANEL "B"

Methodology – Sub-Basin Map



Methodology – Hydrologic Calculations

Basin 10 - Sub-Basin 10A - Hydrology Calculations

Project: Town of Melbourne Beach - Basin 10 Drainage Analysis
Project #: 25-790
Engineer: SES
Chk'd By: DCB
Date 4/8/2026

Land Use Table

Use	Imp. (ac)	Pervious (ac)	Total (ac)
Residential - 1/8 Ac Lot / TH =	0.000	0.000	0.000
*Residential - 1/4 Ac Lot =	8.912	7.292	16.204
*Residential - 1/2 Ac Lot =	0.000	0.000	0.000
Streets / Roads =	1.062	0.000	1.062
Developed Compacted Open Space =	0.000	0.000	0.000
Undeveloped Open Space =	0.000	0.000	0.000
TOTAL =	9.974	7.292	17.266

Stage-Area Table

:see stage-storage chart for information.

Curve Number (Per TR-55)
Soil Storage Table

Cover Type	Area (ac)	Condition	Soil Group	CN	Product
Residential - 1/8 Ac Lot / TH	0.00	N/A	A	77	0
*Residential - 1/4 Ac Lot	16.20	N/A	A	71	1151
*Residential - 1/2 Ac Lot	0.00	N/A	A	71	0
Streets / Roads	1.06	N/A	A	98	104
Dev Compact Open Space	0.00	Good	A	39	0
Undeveloped Open Space	0.00	Good	A	30	0
TOTAL	**17.27**				**1255**

CN Weighted = $\frac{\text{Total Product}}{\text{Total Area}} = \frac{1255}{17.27} =$ **73**

*Curve number of 71 for residential land use coverages assume an average 55% impervious, Type A soils, and "Good" open space cover based on survey data, aerial interpretation, and NRSC Soil Map data within Basin 10.

Basin 10 - Sub-Basin 10A - Hydrology Calculations

Time of Concentration

The following formulas are per the SCS "Urban Hydrology for Small Watersheds" Technical Publication-55.

Sheet flow occurs over plane surfaces.

$$T_{sf} = \frac{.007 * (n * L)^{.8}}{(P_2)^{.5} * (s)^{.4}}$$

T_{sf} = Time of Sheet Flow (hour)
n = Mannings Roughness Coefficient
P_2 = 2-year 24-hour Rainfall (inches)
s = Slope of Hydraulic Grade (feet/feet)
L = Flow Length (feet)

After 300-feet sheet flow usually becomes shallow concentrated flow.

(Unpaved) $V = 16.1345 * (s)^{.5}$
(Paved) $V = 20.3282 * (s)^{.5}$

T_{cf} = Time of Concentrated Flow (hour)
s = Slope of Hydraulic Grade (feet/feet)
V = Average Velocity (feet/second)

Use the velocity to solve for travel time.

$$T_t = \frac{L}{3600 * V}$$

T_t = Travel Time (hour)
L = Flow Length (feet)
V = Average Velocity (feet/second)

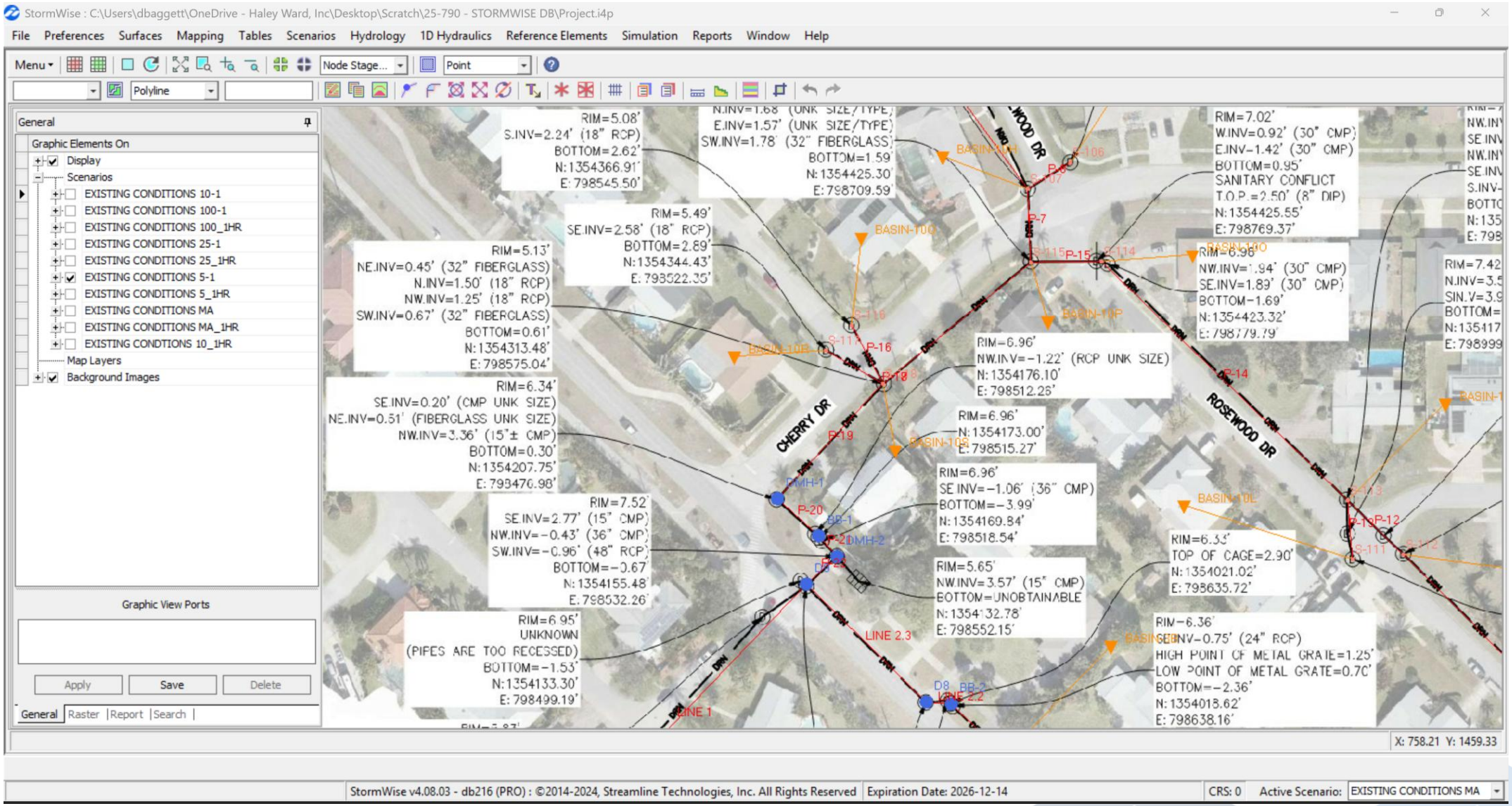
When determining flows in open channels use Manning's equation.

$$V = \frac{1.49 * r^{.67} * s^{.5}}{n}$$

r = Hydraulic Radius (feet) equal to a/p_w
s = Slope of Hydraulic Grade (feet/feet)
V = Average Velocity (feet/second)
n = Mannings Roughness Coefficient
a = cross sectional area (sq.ft.)
p_w = wetted perimeter (feet)

* Use the velocity to solve for travel time with the formula above.

Methodology – StormWise Model



Methodology – Hydrologic Calculations

- Range of intensities, rainfall totals, and return periods
- Mean Annual (50% occurrence)
- 5 Year (20% occurrence)
- 10 Year (10% occurrence)
- 25 Year (4% occurrence)
- 100 Year (1% occurrence)
- Both 24hr and 1 Hr Durations

NOAA Atlas 14, Volume 9, Version 2
Location name: Melbourne Beach, Florida, USA*
Latitude: 28.0592°, Longitude: -80.558°
Elevation: m/ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.553 (0.453-0.688)	0.636 (0.519-0.791)	0.769 (0.627-0.960)	0.879 (0.712-1.10)	1.03 (0.803-1.33)	1.14 (0.872-1.50)	1.26 (0.925-1.68)	1.37 (0.967-1.89)	1.52 (1.03-2.15)	1.63 (1.08-2.35)
10-min	0.810 (0.663-1.01)	0.931 (0.761-1.16)	1.13 (0.918-1.41)	1.29 (1.04-1.61)	1.51 (1.18-1.94)	1.67 (1.28-2.19)	1.84 (1.36-2.47)	2.01 (1.42-2.76)	2.22 (1.51-3.15)	2.39 (1.58-3.44)
15-min	0.988 (0.808-1.23)	1.14 (0.928-1.41)	1.37 (1.12-1.72)	1.57 (1.27-1.97)	1.84 (1.43-2.37)	2.04 (1.56-2.67)	2.24 (1.65-3.01)	2.45 (1.73-3.37)	2.71 (1.84-3.84)	2.91 (1.92-4.20)
30-min	1.48 (1.21-1.84)	1.70 (1.39-2.12)	2.06 (1.68-2.57)	2.36 (1.91-2.95)	2.76 (2.15-3.56)	3.07 (2.34-4.01)	3.37 (2.48-4.52)	3.68 (2.60-5.07)	4.08 (2.77-5.78)	4.38 (2.90-6.33)
60-min	1.93 (1.58-2.40)	2.21 (1.81-2.76)	2.68 (2.18-3.34)	3.06 (2.48-3.84)	3.58 (2.80-4.62)	3.98 (3.04-5.21)	4.38 (3.22-5.87)	4.78 (3.37-6.58)	5.30 (3.59-7.51)	5.69 (3.76-8.21)
2-hr	2.38 (1.96-2.94)	2.73 (2.24-3.37)	3.30 (2.70-4.09)	3.76 (3.06-4.69)	4.41 (3.46-5.64)	4.90 (3.76-6.36)	5.38 (3.99-7.17)	5.87 (4.17-8.04)	6.52 (4.45-9.18)	7.00 (4.66-10.0)
3-hr	2.60 (2.15-3.20)	3.00 (2.47-3.69)	3.64 (2.99-4.50)	4.18 (3.41-5.18)	4.92 (3.88-6.29)	5.50 (4.23-7.12)	6.07 (4.52-8.07)	6.66 (4.75-9.09)	7.44 (5.10-10.4)	8.03 (5.36-11.5)
6-hr	2.99 (2.48 3.65)	3.49 (2.90 4.28)	4.35 (3.59 5.34)	5.09 (4.18 6.27)	6.14 (4.88 7.84)	6.98 (5.42 9.04)	7.85 (5.89 10.4)	8.76 (6.30 11.9)	10.0 (6.91 14.0)	11.0 (7.38 15.6)
12-hr	3.40 (2.84-4.13)	4.07 (3.39-4.95)	5.25 (4.36-6.39)	6.29 (5.20-7.70)	7.85 (6.31-10.0)	9.13 (7.15-11.8)	10.5 (7.93-13.9)	11.9 (8.66-16.2)	14.0 (9.75-19.5)	15.6 (10.6-22.0)
24-hr	3.94 (3.31-4.75)	4.72 (3.96-5.70)	6.14 (5.13-7.43)	7.45 (6.19-9.06)	9.45 (7.68-12.1)	11.2 (8.81-14.4)	13.0 (9.90-17.2)	15.0 (11.0-20.3)	17.8 (12.5-24.8)	20.2 (13.7-28.2)
2-day	4.66 (3.94-5.59)	5.45 (4.59-6.53)	6.91 (5.81-8.31)	8.31 (6.94-10.0)	10.5 (8.61-13.4)	12.4 (9.87-15.9)	14.5 (11.1-19.1)	16.8 (12.4-22.6)	20.1 (14.2-27.8)	22.8 (15.6-31.7)
3-day	5.14 (4.35-6.13)	5.94 (5.02-7.09)	7.44 (6.27-8.91)	8.87 (7.43-10.7)	11.1 (9.13-14.1)	13.0 (10.4-16.7)	15.1 (11.7-19.8)	17.5 (12.9-23.5)	20.9 (14.8-28.8)	23.6 (16.3-32.7)
4-day	5.54 (4.70-6.60)	6.35 (5.38-7.56)	7.86 (6.64-9.38)	9.29 (7.80-11.1)	11.5 (9.49-14.6)	13.4 (10.8-17.2)	15.6 (12.0-20.3)	17.9 (13.3-24.0)	21.3 (15.2-29.2)	24.0 (16.6-33.2)
7-day	6.65 (5.66-7.87)	7.42 (6.32-8.79)	8.89 (7.54-10.6)	10.3 (8.68-12.3)	12.5 (10.3-15.7)	14.4 (11.6-18.2)	16.5 (12.8-21.4)	18.8 (14.0-25.0)	22.1 (15.8-30.2)	24.9 (17.2-34.2)
10-day	7.65 (6.54-9.02)	8.46 (7.23-9.99)	9.98 (8.49-11.8)	11.4 (9.65-13.6)	13.6 (11.3-17.0)	15.5 (12.5-19.6)	17.6 (13.7-22.7)	19.9 (14.9-26.4)	23.2 (16.7-31.6)	25.9 (18.1-35.5)
20-day	10.5 (9.03-12.3)	11.7 (10.0-13.7)	13.7 (11.7-16.1)	15.5 (13.2-18.3)	18.1 (14.9-22.1)	20.2 (16.3-25.0)	22.4 (17.5-28.4)	24.7 (18.5-32.2)	27.9 (20.1-37.5)	30.4 (21.3-41.4)
30-day	12.9 (11.1-15.0)	14.4 (12.4-16.8)	16.9 (14.5-19.8)	19.1 (16.3-22.4)	22.0 (18.2-26.7)	24.4 (19.7-30.0)	26.7 (20.9-33.7)	29.1 (21.9-37.7)	32.3 (23.4-43.1)	34.8 (24.5-47.2)
45-day	15.8 (13.7-18.4)	17.8 (15.4-20.7)	21.0 (18.1-24.4)	23.5 (20.2-27.6)	27.0 (22.4-32.5)	29.7 (24.0-36.2)	32.2 (25.2-40.3)	34.8 (26.2-44.8)	38.2 (27.6-50.5)	40.6 (28.7-54.8)
60-day	18.4 (15.9-21.3)	20.7 (17.9-23.9)	24.3 (21.0-28.2)	27.2 (23.4-31.8)	31.1 (25.8-37.2)	34.0 (27.6-41.4)	36.9 (28.9-45.9)	39.6 (29.9-50.8)	43.2 (31.3-56.9)	45.7 (32.4-61.5)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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PF graphical

NOAA Atlas 14, Volume 9, Version 2
Location name: Melbourne Beach, Florida, USA*
Latitude: 28.0592°, Longitude: -80.558°
Elevation: 7 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	6.64 (5.44-8.26)	7.63 (6.23-9.49)	9.23 (7.52-11.5)	10.5 (8.54-13.2)	12.3 (9.64-15.9)	13.7 (10.5-17.9)	15.1 (11.1-20.2)	16.4 (11.6-22.6)	18.2 (12.4-25.8)	19.6 (12.9-28.2)
10-min	4.86 (3.98-6.04)	5.59 (4.57-6.95)	6.76 (5.51-8.44)	7.73 (6.26-9.68)	9.04 (7.06-11.7)	10.0 (7.66-13.1)	11.0 (8.13-14.8)	12.0 (8.49-16.6)	13.3 (9.05-18.9)	14.3 (9.47-20.7)
15-min	3.95 (3.23-4.91)	4.54 (3.71-5.65)	5.50 (4.48-6.86)	6.28 (5.08-7.87)	7.35 (5.74-9.47)	8.17 (6.23-10.7)	8.98 (6.61-12.0)	9.79 (6.90-13.5)	10.9 (7.36-15.4)	11.6 (7.70-16.8)
30-min	2.96 (2.42-3.68)	3.40 (2.78-4.23)	4.12 (3.35-5.14)	4.71 (3.81-5.90)	5.52 (4.31-7.11)	6.13 (4.68-8.02)	6.75 (4.97-9.04)	7.36 (5.19-10.1)	8.17 (5.54-11.6)	8.77 (5.80-12.7)
60-min	1.93 (1.58-2.40)	2.21 (1.81-2.76)	2.68 (2.18-3.34)	3.06 (2.48-3.84)	3.58 (2.80-4.62)	3.98 (3.04-5.21)	4.38 (3.22-5.87)	4.78 (3.37-6.58)	5.30 (3.59-7.51)	5.69 (3.76-8.21)
2-hr	1.19 (0.978-1.47)	1.36 (1.12-1.69)	1.65 (1.35-2.04)	1.88 (1.53-2.34)	2.20 (1.73-2.82)	2.45 (1.88-3.18)	2.69 (1.99-3.58)	2.94 (2.08-4.02)	3.26 (2.22-4.59)	3.50 (2.33-5.02)
3-hr	0.867 (0.715-1.07)	0.998 (0.822-1.23)	1.21 (0.996-1.50)	1.39 (1.14-1.72)	1.64 (1.29-2.09)	1.83 (1.41-2.37)	2.02 (1.58-3.03)	2.22 (1.58-3.03)	2.48 (1.70-3.48)	2.67 (1.78-3.82)
6-hr	0.498 (0.413-0.610)	0.583 (0.483-0.714)	0.726 (0.600-0.891)	0.849 (0.697-1.05)	1.02 (0.815-1.31)	1.16 (0.905-1.51)	1.31 (0.983-1.74)	1.46 (1.05-1.99)	1.67 (1.15-2.34)	1.83 (1.23-2.60)
12-hr	0.282 (0.235-0.342)	0.337 (0.281-0.410)	0.435 (0.361-0.530)	0.522 (0.431-0.639)	0.651 (0.523-0.833)	0.757 (0.593-0.980)	0.870 (0.658-1.15)	0.991 (0.718-1.35)	1.16 (0.809-1.62)	1.30 (0.877-1.83)
24-hr	0.164 (0.137-0.198)	0.196 (0.164-0.237)	0.255 (0.213-0.309)	0.310 (0.257-0.377)	0.393 (0.320-0.504)	0.464 (0.367-0.600)	0.541 (0.412-0.715)	0.624 (0.456-0.846)	0.743 (0.522-1.03)	0.840 (0.572-1.18)
2-day	0.097 (0.081-0.116)	0.113 (0.095-0.136)	0.144 (0.120-0.173)	0.173 (0.144-0.209)	0.218 (0.179-0.279)	0.258 (0.205-0.332)	0.301 (0.231-0.396)	0.349 (0.257-0.471)	0.418 (0.296-0.579)	0.475 (0.325-0.661)
3-day	0.071 (0.060-0.085)	0.082 (0.069-0.098)	0.103 (0.087-0.123)	0.123 (0.103-0.148)	0.154 (0.126-0.195)	0.180 (0.144-0.231)	0.210 (0.162-0.275)	0.242 (0.179-0.326)	0.289 (0.205-0.399)	0.328 (0.225-0.454)
4-day	0.057 (0.048-0.068)	0.066 (0.056-0.078)	0.081 (0.069-0.097)	0.096 (0.081-0.116)	0.120 (0.098-0.151)	0.140 (0.112-0.178)	0.162 (0.125-0.211)	0.186 (0.138-0.249)	0.221 (0.157-0.304)	0.250 (0.172-0.345)
7-day	0.039 (0.033-0.046)	0.044 (0.037-0.052)	0.052 (0.044-0.062)	0.061 (0.051-0.073)	0.074 (0.061-0.093)	0.085 (0.068-0.108)	0.097 (0.076-0.127)	0.111 (0.083-0.148)	0.131 (0.094-0.179)	0.147 (0.102-0.203)
10-day	0.031 (0.027-0.037)	0.035 (0.030-0.041)	0.041 (0.035-0.049)	0.047 (0.040-0.056)	0.056 (0.047-0.070)	0.064 (0.052-0.081)	0.073 (0.057-0.094)	0.082 (0.062-0.109)	0.096 (0.069-0.131)	0.108 (0.075-0.148)
20-day	0.021 (0.018-0.025)	0.024 (0.020-0.028)	0.028 (0.024-0.033)	0.032 (0.027-0.038)	0.037 (0.031-0.046)	0.042 (0.033-0.052)	0.046 (0.036-0.059)	0.051 (0.038-0.067)	0.058 (0.041-0.078)	0.063 (0.044-0.086)
30-day	0.017 (0.015-0.020)	0.019 (0.017-0.023)	0.023 (0.020-0.027)	0.026 (0.022-0.031)	0.030 (0.025-0.037)	0.033 (0.027-0.041)	0.037 (0.028-0.046)	0.040 (0.030-0.052)	0.044 (0.032-0.059)	0.048 (0.034-0.065)
45-day	0.014 (0.012-0.017)	0.016 (0.014-0.019)	0.019 (0.016-0.022)	0.021 (0.018-0.025)	0.025 (0.020-0.030)	0.027 (0.022-0.033)	0.029 (0.023-0.037)	0.032 (0.024-0.041)	0.035 (0.025-0.046)	0.037 (0.026-0.050)
60-day	0.012 (0.011-0.014)	0.014 (0.012-0.016)	0.016 (0.014-0.019)	0.018 (0.016-0.022)	0.021 (0.017-0.025)	0.023 (0.019-0.028)	0.025 (0.020-0.031)	0.027 (0.020-0.035)	0.029 (0.021-0.039)	0.031 (0.022-0.042)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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PF graphical

Methodology - Rainfall

Table 1-Scenario and Rainfall Data

Scenario	Rainfall Amount	Storm Duration	Storm Peak	Storm Recovery
Mean Annual; 24-Hour	4.72 Inches	24 Hours	12 Hours	72 Hours
5-Year; 24-Hour	6.14 Inches	24 Hours	12 Hours	72 Hours
10-Year; 24-Hour	7.45 Inches	24 Hours	12 Hours	72 Hours
25-Year; 24-Hour	9.45 Inches	24 Hours	12 Hours	72 Hours
100-Year; 24-Hour	13.0 Inches	24 Hours	12 Hours	72 Hours
Mean Annual; 1-Hour	2.21 Inches	1 Hour	30 Mins	12 Hours
5-Year; 1-Hour	2.68 Inches	1 Hour	30 Mins	12 Hours
10-Year; 1-Hour	3.06 Inches	1 Hour	30 Mins	12 Hours
25-Year; 1-Hour	3.58 Inches	1 Hour	30 Mins	12 Hours
100-Year; 1-Hour	4.38 Inches	1 Hour	30 Mins	12 Hours

Results

- We compared low pavement elevations ("Alert Stage") and low finished floor elevations ("Warning Stage") again the peak stage of the various storm events.
- We also compared the duration that flooding occurs

Table 7-Existing 5 Year – 24 Hour Peak Staging Results

5 YEAR – 24 HOUR STORM EVENT							
Inlet Structure	Peak Stage Time (hr)	Peak Stage (ft)	Alert Stage (Road) (ft)	Warning Stage (FFE) (ft)	Flooding Occurring (Y/N)	Recovery Stage Time (hr)	Time of Flood (hr)
S-100	14.0	7.61	6.70	8.50	Y	19.0	5.0
S-101	14.0	6.95	6.57	8.00	Y	15.0	1.0
S-102	14.0	6.94	6.71	7.75	Y	15.0	1.0
S-103	13.0	6.88	6.95	8.00	N	N/A	0.0
S-104	13.0	7.13	6.95	8.50	Y	15.0	2.0
S-105	13.0	7.10	6.82	8.50	Y	15.0	2.0
S-106	13.0	7.38	7.13	9.50	Y	15.0	2.0

Results

Table 7-Existing 5 Year – 24 Hour Peak Staging Results

5 YEAR – 24 HOUR STORM EVENT							
Inlet Structure	Peak Stage Time (hr)	Peak Stage (ft)	Alert Stage (Road) (ft)	Warning Stage (FFE) (ft)	Flooding Occurring (Y/N)	Recovery Stage Time (hr)	Time of Flood (hr)
S-100	14.0	7.61	6.70	8.50	Y	19.0	5.0
S-101	14.0	6.95	6.57	8.00	Y	15.0	1.0
S-102	14.0	6.94	6.71	7.75	Y	15.0	1.0
S-103	13.0	6.88	6.95	8.00	N	N/A	0.0
S-104	13.0	7.13	6.95	8.50	Y	15.0	2.0
S-105	13.0	7.10	6.82	8.50	Y	15.0	2.0
S-106	13.0	7.38	7.13	9.50	Y	15.0	2.0

Table 12-Existing 5 Year – 1 Hour Peak Staging Results

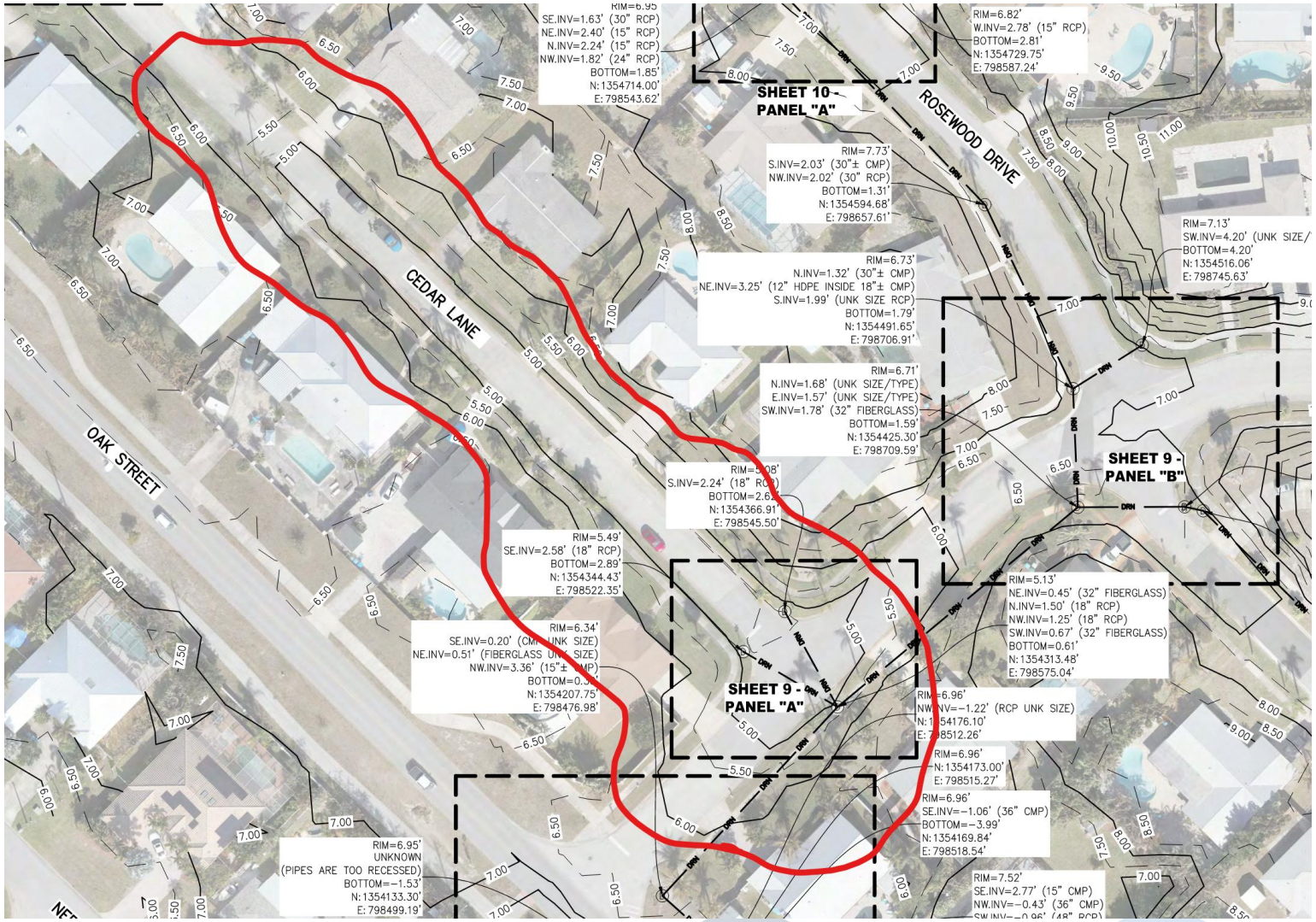
5 YEAR – 1 HOUR STORM EVENT							
Inlet Structure	Peak Stage Time (hr)	Peak Stage (ft)	Alert Stage (Road) (ft)	Warning Stage (FFE) (ft)	Flooding Occurring (Y/N)	Recovery Stage Time (hr)	Time of Flood (hr)
S-100	2.0	6.59	6.70	8.50	N	N/A	0.0
S-101	1.0	6.16	6.57	8.00	N	N/A	0.0
S-102	1.0	6.16	6.71	7.75	N	N/A	0.0
S-103	1.0	6.13	6.95	8.00	N	N/A	0.0
S-104	1.0	6.30	6.95	8.50	N	N/A	0.0
S-105	1.0	6.29	6.82	8.50	N	N/A	0.0
S-106	1.0	6.53	7.13	9.50	N	N/A	0.0

Results

- Contributing Area vs # of Inlets ratio is large in some areas, may cause elevated stages
- Generally, during 1-hr storm events roads do not flood until the 100-year storm. This is likely due to the short duration of the rainfall and the lag of time it takes to produce runoff
- In half of the model sub-basins the lowest Finished Floors elevation are exceeded during the 100YR-24HR storm only, though many are close to FFE during the 25YR-24HR storm.
- Model shows that streets and front of lots at low spots within the various sub-basins may have flooding for greater than a 5-year storm event (6.14" in 24 hrs).
- Mostly short duration flooding (1-5hrs depending on severity of storms), longer duration flooding (8-10hrs) for the 100-year storm
- Pipes sunk/cast below structure bottom in some areas.
- Shallow drainage structures

Results

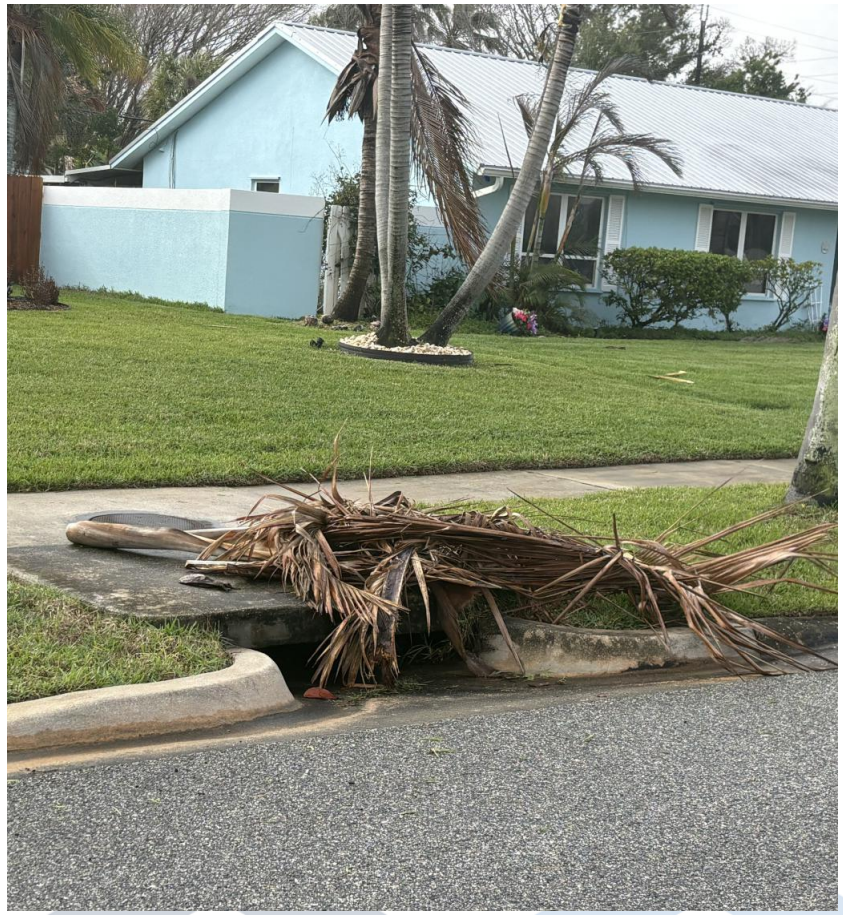
- Cherry and Cedar – Finished floor elevations have relatively little vertical separation from the low pavement elevations.
- Cedar Lane has a relatively low profile grade, thus flooding on the road spreads to a greater extent



Results

- Some flooding results in the model along Oak Street for larger events. This is likely due to the modeled off-site flows from previously designed/permitted projects at Flutie Athletic Complex and Oak Street Drainage Improvements
- Significant amount of area (over 17 acres) appears to drain to a single inlet at Orange and Rosewood. Structure has a small pipe for such service (12")
- Baffle Box at Oak Street does not appear to be a significant hindrance to Basin 10 outfall flow.
- Dissimilar pipe sizes and inverts not on downstream grade
- Certain structures were not fully accessible, utilized historical data
- Field Observations – inlet screens/baffles may be subject to clogging, yard debris placed at inlets

Cherry Dr and Cedar Lane

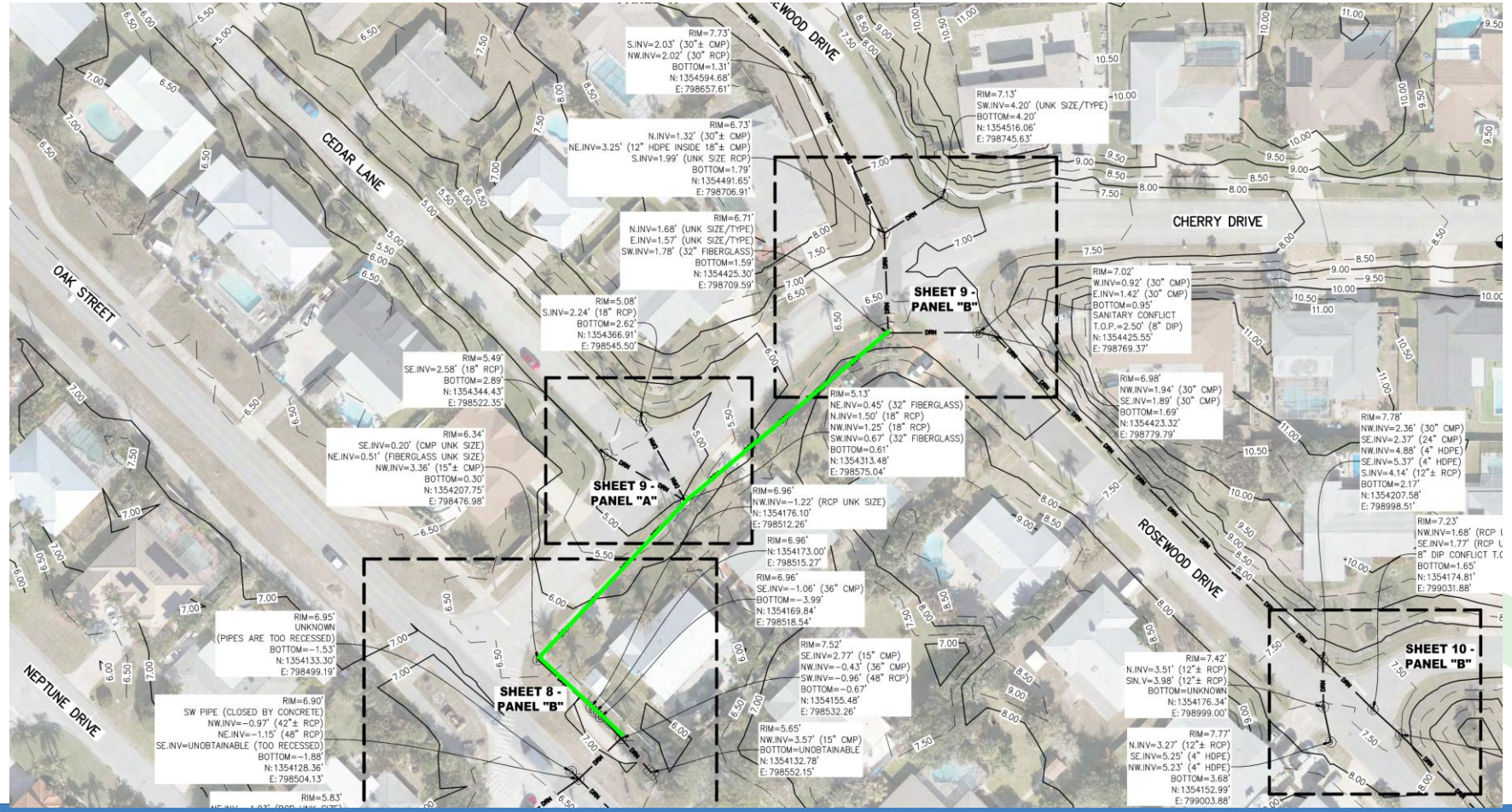


Recommendations

- TV Sewer Inspection storm sewer system along Cherry and Rosewood before any design or new improvements are proposed. Other runs may be less of a priority, but a comprehensive TV inspection of the rest of the system would provide more assurance

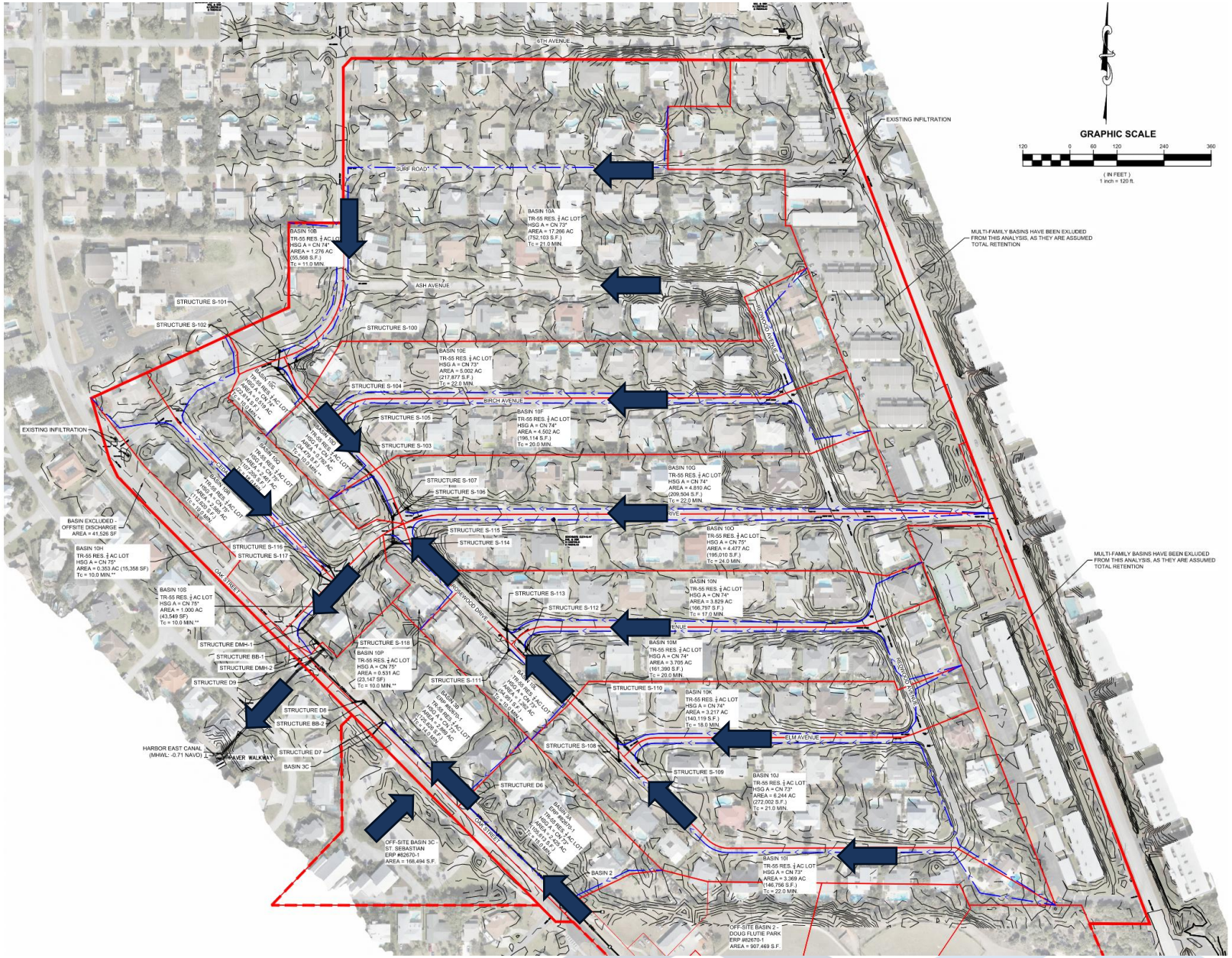
Reccomendations

- Increase pipe size downstream of Cherry Drive intersections to outfall pipe at Oak Street (alternative, install parallel pipe)



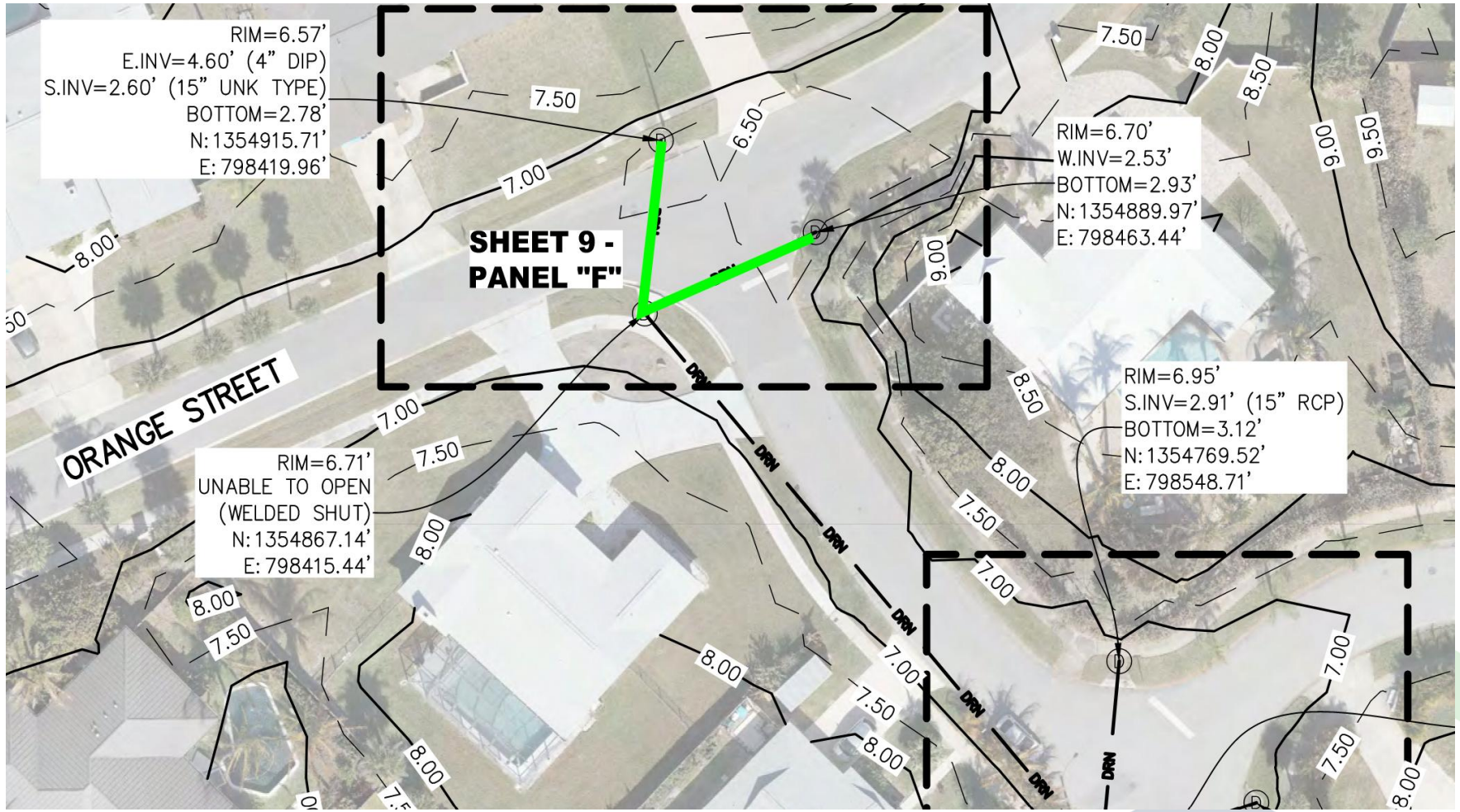
Reccomendations

- If flooding along Rosewood is a frequent concern, adding inlets along the contributing E-W streets will break sub-basins in to smaller drainage catchment areas. Rosewood inlets will not be as overwhelmed (according to model)
- Upsizing pipes along Rosewood would improve capacity but may only be necessary if regular concerns persist after the Cherry Dr trunk line pipe is upsized

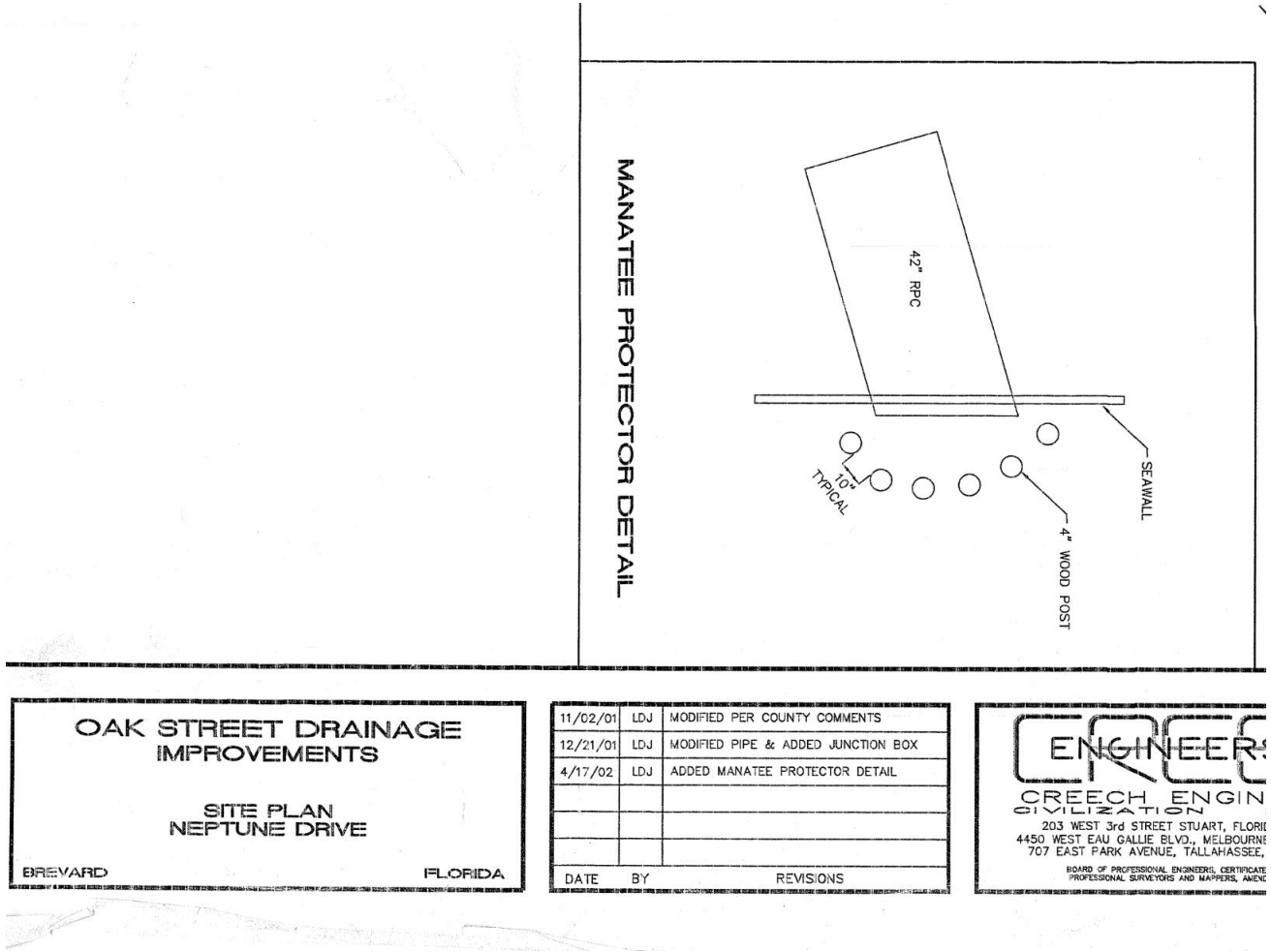


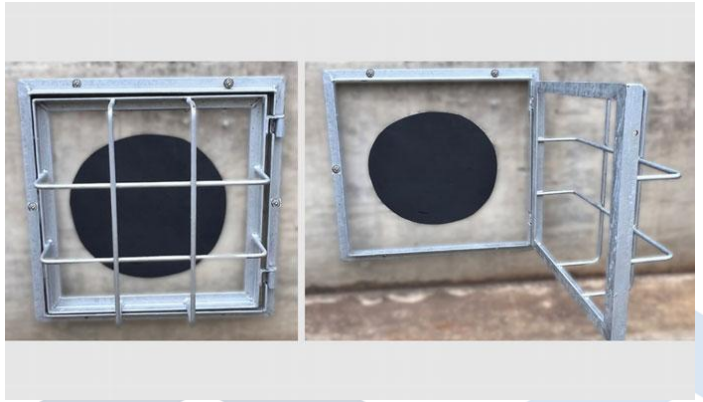
Reccomendations

- Upsize pipes at Orange St and Rosewood



Recommendations – Manatee Protection





THANK YOU