



HOME GARDENS DRAINAGE INVESTIGATION

WAKE FOREST / WKF-24004 / JULY 2026



HOME GARDENS DRAINAGE INVESTIGATION

WAKE FOREST, NC

TECHNICAL MEMORANDUM

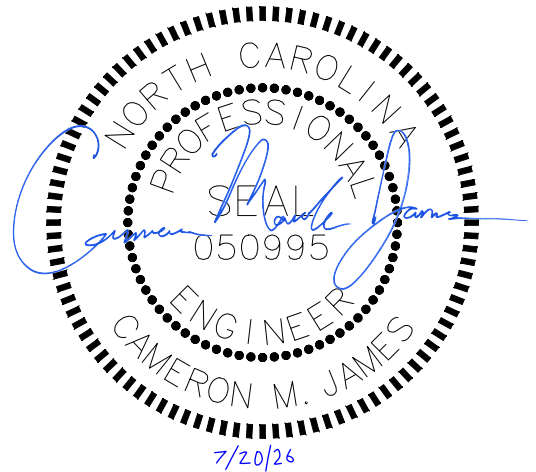
PROJECT NUMBER: WKF-24004
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DATE: JULY 2026



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TABLE OF CONTENTS

Executive Summary	4
Calculation Methodology	5
Existing Conditions	6
Alternative Analysis	6
Conclusion	11

EXHIBITS

Exhibit 1 – Drainage Area Map	14
Exhibit 2 – Land Cover Map	16
Exhibit 3 – Soil Data Map	18
Exhibit 4 – Existing Conditions Survey	20
Exhibit 5 – Existing Conditions Modeling Results	24
Exhibit 6 – Recommended Alternative Conceptual Plan	32
Exhibit 7 – Recommended Alternative Modeling Results	37
Exhibit 8 – 10 Year Flood Depth Comparison Map	45
Exhibit 9 – Recommended Alternative Opinion of Probable Construction Cost	47

TABLES

Table 1: Landcover Breakdown	6
Table 2: Recommended Alternative Components (itemized)	7
Table 3: Summary of Analysis	12

FIGURES

Figure 1: Project Location Map	4
Figure 2: McAdams Survey Scope	5
Figure 3: Alternative Pipe Alignment	8
Figure 4: Wake Drive Proposed Infrastructure	9
Figure 5: Upsizing Existing Infrastructure	10
Figure 6: Sizing Wake Drive Culvert	11

1. EXECUTIVE SUMMARY

McAdams was contracted by the Town of Wake Forest to evaluate alternatives to reduce recurring flooding affecting private properties in the Home Gardens neighborhood near Wake Dr. and Forest Rd. in Wake Forest, North Carolina. Flooding has been reported at 1648 Forest Road and adjacent residences (see Figure 1), likely due to existing topographic conveyance patterns and limited storm drainage infrastructure. Based on a location survey, hydrologic and hydraulic (H&H) analysis, and evaluation of improvement alternatives, McAdams recommends storm drainage upgrades that provide collection and conveyance for just over 13 acres of contributing area and achieve a 25-year level of service within the project area, while maintaining downstream system performance. The total project cost is estimated to be approximately \$1.15 million.



Figure 1: Project Location Map

2. CALCULATION METHODOLOGY

Site Survey

- > McAdams conducted a location survey and subsurface utility engineering (SUE, Level B) along portions of Wake Dr and Forest Rd; see Figure 2 below for scoping elements and the PLS prepared survey on Exhibit 4.



Figure 2: McAdams Survey Scope

H&H Modeling

- > Rainfall data for Wake Forest, North Carolina was derived from NOAA Atlas 14 Point Precipitation Estimates. Rainfall volumes for each storm (24-hour duration) were applied across the SCS Type II distribution.
- > North Carolina Spatial Data Download (SDD) was utilized to obtain Quality Level 2 (QL2) LiDAR data for the drainage areas contributing to the Home Gardens drainage system. This LiDAR data was used to compile the terrain for subbasin delineation, slope calculations, and terrain modeling in PCSWMM.
- > Hydrologic soil group data were obtained from SSURGO Web Soil Survey. Land cover data were derived from Google satellite imagery.
- > Weighted curve numbers were calculated using this soil and land cover data.
- > Time of concentration (Tc) was calculated using the TR-55 segmental method. A Tc of 5 minutes was applied to any subbasin with an area of one acre or less.
- > An H&H model was created in PCSWMM 2D v7.7 for the drainage areas and pipe networks servicing the project area. The SCS curve number method was used to develop rainfall-runoff hydrographs for the 1-, 2-, 5-, 10-, 25-, 50-, and 100-year storm events. All overland flooding and surcharging was modeled in a 2D hexagonal grid with elevations derived from LiDAR data.

- > Alternatives were modeled using varying pipe sizes and alignments to balance flood mitigation with minimizing adverse downstream impacts. The design objective was to maintain the 10-year hydraulic grade line (HGL) within the pipes and keep the 25-year HGL below ground surface.

3. EXISTING CONDITIONS

The drainage area analyzed totals approximately 55.51 acres and consists of a mix of impervious surfaces, open areas, and wooded land. The primary focus area includes Subbasin 7 (9.23 acres) draining from the area between Wake Drive and Forest Road, and Subbasin 8 (3.83 acres) discharging to the 15-inch reinforced concrete pipe (RCP) crossing Wake Drive. Refer to Exhibit 1 for subbasin locations. Runoff from these 13.66 acres flow through the 15-inch RCP into the existing storm system along Forest Road. Additional drainage from 41.85 acres enters the Forest Road system at various locations: approximately 1.81 acres upstream of the focus area and 40.04 acres downstream. The system conveys flow northwest along Forest Road, crossing at the intersection with Wake Drive, before discharging into a channel that flows south toward three 36-inch HDPE culverts. These culverts outlet into a secondary channel downstream and represent the final point of downstream analysis for adverse impact evaluation, as flow becomes fully channelized beyond this location.

Table 1: Landcover Breakdown

Land Cover	Area (AC)	Area (%)
Impervious	21.5	38.6
Open Space	25.2	45.3
Wooded	8.9	16.1

Existing conditions modeling (see Exhibit 5) indicates that the Forest Road storm system provides sufficient capacity for up to a 100-year storm event at its upstream end; however, the level of service decreases after the confluence with private drainage, where capacity is limited to a 10-year event. Due to the lack of storm infrastructure between Forest Road and Wake Drive, runoff from the 13.66-acre focus area floods private property before reaching the existing system. Flooding primarily occurs on the eastern side of 1648 Forest Road and within the backyards of adjacent properties to the east, with depths reaching approximately 13 inches at 1648 Forest Road, during a 10-year storm and increasing for larger events. These conditions result in prolonged ponding and restricted usage for affected properties, resulting in recurring flooding during major rainfall events.

4. ALTERNATIVES ANALYSIS

4.1 RECOMMENDED ALTERNATIVE

The recommended alternative consists of adding additional storm infrastructure on private property between Wake Drive and Forest Road and an overflow system paralleling Forest Road, which discharges into an existing stream, as shown on Exhibit 6. Consideration was given during the alternative assessment to ensure that adverse impacts

would not be introduced on existing storm drainage downstream. The design process began by evaluating a smaller storm system consisting of 15-inch RCP pipes. This initial alternative did not create adverse downstream impacts; however, it provided minimal improvement to flooding within the focus area. To achieve meaningful flood reduction, the next step was to target a system capable of conveying the 10-year storm event without surcharging pipes. This led to the development of a larger system, ranging from 18-inch to 30-inch RCP, which significantly reduced flooding on private property with reduced ponding during the 25-year storm event.

The larger system was first modeled as connecting directly to the existing storm drain along Forest Road. While this configuration improved local flooding, it resulted in surcharged pipes downstream that are not present in existing conditions. To address this, a flow splitter was introduced at the proposed junction box, creating an overflow bypass system that runs parallel to the existing system on the southwestern side of Forest Rd. This bypass consists of four 18-inch pipes and three manholes, discharging into the channel upstream of the three 36-inch HDPE culverts. The recommended design provides overflow relief without negatively impacting the existing storm system downstream. Consideration was also given to crossing the existing sewer line during layout to avoid conflicts.

Table 2: Recommended Alternative Components (itemized)

Storm Infrastructure	Unit	Quantity
18" RC Pipe Culvert, Class IV	LF	350
24" RC Pipe Culvert, Class IV	LF	220
30" RC Pipe Culvert, Class IV	LF	320
Precast Concrete Combination Curb Inlet	EA	1
Precast Concrete Drop Inlet	EA	6
60" Precast Concrete Manhole	EA	1
48" Precast Concrete Manhole	EA	3
18" Precast Concrete parallel Pipe End Section	EA	1
2'-6" Curb and Gutter	LF	230

The opinion of probable construction cost for this alternative is \$893,840.00, and the total project cost is expected to be \$1,167,817.50, which includes engineering and design, environmental permitting, easement acquisition, and a general project contingency.

4.2 ADDITIONAL CONSIDERATIONS

Several mitigatory options were considered before settling on the final recommended alternative by weighing construction cost and feasibility with flood mitigation benefit; each of these considerations is described below in further detail.

4.2.1 STORM INFRASTRUCTURE PIPED THROUGH YARDS

A modification to the recommended alternative was considered in which the proposed storm alignment transects backyard areas instead of following property lines (see Figure 3). This would likely provide a slight hydraulic advantage compared to the recommended alternative due to more gradual turns in the system and a shorter overall length of pipe. The cost of this solution would likely be similar to or slightly less than the recommended alternative. Overall, this solution was not proposed due to the town's expressed preference for the recommended alternative, which minimizes the impact of construction and maintenance on residents.



Figure 3: Alternative Pipe Alignment

4.2.2 ADDITIONAL INFRASTRUCTURE ALONG WAKE DRIVE

During the initial site visit and early stages of analysis, one option considered was a new storm trunkline along Wake Drive to intercept approximately 3.83 acres of upstream drainage (see Subbasin 8, Exhibit 1). The concept involved collecting runoff north of Wake Drive and conveying it westward through approximately 750 feet of new storm pipe before tying into the existing system at the Wake Drive–Forest Road intersection (see Figure 4). SUE (Level B) identified multiple utility conflicts along this alignment, increasing construction complexity and cost. Further modeling showed that flooding in the focus area primarily originates from the 9.23-acre drainage area between Wake Drive and Forest Road (Subbasin 7), meaning this option would likely provide minimal flood reduction. Given the limited benefit relative to cost and constructability challenges, this alternative was not recommended.

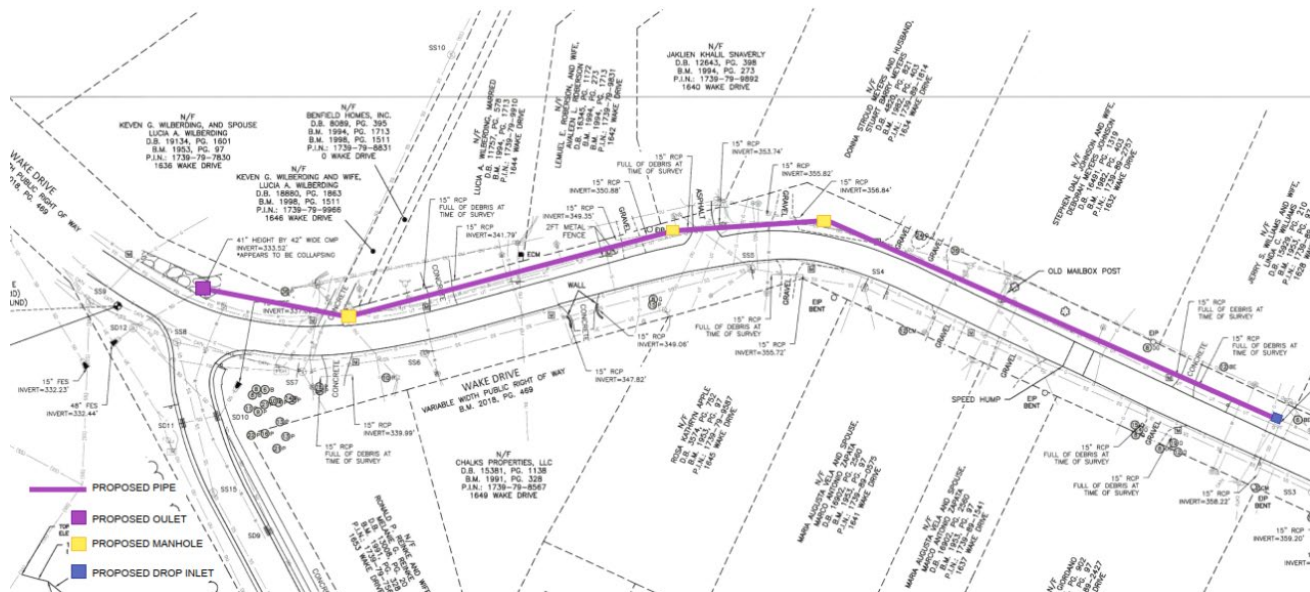


Figure 4: Wake Drive Proposed Infrastructure

4.2.3 UPSIZING THE EXISTING INFRASTRUCTURE ALONG FOREST ROAD

When the proposed storm system was modeled to discharge directly into the existing Forest Road storm network, the reduced time of concentration caused by the new pipes resulted in adverse hydraulic impacts. Specifically, several existing pipes along Forest Road began surcharging during the 5-year storm event—a condition that did not occur under existing conditions. This surcharge also caused a reduction in the overall flood mitigation benefit. Figure 5 highlights the affected pipes within the Forest Road system.

One potential solution considered was upsizing the impacted infrastructure along Forest Road. This approach would require replacing four existing storm pipes, which involves removing sections of roadway to accommodate larger diameters. After evaluating cost and constructability, this option was deemed less favorable compared to constructing a parallel overflow system. The parallel system provides comparable hydraulic benefits at a lower cost and with fewer disruptions to existing infrastructure.

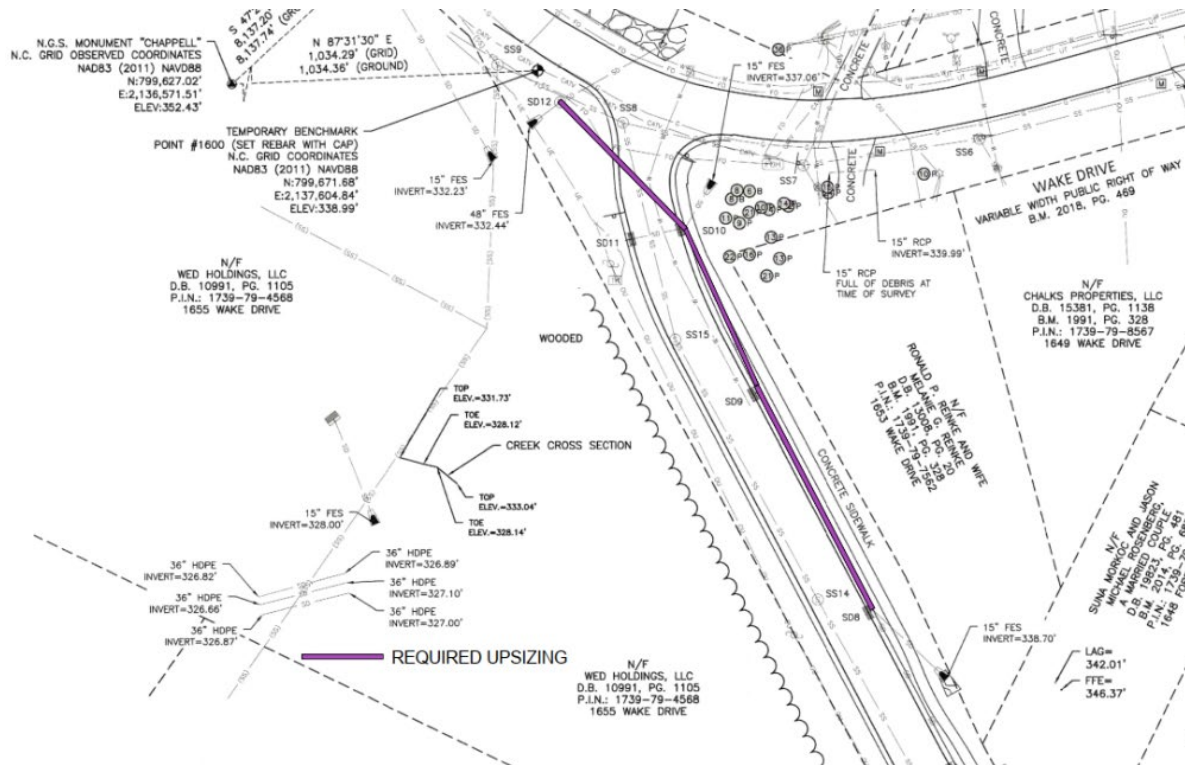


Figure 5: Upsizing Existing Infrastructure

4.2.4 SIZING WAKE DRIVE CULVERT

McAdams analyzed the existing 42-inch corrugated metal pipe (CMP) culvert that crosses Wake Drive, draining southwest (see Figure 6), for hydraulic capacity. This culvert receives drainage from Subbasin 2 (see Exhibit 1), which consists of approximately 34.91 acres. Existing conditions modeling indicates that this culvert is flowing full during the 5-year storm event, with roadway overtopping occurring during the 25-year storm event. To achieve compliance with the Town of Wake Forest's 25-year LOS requirement (per UDO/MSSD Section 6.3.3), this culvert is recommended to be upsized to a 54-inch RCP, which includes replacement of the existing 48-inch RCP located downstream of the storm junction box "SD12" as noted on the McAdams survey. Modeling shows the 54-inch RCP will meet the 25-year LOS, while overtopping of the roadway shifts to the 50-year storm event.

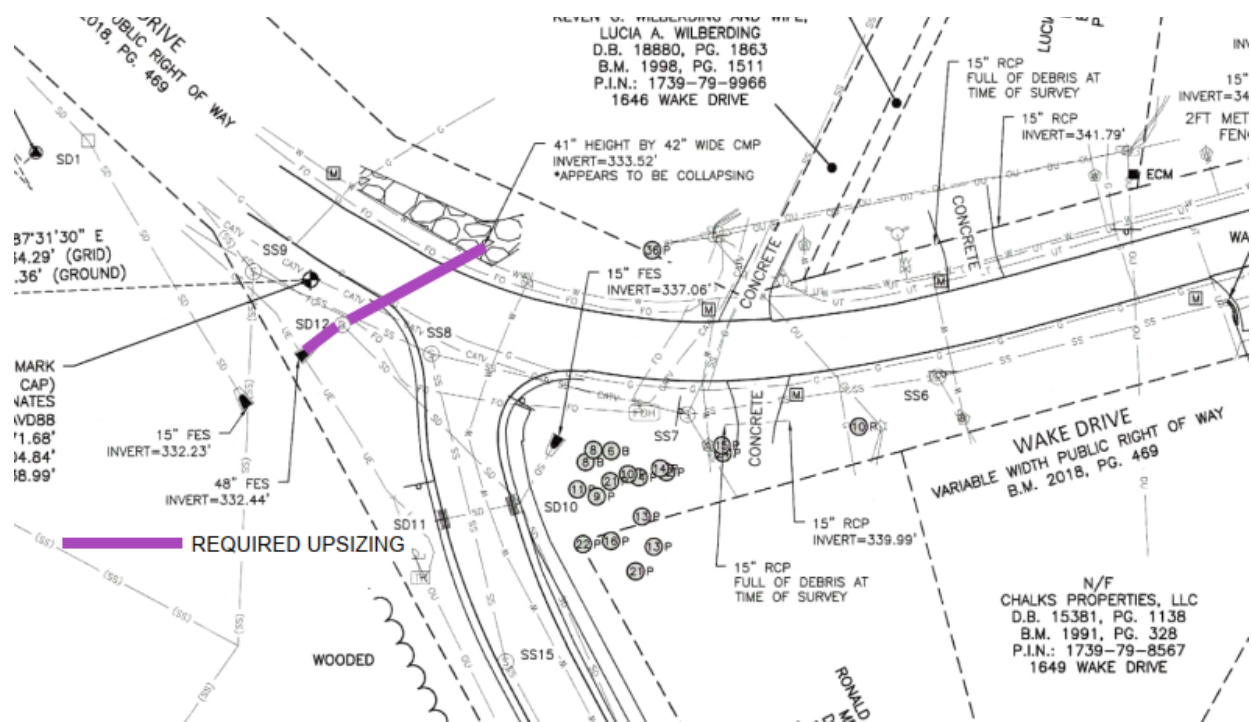


Figure 6: Sizing Wake Drive Culvert

5. CONCLUSION

McAdams analyzed the existing stormwater infrastructure in the Home Gardens neighborhood to address recurring flooding on private properties. Flooding primarily occurs in the backyards of residences along Forest Road, where runoff concentrates and ponds near 1648 Forest Road due to topography and a lack of infrastructure. Using PCSWMM v7.7, existing conditions were modeled and verified (see Exhibit 5).

Several alternatives were evaluated before selecting the recommended alternative. Initial considerations included routing the proposed storm system through backyards; however, this option was dismissed based on the Town's preference for piping along property lines to reduce construction impact to private property. Another alternative involved installing additional infrastructure to intercept drainage from Subbasin 8 (see Exhibit 1), but this approach was deemed too costly for the limited benefit it provided. Upsizing the existing Forest Road storm system was also considered; however, this option was deemed less favorable than the proposed bypass system due to increased construction costs.

The recommended alternative (see Exhibits 6–8) consists of installing new storm infrastructure between Wake Drive and Forest Road and constructing an overflow system parallel to the existing Forest Road network. This design effectively mitigates flooding without introducing adverse downstream impacts, maintains the 10-year hydraulic grade line within the pipes, and achieves a 25-year level of service as demonstrated in Exhibit 7. Table 1 summarizes the recommended alternative, including cost, level of service, and key considerations.

Table 3: Summary of Analysis

Alternative	OPCC	Total Project Cost*	Level of Service	Notes
Recommended	\$893,840.00	\$1,167,817.50	25	Mitigates flooding that occurs around 1648 Forest Road without causing adverse impact downstream.

**Total Project Cost includes OPCC plus contingencies*

In addition to the recommended alternative, McAdams evaluated the culvert crossing at Wake Drive, which currently consists of a 42-inch CMP and a 48-inch RCP conveying flow from Subbasin 2 (see Exhibit 1) southwestward into an existing channel. Modeling indicates that this culvert flows full during the 5-year storm event and overtops the roadway during the 25-year event. To comply with the Town of Wake Forest's 25-year level-of-service requirement, McAdams proposes replacing the full length of the existing culvert with a 54-inch RCP. Repairs and upgrades to this crossing would represent a prudent use of public funds, offering several benefits: increased hydraulic capacity, reduced frequency of roadway overtopping, and enhanced protection of public right-of-way, critical infrastructure, and adjacent properties. McAdams recommends further survey and analysis to develop design and construction documents for this culvert replacement.

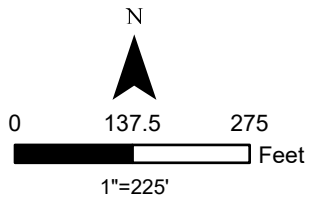
EXHIBITS

EXHIBIT 1

DRAINAGE AREA MAP



Subbasin	Area (Acre)	Curve Number	TC (Min)
01	3.91	87	10.4
02	34.91	80	18.7
03	0.12	96	5
04	0.24	80	5
05	0.33	64	5
06	1.06	70	8.8
07	9.23	66	14.2
08	3.83	67	13.1
09	0.07	76	5
10	0.24	81	5
11	0.2	60	5
12	0.65	69	5
13	0.43	68	5
14	0.08	73	5
15	0.21	79	5



DRAINAGE AREA EXHIBIT
HOME GARDENS
PROJECT #: WKF24004
WAKE FOREST, NC



EXHIBIT 2

LAND COVER MAP

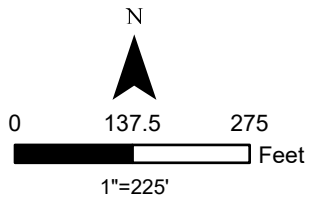


EXHIBIT 3

SOIL DATA MAP



- Legend**
- Subbasins
 - Soil Group
 - B
 - C
 - D

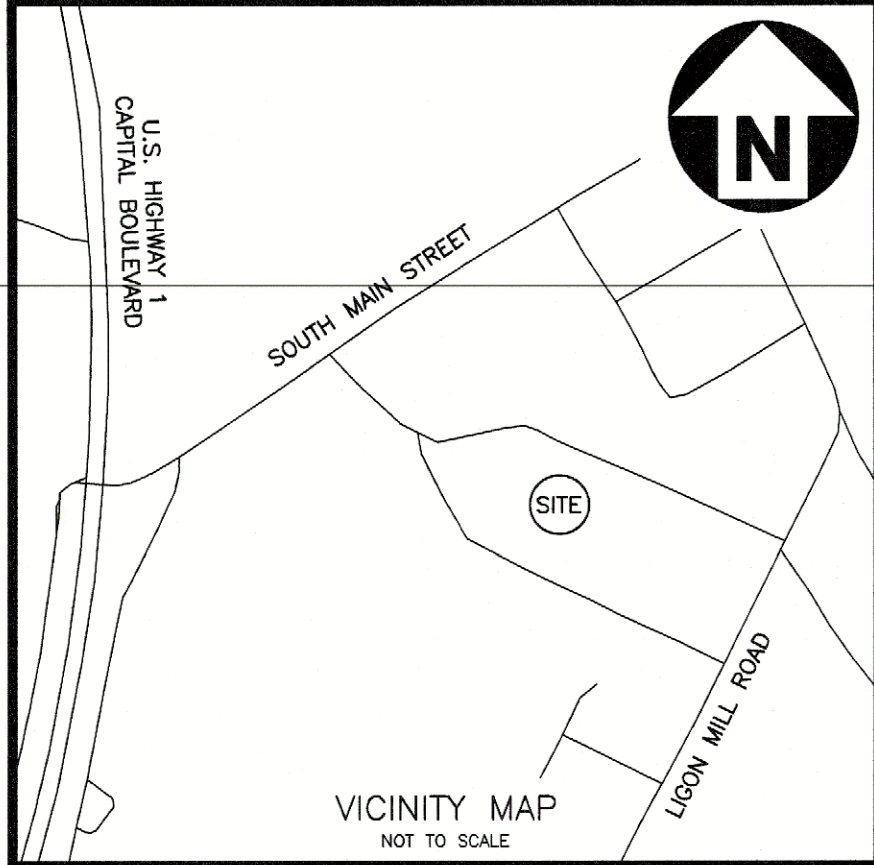


SOIL DATA EXHIBIT
HOME GARDENS
PROJECT #: WKF24004
WAKE FOREST, NC



EXHIBIT 4

EXISTING CONDITIONS SURVEY

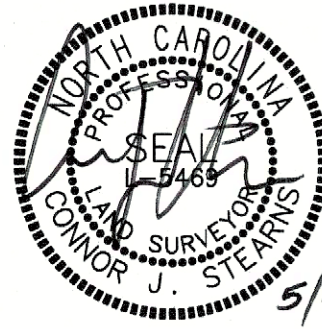


SURVEYOR'S CERTIFICATE

I, CONNOR J. STEARNS, CERTIFY THAT THIS PLAT WAS DRAWN UNDER MY SUPERVISION FROM AN ACTUAL SURVEY MADE UNDER MY SUPERVISION (DEED DESCRIPTION RECORDED IN BOOK AND PAGE AS SHOWN); THAT THE BOUNDARIES NOT SURVEYED ARE CLEARLY INDICATED AS DRAWN FROM INFORMATION FOUND IN BOOK AND PAGE AS SHOWN; THAT THE RATIO OF PRECISION OR POSITIONAL ACCURACY IS 1":53,311"; AND THAT THIS MAP MEETS THE REQUIREMENTS OF THE STANDARDS OF PRACTICE FOR LAND SURVEYING IN NORTH CAROLINA (21 NCAC 56.1600).

WITNESS MY ORIGINAL SIGNATURE, LICENSE NUMBER AND SEAL
THIS 5th DAY OF MAY, A.D. 2025

CONNOR J. STEARNS, PROFESSIONAL LAND SURVEYOR L-5469



I, CONNOR J. STEARNS, CERTIFY THAT THIS PROJECT WAS COMPLETED UNDER MY DIRECT AND RESPONSIBLE CHARGE FROM AN ACTUAL SURVEY MADE UNDER MY SUPERVISION; THAT THIS GROUND SURVEY WAS PERFORMED AT THE 95 PERCENT CONFIDENCE LEVEL TO MEET FEDERAL GEOGRAPHIC DATA COMMITTEE STANDARDS; THAT THIS SURVEY WAS PERFORMED TO MEET THE REQUIREMENTS FOR A TOPOGRAPHIC/PLANIMETRIC SURVEY TO THE ACCURACY OF CLASS A AND VERTICAL ACCURACY WHEN APPLICABLE TO THE CLASS A STANDARD, AND THAT THE ORIGINAL DATA WAS OBTAINED ON FEBRUARY 18, 2025; THAT THE SURVEY WAS COMPLETED ON MAY 5, 2025; THAT CONTOURS SHOWN AS [BROKEN LINES] MAY MEET THE STATED STANDARD; AND ALL COORDINATES ARE BASED ON NAD83 AND REALIZATION (2011) AND ALL ELEVATIONS ARE BASED ON NAVD88.

CONNOR J. STEARNS, PLS L-5469 DATE 5/5/2025

I, CONNOR J. STEARNS, CERTIFY THAT THIS MAP WAS DRAWN UNDER MY SUPERVISION FROM AN ACTUAL GPS SURVEY MADE UNDER MY SUPERVISION AND THE FOLLOWING INFORMATION WAS USED TO PERFORM THE SURVEY:

- (1) CLASS OF SURVEY: A
- (2) POSITIONAL ACCURACY: HORIZONTAL 0.009' VERTICAL 0.035'
- (3) TYPE OF GPS FIELD PROCEDURE: NC REAL TIME NETWORK (VRS)
- (4) DATES OF SURVEY: FEBRUARY 18, 2025 - MARCH 3, 2025
- (5) DATUM/EPOCH: NAD83 (2011)
- (6) PUBLISHED/FIXED-CONTROL USE: NC REAL TIME NETWORK (VRS)
- (7) GEOID MODEL: 18
- (8) COMBINED GRID FACTOR(S): 0.99993411
- (9) UNITS: U.S. SURVEY FEET

CONNOR J. STEARNS, PLS L-5469 DATE 5/5/2025

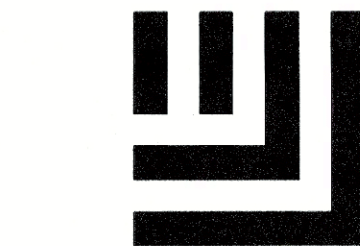
GENERAL NOTES

1. THIS IS A SURVEY OF AN EXISTING PARCEL OF LAND. THIS IS A LOCATION AND TOPOGRAPHIC SURVEY.
2. BEARINGS FOR THIS SURVEY ARE BASED ON NC GRID NAD83 (2011).
3. ALL DISTANCES ARE HORIZONTAL GROUND DISTANCES.
4. ZONING: CU GR3 RZ-12-03 AND CU HB RZ-04-04 PER WAKE COUNTY GIS.
5. AREA BY COORDINATE GEOMETRY.
6. FLOOD NOTE: THIS PROPERTY IS NOT LOCATED IN A SPECIAL FLOOD HAZARD ZONE. IT IS LOCATED IN ZONE "X" AS DEFINED BY F.E.M.A F.J.R.M COMMUNITY PANEL #3720173900K DATED 07/19/2022.
7. REFERENCES: AS SHOWN
8. UTILITY STATEMENT
THE UNDERGROUND UTILITIES SHOWN HAVE BEEN LOCATED FROM FIELD SURVEY INFORMATION AND EXISTING DRAWINGS. THE SURVEYOR MAKES NO GUARANTEE THAT THE UNDERGROUND UTILITIES SHOWN COMPRISE ALL SUCH UTILITIES IN THE AREA, EITHER IN SERVICE OR ABANDONED. THE SURVEYOR FURTHER DOES NOT WARRANT THAT THE UNDERGROUND UTILITIES SHOWN ARE IN THE EXACT LOCATION INDICATED. ALTHOUGH HE DOES CERTIFY THAT THEY ARE LOCATED AS ACCURATELY AS POSSIBLE FROM INFORMATION AVAILABLE. THE SURVEYOR HAS NOT PHYSICALLY LOCATED THE UNDERGROUND UTILITIES.
9. THIS SURVEY PERFORMED AND MAP PREPARED WITHOUT BENEFIT OF A TITLE REPORT. THIS SURVEY SUBJECT TO ANY FACTS AND EASEMENTS WHICH MAY BE DISCLOSED BY A FULL AND ACCURATE TITLE SEARCH.
10. ELEVATIONS FOR THIS SURVEY ARE BASED ON NAVD88.
11. PIPE SIZE AND MATERIALS IN PARENTHESIS ARE PER WAKE COUNTY GIS.

- SD1-DI
GRATE=340.82'
15" RCP (NW)=338.30'
15" RCP (SE)=336.73'
- SD2-CB
TOP=364.99'
15" RCP (NW)=361.63'
- SD3-CB
TOP=363.98'
15" RCP (SE)=361.09'
15" RCP (NW)=360.66'
- SD4-CB
TOP=361.04'
15" RCP (SE)=357.86'
15" RCP (NW)=355.95'
- SD5-CB
TOP=349.72'
15" RCP (S)=346.40'
15" RCP (SE)=346.12'
15" RCP (NW)=346.00'
- SD6-CB
TOP=349.79'
15" RCP (N)=346.92'
- SD7-CB
TOP=342.89'
15" RCP (SE)=338.14'
15" RCP (N)=337.97'
- SD8-CB
TOP=340.61'
15" RCP (SE)=336.72'
15" RCP (S)=336.58'
24" RCP (N)=336.50'
- SD9-CB
TOP=339.46'
24" RCP (S)=335.45'
24" RCP (N)=335.47'
- SD10-CB
TOP=338.85'
15" RCP (NE)=335.39'
15" RCP (SW)=334.75'
24" RCP (S)=334.54'
24" RCP (NW)=334.60'
- SD11-CB
TOP=338.81'
15" RCP (NE)=335.22'
- SD12-DMH
RIM=340.09'
BOTTOM OF BOX=332.46'
*UNABLE TO MEASURE
INVERTS AT TIME OF
SURVEY
- SS1-SMH
RIM=365.62'
(8" PVC) (NW)=348.08'
*FULL OF DEBRIS AT
TIME OF SURVEY
- SS2-SMH
RIM=367.63'
4" PVC (E)=346.73'
4" PVC (S)=347.45'
8" (PVC) (SE)=346.33'
8" (PVC) (NW)=346.32'
- SS3-SMH
RIM=361.04'
4" PVC (N)=345.10'
8" PVC (SE)=344.52'
8" (PVC) (NW)=344.48'
*FULL OF DEBRIS AT
TIME OF SURVEY
- SS4-SMH
RIM=359.19'
4" PVC (S)=343.61'
8" (PVC) (SE)=342.81'
8" (PVC) (W)=342.73'
- SS5-SMH
RIM=355.35'
4" PVC (S)=351.28'
4" PVC (NW)=342.73'
8" (PVC) (E)=342.02'
8" (PVC) (SW)=341.98'
- SS6-SMH
RIM=343.35'
4" PVC (S)=339.04'
8" HOPE (SE)=337.33'
8" PVC (SW)=337.28'
- SS7-SMH
RIM=340.40'
4" PVC (S)=335.26'
8" PVC (NE)=332.25'
8" PVC (N)=331.84'
8" PVC (NW)=331.68'
- SS8-SMH
RIM=339.38'
8" PVC (S)=331.97'
8" PVC (SE)=331.19'
8" DIP (NW)=331.13'
*FULL OF DEBRIS AT
TIME OF SURVEY
- SS9-SMH
RIM=338.35'
8" DIP (SE)=330.95'
12" DIP (NW)=330.81'
12" DIP (S)=330.73'
- SS10-SMH
RIM=342.38'
8" (PVC) (S)=334.97'
- SS11-SMH
RIM=361.36'
4" PVC (NE)=355.24'
8" HOPE (NW)=354.31'
- SS12-SMH
RIM=347.98'
8" HOPE (SE)=342.00'
8" HOPE (NW)=338.08'
- SS13-SMH
RIM=344.24'
8" HOPE (SE)=337.58'
8" HOPE (N)=337.53'
- SS14-SMH
RIM=340.17'
8" HOPE (S)=334.62'
8" HOPE (N)=334.42'
- SS15-SMH
RIM=338.81'
8" PVC (S)=333.07'
8" PVC (N)=332.93'
- SS16-SMH
RIM=366.02'
4" PVC (N)=362.87'
8" HOPE (SE)=362.44'
- SS17-SMH
RIM=367.02'
4" PVC (S)=362.45'
4" PVC (N)=362.28'
8" HOPE (NW)=361.62'
8" HOPE (SE)=361.59'
*FULL OF DEBRIS AT
TIME OF SURVEY

LEGEND

- BENCHMARK
EXISTING CONCRETE MONUMENT
EXISTING IRON PIPE
EXISTING AXLE
N.G.S. MONUMENT
EXISTING REBAR
FIRE HYDRANT
WATER METER
WATER MARKER
WATER VALVE
DRAINAGE INLET/YARD INLET
CL CATCH BASIN AT BC
FES
ELECTRIC BOX
GUY WIRE
LIGHT POLE
POWER/UTILITY POLE
ELECTRIC TRANSFORMER
CLEAN OUT
SEWER MANHOLE
CABLE TV BOX
TELEPHONE PEDESTAL
FIBER OPTIC HANDHOLE
SIGN
MAILBOX
- ADJOINER GIS LINE
GAS LINE
WATER LINE
SEWER LINE
STORM LINE
WATER LINE PER RECORD/GIS
SEWER LINE PER RECORD/GIS
STORM LINE PER RECORD/GIS
FENCE
SPLIT RAIL FENCE
UNDERGROUND TV CABLE
UNDERGROUND ELECTRIC LINE
UNDERGROUND FIBER OPTIC CABLE
OVERHEAD TELEPHONE CABLE
OVERHEAD ELECTRIC LINE
WOOD LINE/LANDSCAPING
RIP RAP
- BE
CM
DG
G
O
O
PER
P
N/F
D.B.
B.M.
PAGE
PVC
RCP
HDPE
FES
CMP
CPP
DIP
N.G.S.
E.O.I.
EIP
EIP CT
ERB
EAX
FFE
LAG
- BEECH
CRAPE MYRTLE
DOGWOOD
SWEET GUM
OAK
ORNAMENTAL
PEAR
PINE
NOW OR FORMERLY
DEED BOOK
BOOK OF MAPS
PAGE
POLYVINYL CHLORIDE
REINFORCED CONCRETE PIPE
HIGH-DENSITY POLYETHYLENE
FLARED END SECTION
CORRUGATED METAL PIPE
CORRUGATED PLASTIC PIPE
DUCTILE IRON PIPE
NATIONAL GEODETIC SURVEY
END OF INFORMATION
EXISTING IRON PIPE
EXISTING IRON PIPE WITH CAP AND TACK
EXISTING REBAR
EXISTING AXLE
FINISHED FLOOR ELEVATION
LOWEST ADJACENT GROUND ELEVATION



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TOWN OF WAKE FOREST
301 S. BROOKS STREET
WAKE FOREST, NORTH CAROLINA 27587

HOME GARDENS
NEIGHBORHOOD STUDY
TOPOGRAPHIC AND LOCATION SURVEY
WAKE DRIVE AND FOREST ROAD
WAKE FOREST TOWNSHIP, WAKE COUNTY, NORTH CAROLINA

REVISIONS

NO. DATE

PLAN INFORMATION

PROJECT NO. WKF-24004
FILENAME WKF24004-C1
CHECKED BY JBT
DRAWN BY CIS
SCALE NOT TO SCALE
DATE 02. 14. 2025

SHEET

TOPOGRAPHIC AND
LOCATION SURVEY

1-3

NOT TO SCALE

GENERAL NOTES

- SEE SHEET 1 FOR GENERAL NOTES.
- SEE SHEET 1 FOR FORM AND SEWER INVERT TABLE.



NC GRID NAD83 (2011)



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HOME GARDENS NEIGHBORHOOD STUDY TOPOGRAPHIC AND LOCATION SURVEY WAKE DRIVE AND FOREST ROAD WAKE FOREST TOWNSHIP, WAKE COUNTY, NORTH CAROLINA



REVISIONS

NO. DATE

PLAN INFORMATION

PROJECT NO. WKF-24004
FILENAME WKF24004-C1
CHECKED BY JBT
DRAWN BY CIS
SCALE 1"=40'
DATE 02.14.2025

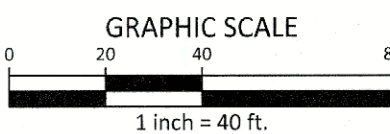
SHEET

TOPOGRAPHIC AND
LOCATION SURVEY

2-3

LEGEND

	BENCHMARK		BEECH
	EXISTING CONCRETE MONUMENT		CRAPPE MYRTLE
	EXISTING IRON PIPE		DOGWOOD
	EXISTING AXLE		SWEET GUM
	N.G.S. MONUMENT		OAK
	EXISTING REBAR		ORNAMENTAL
	FIRE HYDRANT		PEAR
	WATER METER		PINE
	WATER MARKER		NOW OR FORMERLY
	WATER VALVE		DEED BOOK
	DRAINAGE INLET/YARD INLET		BOOK OF MAPS
	CL CATCH BASIN AT BC		PAGE
	FES		POLYVINYL CHLORIDE
	ELECTRIC BOX		HIGH-DENSITY POLYETHYLENE
	GUY WIRE		FLARED END SECTION
	LIGHT POLE		CORRUGATED METAL PIPE
	POWER/UTILITY POLE		CORRUGATED PLASTIC PIPE
	ELECTRIC TRANSFORMER		DUCTILE IRON PIPE
	CLEAN OUT		NATIONAL GEODETIC SURVEY
	SEWER MANHOLE		END OF INFORMATION
	CABLE TV BOX		EXISTING IRON PIPE
	TELEPHONE PEDESTAL		EXISTING IRON PIPE WITH CAP AND TACK
	FIBER OPTIC HANDHOLE		EXISTING REBAR
	SIGN		EXISTING AXLE
	MAILBOX		FINISHED FLOOR ELEVATION
	ADJOINTER GIS LINE		LOWEST ADJACENT GROUND ELEVATION
	GAS LINE		
	WATER LINE		
	SEWER LINE		
	STORM LINE		
	WATER LINE PER RECORD/GIS		
	SEWER LINE PER RECORD/GIS		
	STORM LINE PER RECORD/GIS		
	FENCE		
	SPLIT RAIL FENCE		
	UNDERGROUND TV CABLE		
	UNDERGROUND ELECTRIC LINE		
	UNDERGROUND FIBER OPTIC CABLE		
	UNDERGROUND TELEPHONE CABLE		
	OVERHEAD ELECTRIC LINE		
	WOOD LINE/LANDSCAPING		
	RIP RAP		

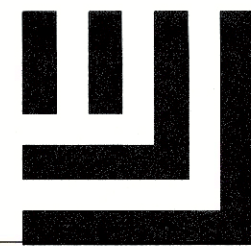


GENERAL NOTES

1. SEE SHEET 1 FOR GENERAL NOTES.
2. SEE SHEET 1 FOR STORM AND SEWER INVERT TABLE.



NC GRID NAD83 (2011)



McADAMS

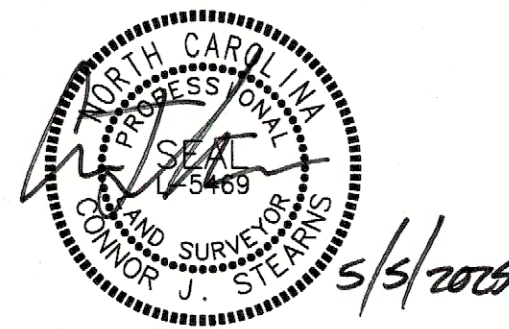
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HOME GARDENS
NEIGHBORHOOD STUDY
TOPOGRAPHIC AND LOCATION SURVEY
WAKE DRIVE AND FOREST ROAD
WAKE FOREST TOWNSHIP, WAKE COUNTY, NORTH CAROLINA



REVISIONS

NO. DATE

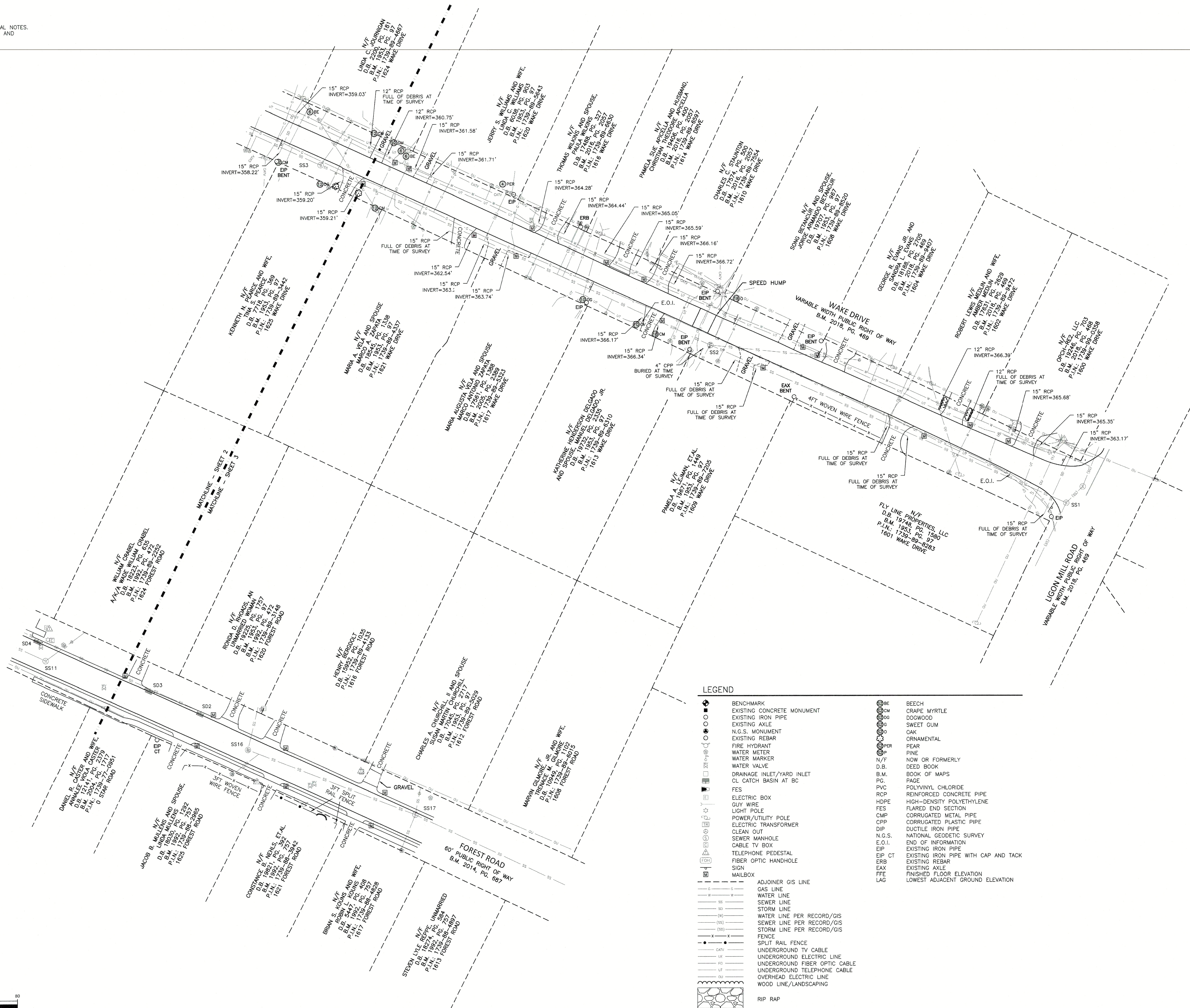
PLAN INFORMATION

PROJECT NO. WKF-24004
FILENAME WKF24004-C1
CHECKED BY JBT
DRAWN BY CJS
SCALE 1"=40'
DATE 02. 14. 2025

SHEET

TOPOGRAPHIC AND
LOCATION SURVEY

3-3



LEGEND

- | | | | |
|--|------------------------------|--|--------------------------------------|
| | BENCHMARK | | BEECH |
| | EXISTING CONCRETE MONUMENT | | CRAPPE MYRTLE |
| | EXISTING IRON PIPE | | DOGWOOD |
| | EXISTING AXLE | | SWEET GUM |
| | N.G.S. MONUMENT | | OAK |
| | EXISTING REBAR | | ORNAMENTAL |
| | FIRE HYDRANT | | PEAR |
| | WATER METER | | PINE |
| | WATER MARKER | | NOW OR FORMERLY |
| | WATER VALVE | | DEED BOOK |
| | DRAINAGE INLET/YARD INLET | | BOOK OF MAPS |
| | CL CATCH BASIN AT BC | | PAGE |
| | FES | | PVC |
| | ELECTRIC BOX | | REINFORCED CONCRETE PIPE |
| | GUY WIRE | | HIGH-DENSITY POLYETHYLENE |
| | LIGHT POLE | | FLARED END SECTION |
| | POWER/UTILITY POLE | | CORRUGATED METAL PIPE |
| | ELECTRIC TRANSFORMER | | CORRUGATED PLASTIC PIPE |
| | CLEAN OUT | | DUCTILE IRON PIPE |
| | SEWER MANHOLE | | NATIONAL GEODEIC SURVEY |
| | CABLE TV BOX | | END OF INFORMATION |
| | TELEPHONE PEDESTAL | | EXISTING IRON PIPE |
| | FIBER OPTIC HANDHOLE | | EXISTING IRON PIPE WITH CAP AND TACK |
| | SIGN | | EXISTING REBAR |
| | MAILBOX | | EXISTING AXLE |
| | ADJOINER GIS LINE | | FINISHED FLOOR ELEVATION |
| | GAS LINE | | LOWEST ADJACENT GROUND ELEVATION |
| | WATER LINE | | |
| | SEWER LINE | | |
| | STORM LINE | | |
| | WATER LINE PER RECORD/GIS | | |
| | SEWER LINE PER RECORD/GIS | | |
| | STORM LINE PER RECORD/GIS | | |
| | FENCE | | |
| | SPLIT RAIL FENCE | | |
| | UNDERGOUND TV CABLE | | |
| | UNDERGOUND ELECTRIC LINE | | |
| | UNDERGOUND FIBER OPTIC CABLE | | |
| | UNDERGOUND TELEPHONE CABLE | | |
| | OVERHEAD ELECTRIC LINE | | |
| | WOOD LINE/LANDSCAPING | | |
| | RIP RAP | | |

GRAPHIC SCALE

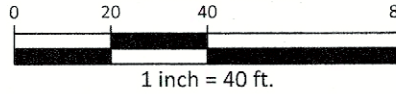


EXHIBIT 5

EXISTING CONDITIONS

MODELING RESULTS



HOME GARDENS 1 YEAR EXISTING RESULTS

HOME GARDENS
PROJECT #: WKF24004
WAKE FOREST, NC





Legend

Structure Type

- Inlet - Curb
- ▲ Inlet - Flared
- ⊙ Manhole
- ▲ Outlet

Max Flow of Pipes

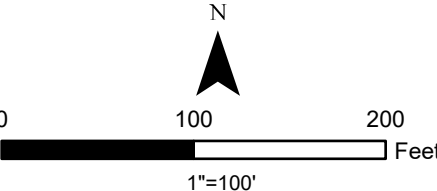
- Channel
- ➔ Partially Full

Flooding Depth (in)



HOME GARDENS 2 YEAR EXISTING RESULTS

HOME GARDENS
PROJECT #: WKF24004
WAKE FOREST, NC





HOME GARDENS 5 YEAR EXISTING RESULTS

HOME GARDENS
PROJECT #: WKF24004
WAKE FOREST, NC

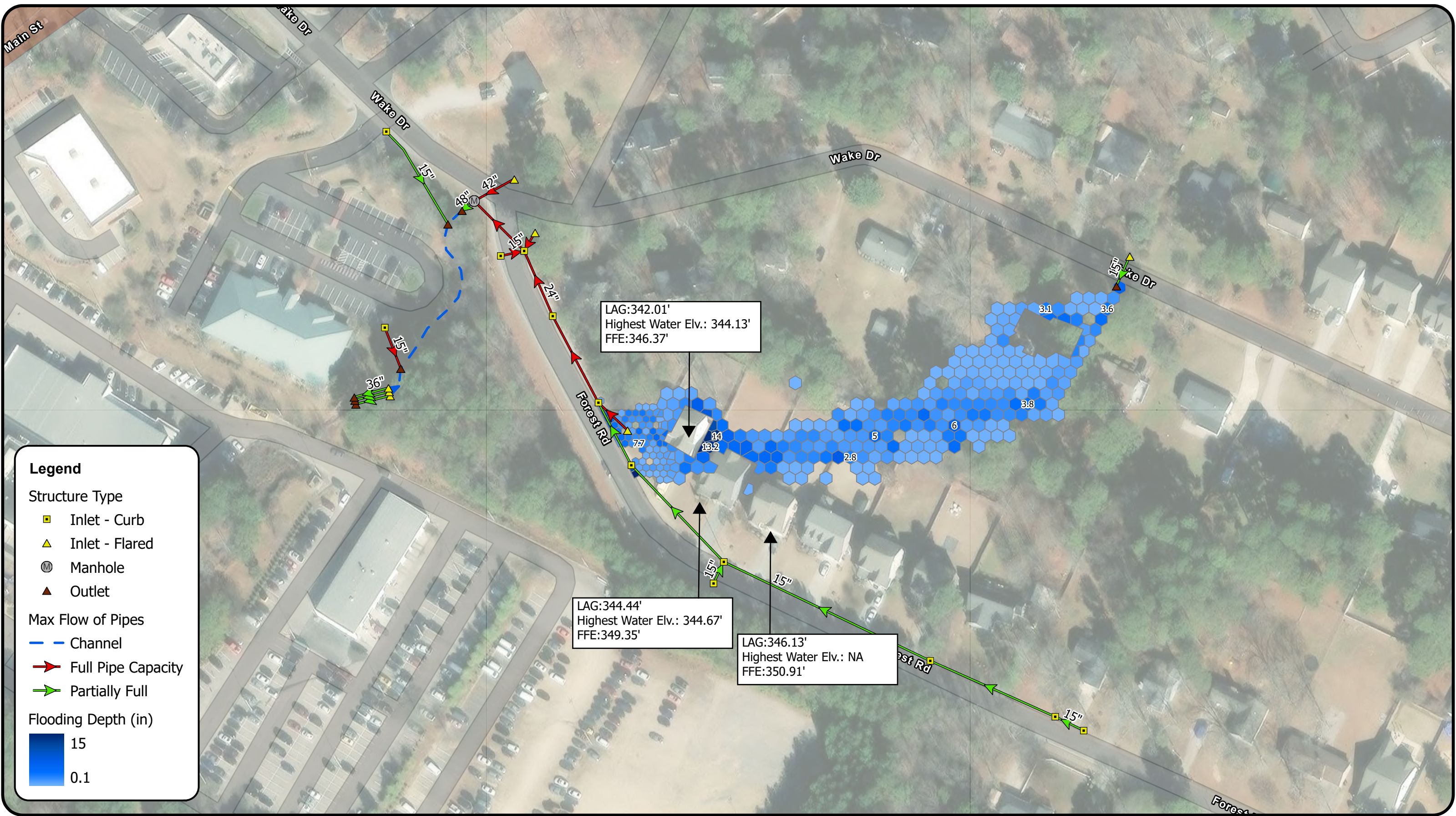




HOME GARDENS 10 YEAR EXISTING RESULTS

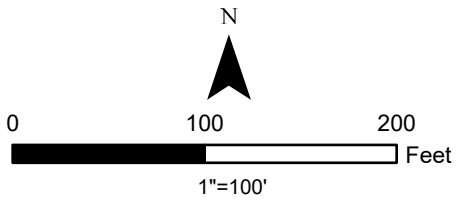
HOME GARDENS
PROJECT #: WKF24004
WAKE FOREST, NC

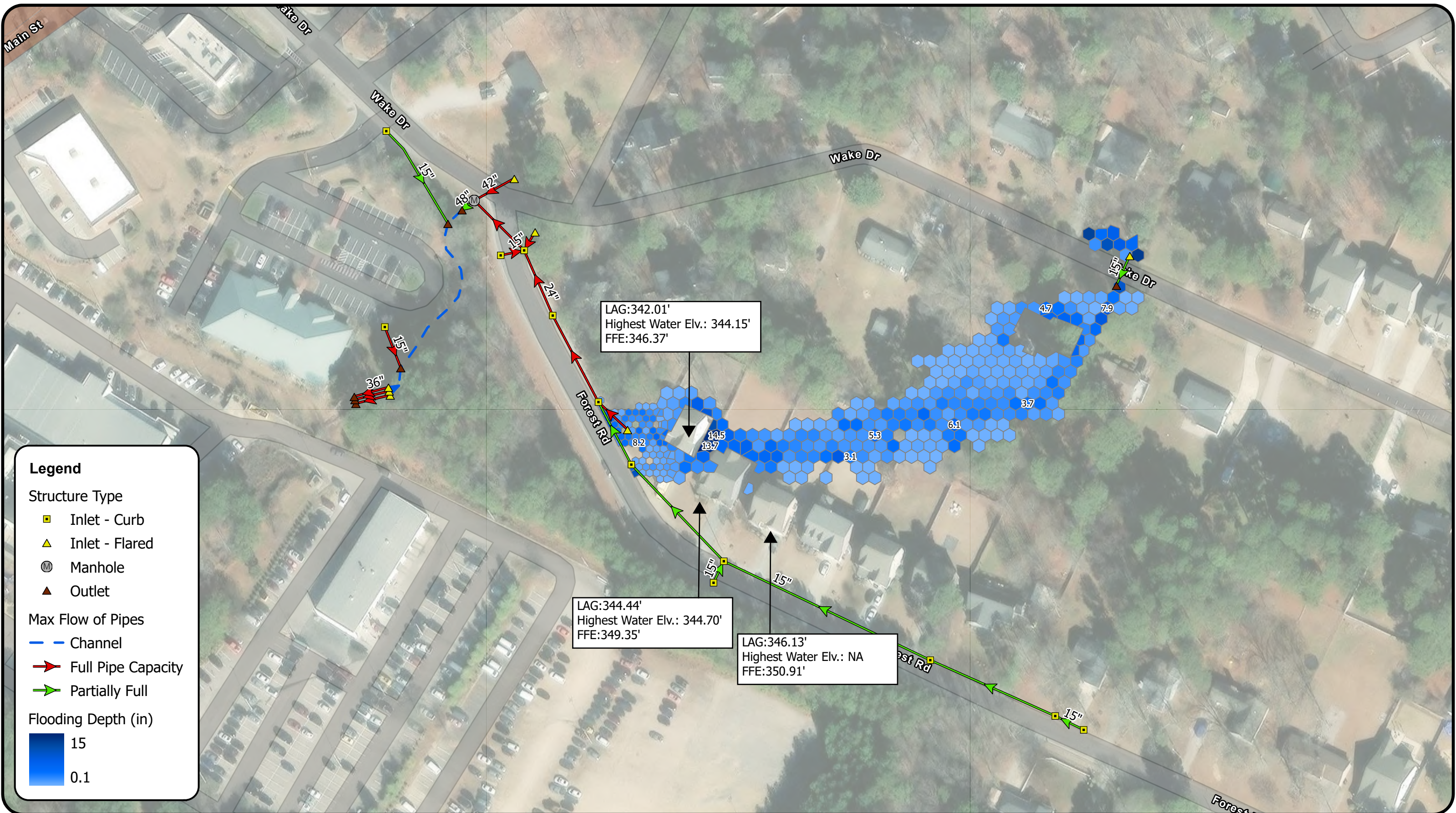




HOME GARDENS 25 YEAR EXISTING RESULTS

HOME GARDENS
PROJECT #: WKF24004
WAKE FOREST, NC





HOME GARDENS 50 YEAR EXISTING RESULTS

HOME GARDENS
PROJECT #: WKF24004
WAKE FOREST, NC





HOME GARDENS 100 YEAR EXISTING RESULTS

HOME GARDENS
PROJECT #: WKF24004
WAKE FOREST, NC



EXHIBIT 6
RECOMMENDED ALTERNATIVE
CONCEPTUAL PLAN



HOME GARDENS RECOMMENDED ALTERNATIVE

HOME GARDENS
PROJECT #: WKF24004
WAKE FOREST, NC





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PHONE: 919. 435. 9510



**HOME GARDENS DRAINAGE
IMPROVEMENTS**
PROPOSED ALTERNATIVE
HOME GARDENS NEIGHBORHOOD
WAKE FOREST, NC 27587

REVISIONS

NO.	DATE	DESCRIPTION	AMOUNT
1	10/1/20	...	...
2	10/2/20	...	...
3	10/3/20	...	...
4	10/4/20	...	...
5	10/5/20	...	...
6	10/6/20	...	...
7	10/7/20	...	...
8	10/8/20	...	...
9	10/9/20	...	...
10	10/10/20	...	...
11	10/11/20	...	...
12	10/12/20	...	...
13	10/13/20	...	...
14	10/14/20	...	...
15	10/15/20	...	...
16	10/16/20	...	...
17	10/17/20	...	...
18	10/18/20	...	...
19	10/19/20	...	...
20	10/20/20	...	...
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25	10/25/20	...	...
26	10/26/20	...	...
27	10/27/20	...	...
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29	10/29/20	...	...
30	10/30/20	...	...
31	10/31/20	...	...

PLAN INFORMATION

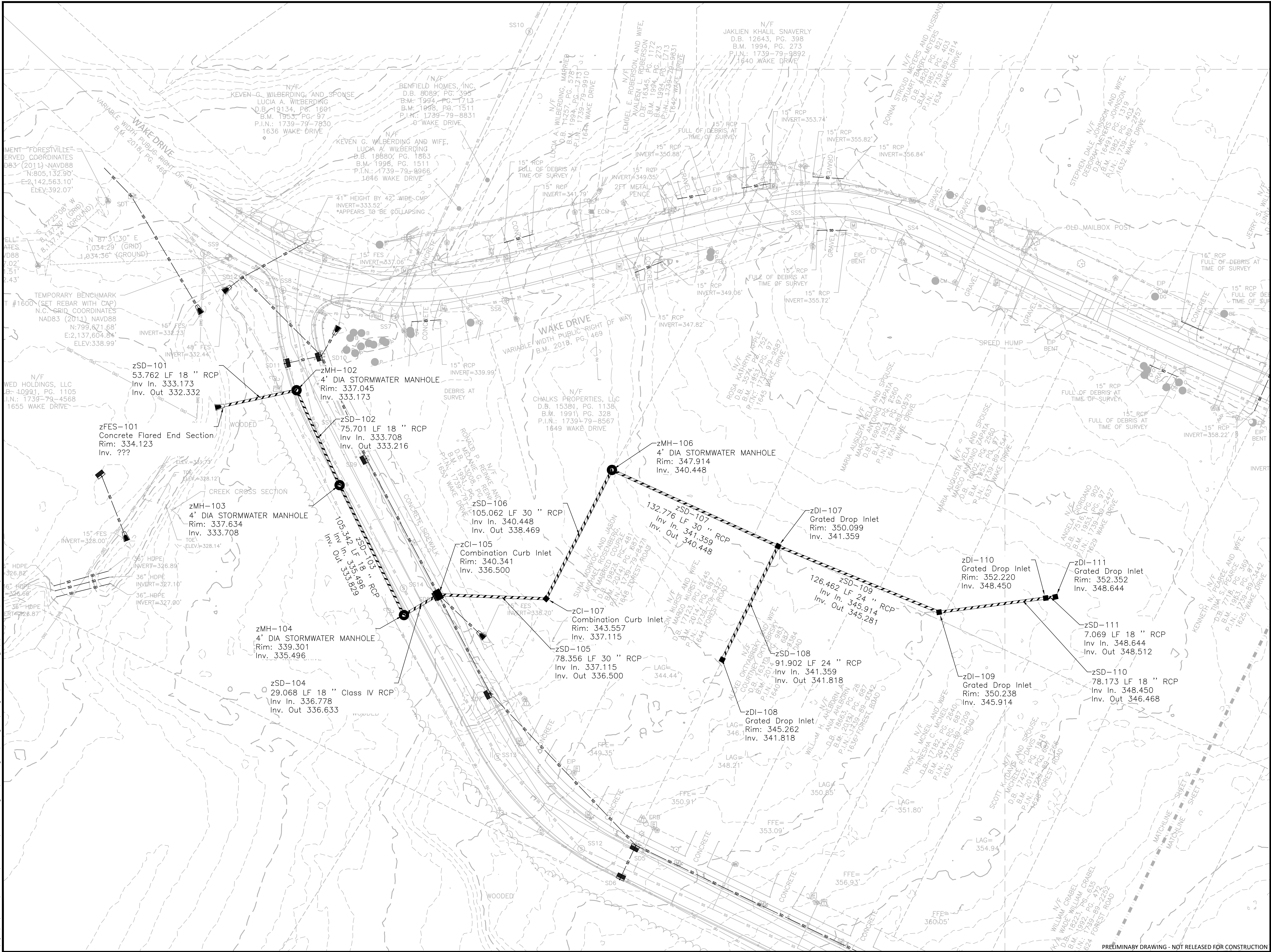
PROJECT NO.	WKF-24004
FILENAME	WKF-24004-zSD
CHECKED BY	CMJ
DRAWN BY	DOF
SCALE	1"=30'
DATE	12. 22. 2025

SHEET

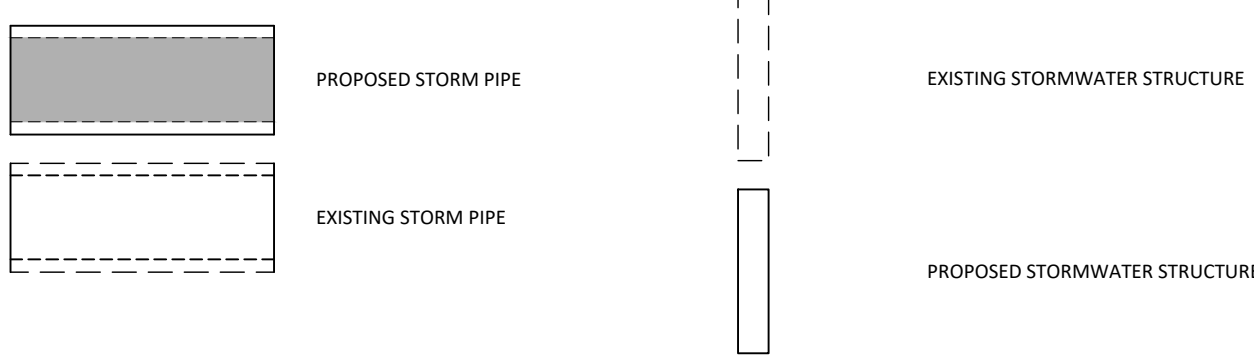
HOME GARDENS STORM PLAN

C1.01

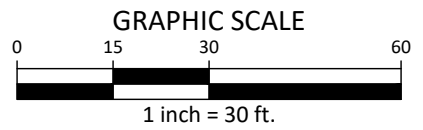
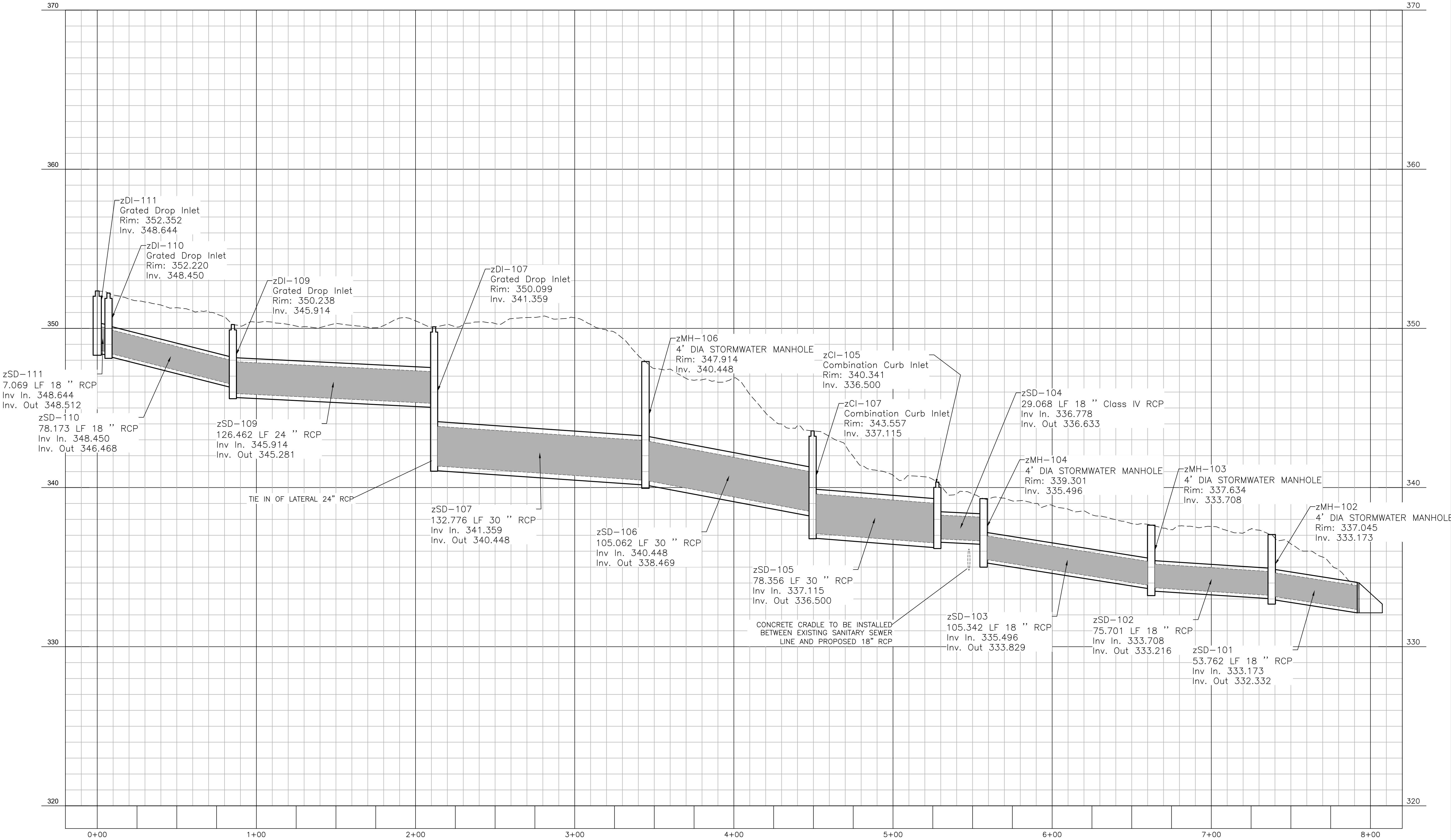
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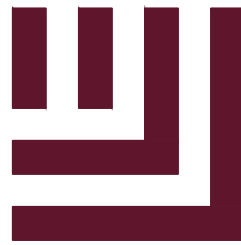
SITE LEGEND



Proposed Storm Alignment



PRELIMINARY DRAWING - NOT RELEASED FOR CONSTRUCTION



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WAKE FOREST, NORTH CAROLINA 27587
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TOWN of
WAKE FOREST

HOME GARDENS DRAINAGE
IMPROVEMENTS
PROPOSED ALTERNATIVE
HOME GARDENS NEIGHBORHOOD
WAKE FOREST, NC 27587

REVISIONS

NO. DATE

PLAN INFORMATION

PROJECT NO. WKF-24004
FILENAME WKF-24004-zSD
CHECKED BY CMJ
DRAWN BY DOF
SCALE 1"=30'
DATE 12. 22. 2025

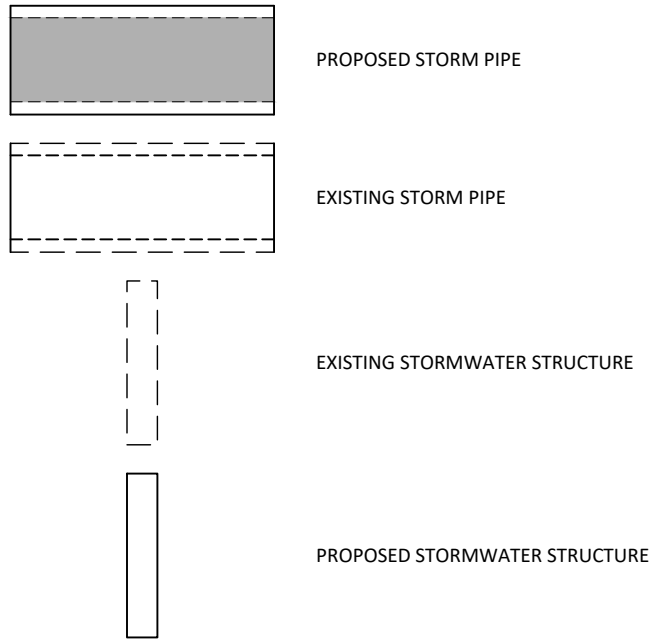
SHEET

HOME GARDENS
STORM PROFILE

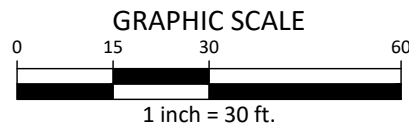
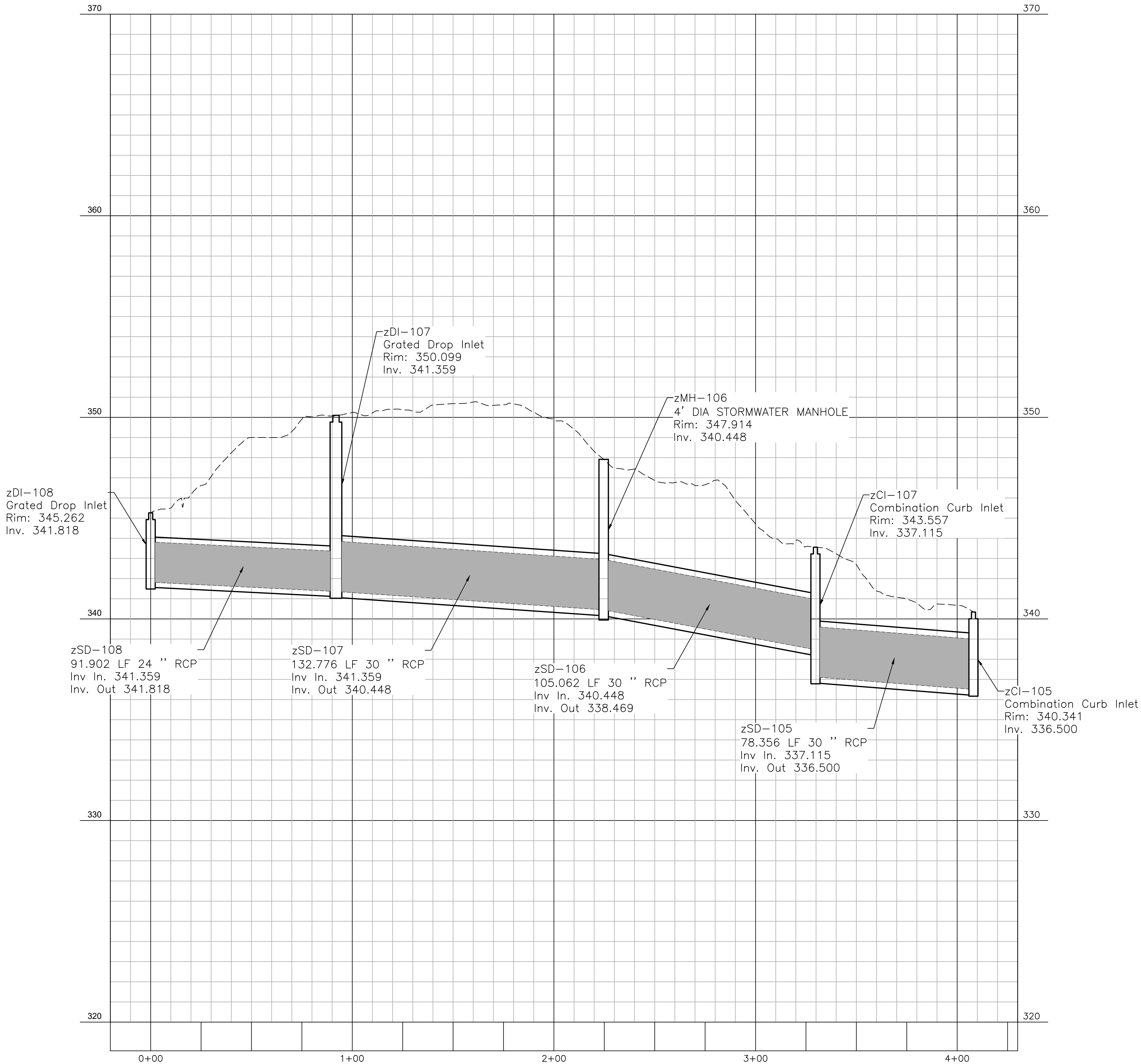
C1.02

X:\Projects\WKF\WKF24004\04-Production\Water Resources\Stormwater Management\Master Design Files\00 - Design Files\Drawing Files\WKF24004-zSD.dwg, 12/22/2025 6:48:45 PM, Daniel Friday

SITE LEGEND



Proposed Lateral RCP Branch



McADAMS

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TOWN of
WAKE FOREST

HOME GARDENS DRAINAGE
IMPROVEMENTS
PROPOSED ALTERNATIVE
HOME GARDENS NEIGHBORHOOD
WAKE FOREST, NC 27587

REVISIONS

NO. DATE

PLAN INFORMATION

PROJECT NO. WKF-24004
FILENAME WKF-24004-zSD
CHECKED BY CMJ
DRAWN BY DOF
SCALE 1"=30'
DATE 12. 22. 2025

SHEET

HOME GARDENS LATERAL
STORM PROFILE

C1.03

EXHIBIT 7

RECOMMENDED ALTERNATIVE MODELING RESULTS



HOME GARDENS 1 YEAR RESULTS RECOMMENDED ALTERNATIVE

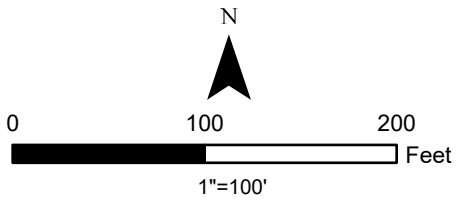
HOME GARDENS
PROJECT #: WKF24004
WAKE FOREST, NC





HOME GARDENS 2 YEAR RESULTS RECOMMENDED ALTERNATIVE

HOME GARDENS
PROJECT #: WKF24004
WAKE FOREST, NC







Legend

Structure Type

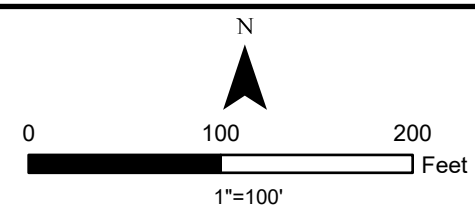
- Inlet - Curb
- Inlet - Drop
- ▲ Inlet - Flared
- Ⓜ Manhole
- ▲ Outlet

Max Flow of Pipes

- Channel
- Full
- Partially Full

Flooding Depth (in)

- 29
- 0.1



HOME GARDENS 10 YEAR RESULTS RECOMMENDED ALTERNATIVE

HOME GARDENS
PROJECT #: WKF24004
WAKE FOREST, NC





Legend

Structure Type

- Inlet - Curb
- ▣ Inlet - Drop
- ▲ Inlet - Flared
- ⊙ Manhole
- ▲ Outlet

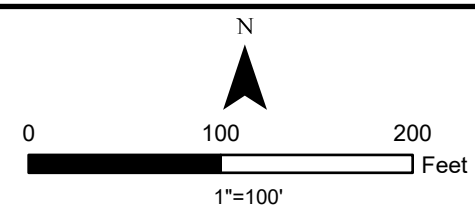
Max Flow of Pipes

- Channel
- Full
- Partially Full

Flooding Depth (in)

46

0.1



HOME GARDENS 25 YEAR RESULTS RECOMMENDED ALTERNATIVE

HOME GARDENS
PROJECT #: WKF24004
WAKE FOREST, NC





HOME GARDENS 50 YEAR RESULTS RECOMMENDED ALTERNATIVE

HOME GARDENS
PROJECT #: WKF24004
WAKE FOREST, NC





HOME GARDENS 100 YEAR RESULTS RECOMMENDED ALTERNATIVE

HOME GARDENS
PROJECT #: WKF24004
WAKE FOREST, NC

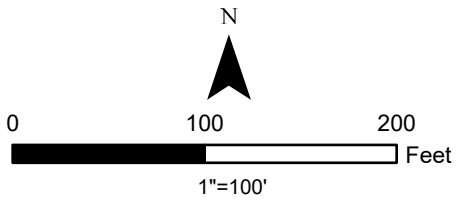
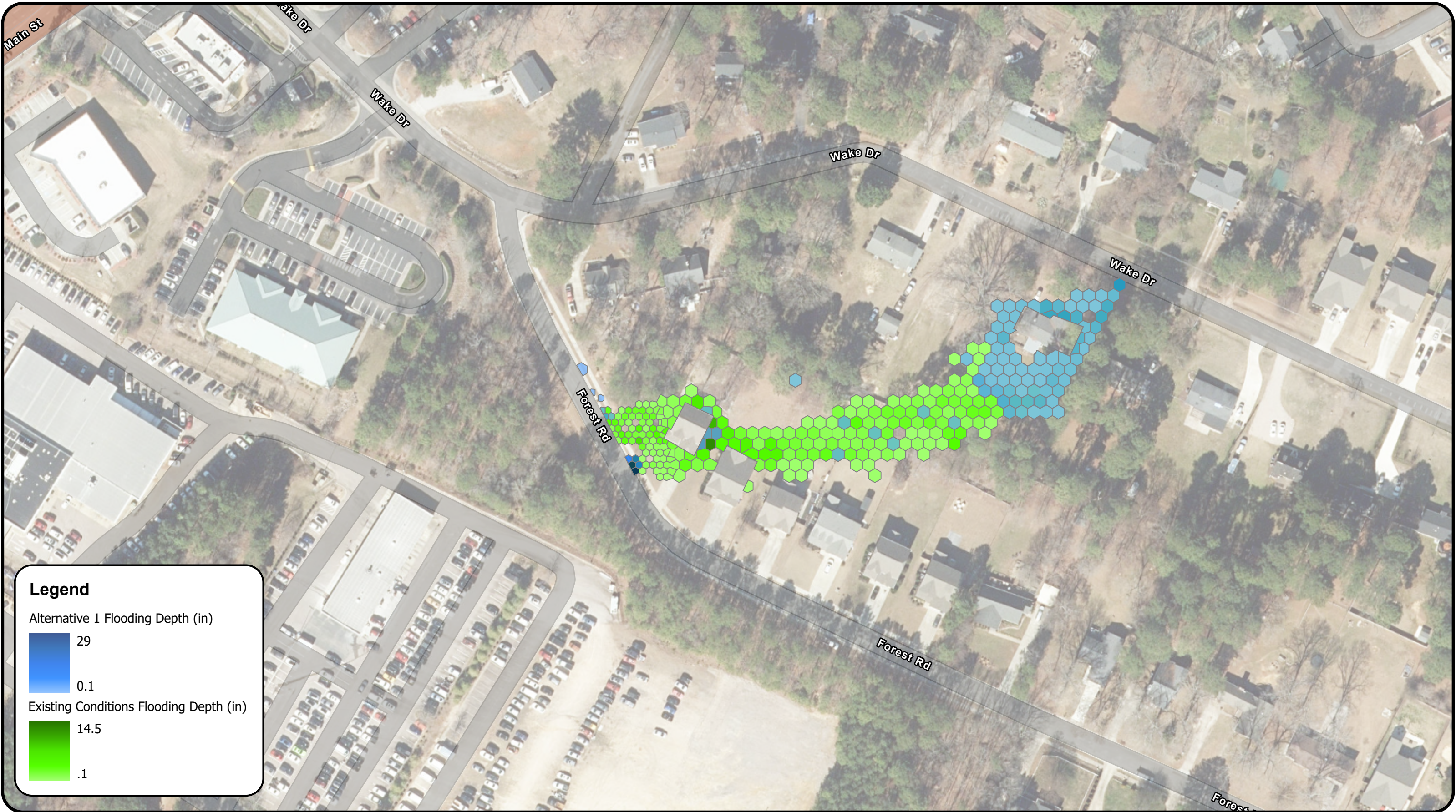
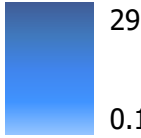


EXHIBIT 8
EXISTING VS RECOMMENDED 10
YEAR FLOOD DEPTH COMPARISON
MAP

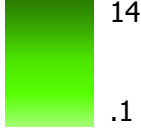


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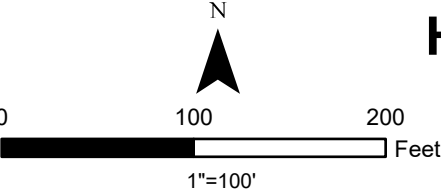
Alternative 1 Flooding Depth (in)



Existing Conditions Flooding Depth (in)



HOME GARDENS EXISTING VS RECOMMENDED - 10 YEAR FLOOD DEPTH MAP



HOME GARDENS
PROJECT #: WKF24004
WAKE FOREST, NC



EXHIBIT 9
RECOMMENDED ALTERNATIVE
OPINION OF PROBABLE
CONSTRUCTION COST

Opinion of Probable Construction Cost - Home Gardens

Project:	Cardinal Hills Drainage Study				Project No.:
Owner:	Town of Wake Forest				WKF24004
Engineer:	McAdams				
Offeror:					
Item No.	Item Description	Unit	Estimated Quantity	Unit Price	Extended Amount
Items in Cost Estimate					
GENERAL REQUIREMENTS					\$ 44,500.00
A-01	Mobilization (Max 5% Base Bid)	LS	1	\$ 44,500.00	\$ 44,500.00
DEMOLITION					\$ 53,875.00
A-02	Clearing and Grubbing (includes allowance for tree removal)	LS	1	\$ 25,000.00	\$ 25,000.00
A-03	Pavement and Base Course Removal	SY	235	\$ 75.00	\$ 17,625.00
A-04	Removal of Existing Curb and Gutter	LF	230	\$ 25.00	\$ 5,750.00
A-05	Demolition and Removal of Private Fencing	LF	350	\$ 15.00	\$ 5,250.00
A-06	Removal of Existing Concrete Sidewalk	SY	5	\$ 50.00	\$ 250.00
EARTHWORK + MATERIALS					\$ 310,730.00
A-07	Unclassified Excavation (Dispose of Offsite)	CY	3,900	\$ 50.00	\$ 195,000.00
A-08	Select Material Backfill (Class I)	CY	1,950	\$ 40.00	\$ 78,000.00
A-09	Fine Grading	LS	1	\$ 10,000.00	\$ 10,000.00
A-10	Silt Fence	LF	810	\$ 7.00	\$ 5,670.00
A-11	Tree Protection Fencing	LF	470	\$ 8.00	\$ 3,760.00
A-12	Orange Construction Safety Fence	LF	1,800	\$ 6.00	\$ 10,800.00
A-13	Seeding and Mulching	LS	1	\$ 7,500.00	\$ 7,500.00
SITE / STORM DRAINAGE					\$ 318,500.00
A-14	18" RC Pipe Culvert, Class IV	LF	350	\$ 175.00	\$ 61,250.00
A-15	24" RC Pipe Culvert, Class IV	LF	240	\$ 200.00	\$ 48,000.00
A-16	30" RC Pipe Culvert, Class IV	LF	215	\$ 250.00	\$ 53,750.00
A-17	Precast Concrete Combination Curb Inlet Flow Splitter (per NCDOT Std. 840.02)	EA	1	\$ 15,000.00	\$ 15,000.00
A-18	Precast Concrete Drop Inlet (per NCDOT Std. 840.14)	EA	6	\$ 6,500.00	\$ 39,000.00
A-19	60" Precast Concrete Manhole (per NCDOT Std. 840.52)	EA	1	\$ 9,000.00	\$ 9,000.00
A-20	48" Precast Concrete Manhole (per NCDOT Std. 840.52)	EA	3	\$ 7,500.00	\$ 22,500.00
A-21	18" Precast Concrete Parallel Pipe End Section (per NCDOT Std. 310.02)	EA	1	\$ 6,000.00	\$ 6,000.00
A-22	2'-6" Curb and Gutter (per NCDOT Std. 846.01)	LF	230	\$ 50.00	\$ 11,500.00
A-23	Replacement of Private Fencing	LF	350	\$ 150.00	\$ 52,500.00
PAVING					\$ 43,235.00
A-24	Asphalt Concrete Surface Course, Type S 9.5 B	TN	25	\$ 250.00	\$ 6,250.00
A-25	Asphalt Concrete Intermediate Course, Type I 19.0 C	TN	26	\$ 300.00	\$ 7,800.00
A-26	Aggregate Base Course	TN	101	\$ 185.00	\$ 18,685.00
A-27	Asphalt Binder for Plant Mix (e38a)	TN	10	\$ 950.00	\$ 9,500.00
A-28	4" Concrete Sidewalk (per NCDOT Std. 848.01)	SY	5	\$ 200.00	\$ 1,000.00
MISCELLANEOUS					\$ 126,500.00
A-29	Utility Contingency (10%)	LS	1	\$ 89,000.00	\$ 89,000.00
A-30	Construction Surveying and As-Built Surveying	LS	1	\$ 12,500.00	\$ 12,500.00
A-31	Traffic Control + Detours	LS	1	\$ 15,000.00	\$ 15,000.00
A-32	Testing + Inspections	LS	1	\$ 10,000.00	\$ 10,000.00
A	Subtotal Estimate Amount (Sum of Extended Amounts for each Cost Estimate Line Item) in Figures: (I.E. 1,727,850.00)				\$ 897,340.00
B	ADDITIONAL CONTINGENCIES				
B-1	General Project Contingency			10%	\$ 89,740.00
B-2	Permanent Drainage Easement Acquisition (\$2/sf)	SF	16,090	\$ 1.75	\$ 28,157.50
B-3	Environmental Permitting			2.5%	\$ 22,440.00
B-4	Engineering and Design Contingency			15%	\$ 134,610.00
C	Total Estimate Amount (Sum of Extended Amounts for each Cost Estimate Line Item) in Figures: (I.E. 1,727,850.00)				\$ 1,172,287.50