

Water System Sustainability using Unidirectional Flushing: Utility Success Stories



What is UDF?

Unidirectional Flushing

- Flushing in one direction from a clean source
- Selected valves closed to increase velocity in flushing pipes
- Target velocities > 5 ft/s
- High velocities scour pipes, remove debris build-up
- Water savings $> 70\%$

Conventional Flushing

- Regular flushing of system at fixed rate
- Reduces retention time (water age)
- No valves manipulated
- Lower velocities (< 2 ft/sec)
- Partial debris removal may occur

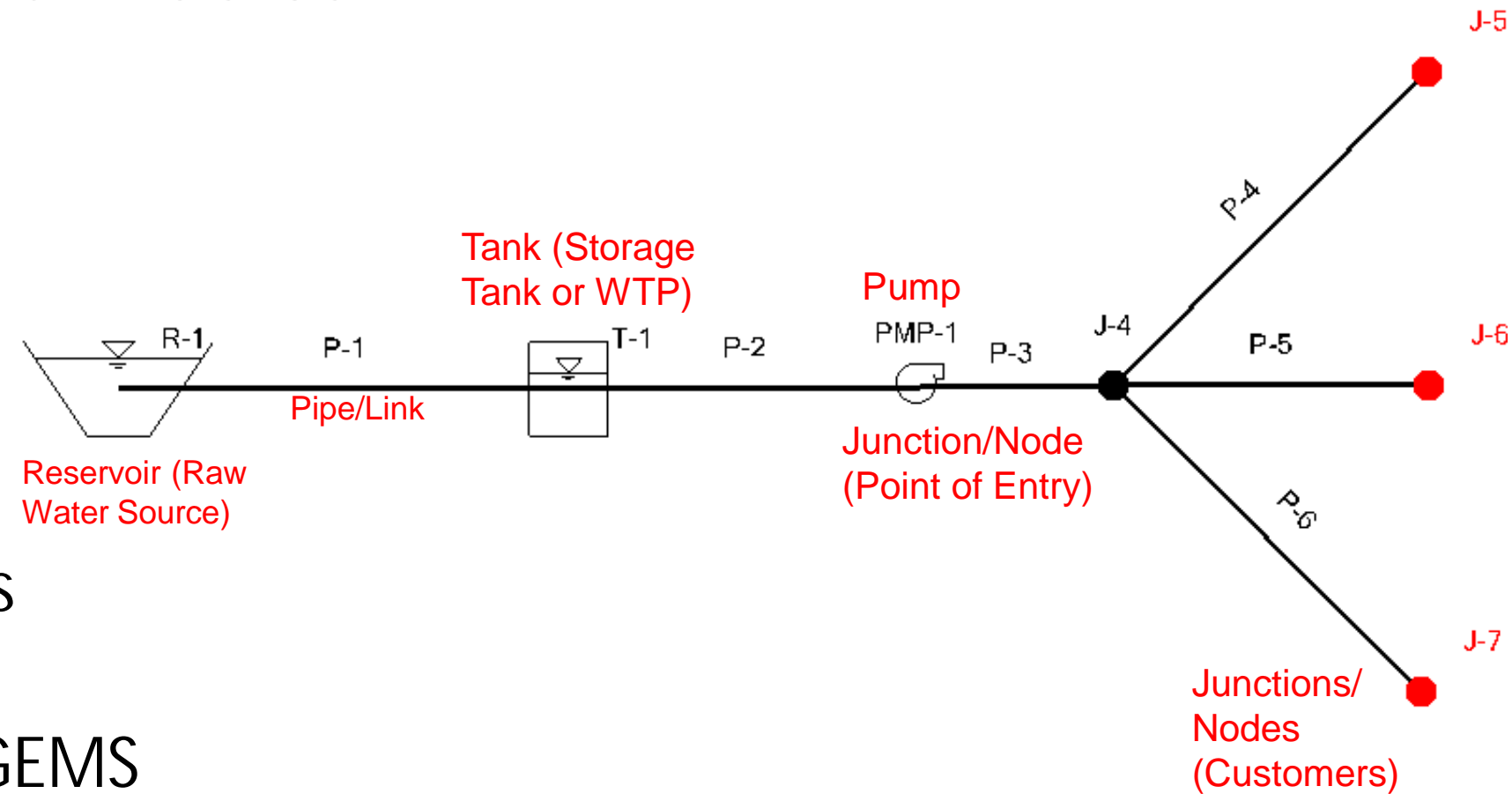
UDF Program

- Planning
- Coordination
- Communication
- Water Quality Control



Hydraulic Model Basics

- Model Preparation
 - ✓ Update
 - ✓ Calibrate
 - ✓ Develop Scenarios

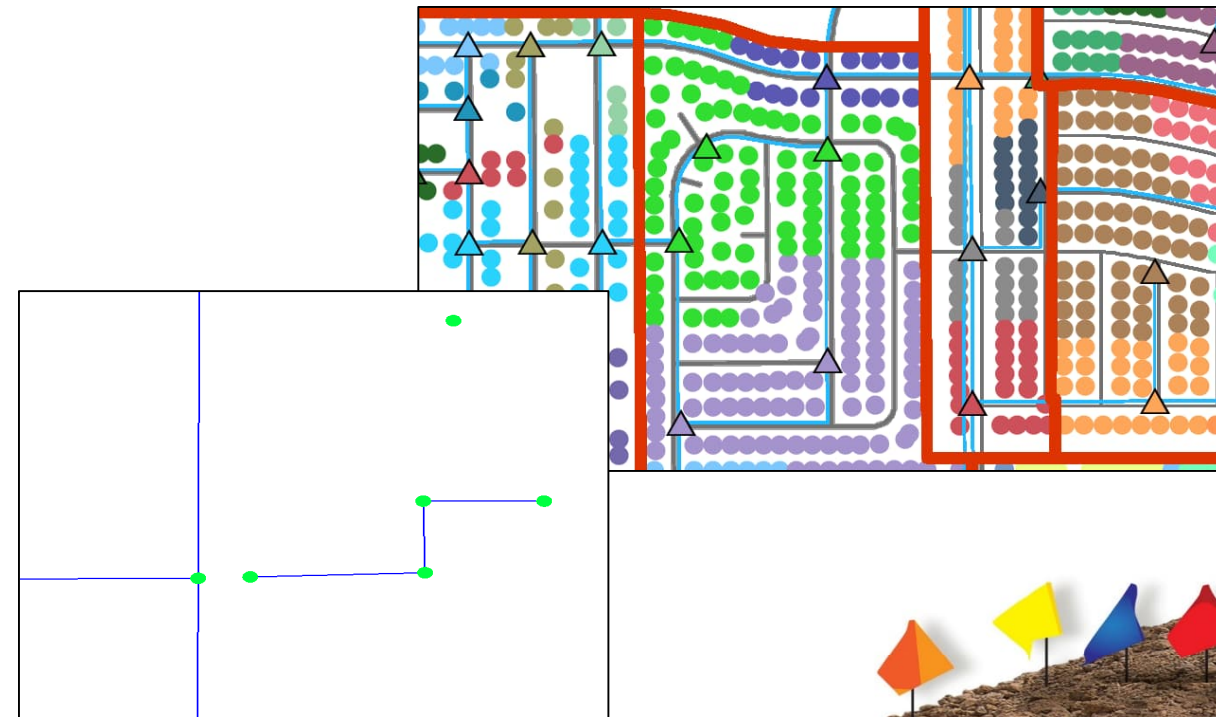
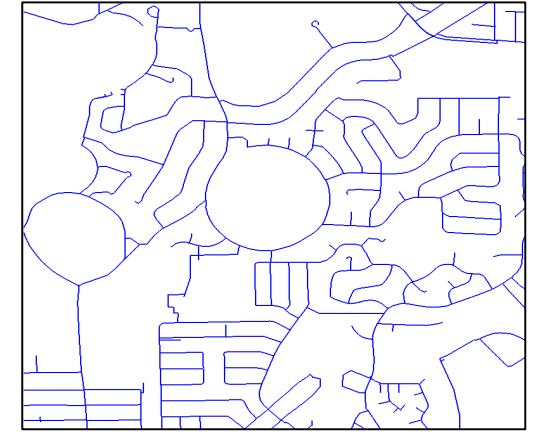
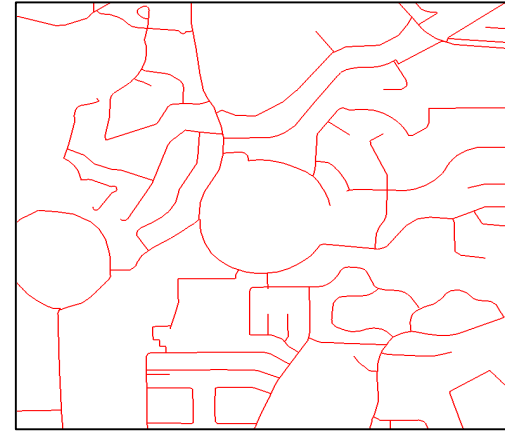


- Available UDF Modules
 - ✓ Infowater
 - ✓ WaterCAD/ WaterGEMS



Hydraulic Modeling

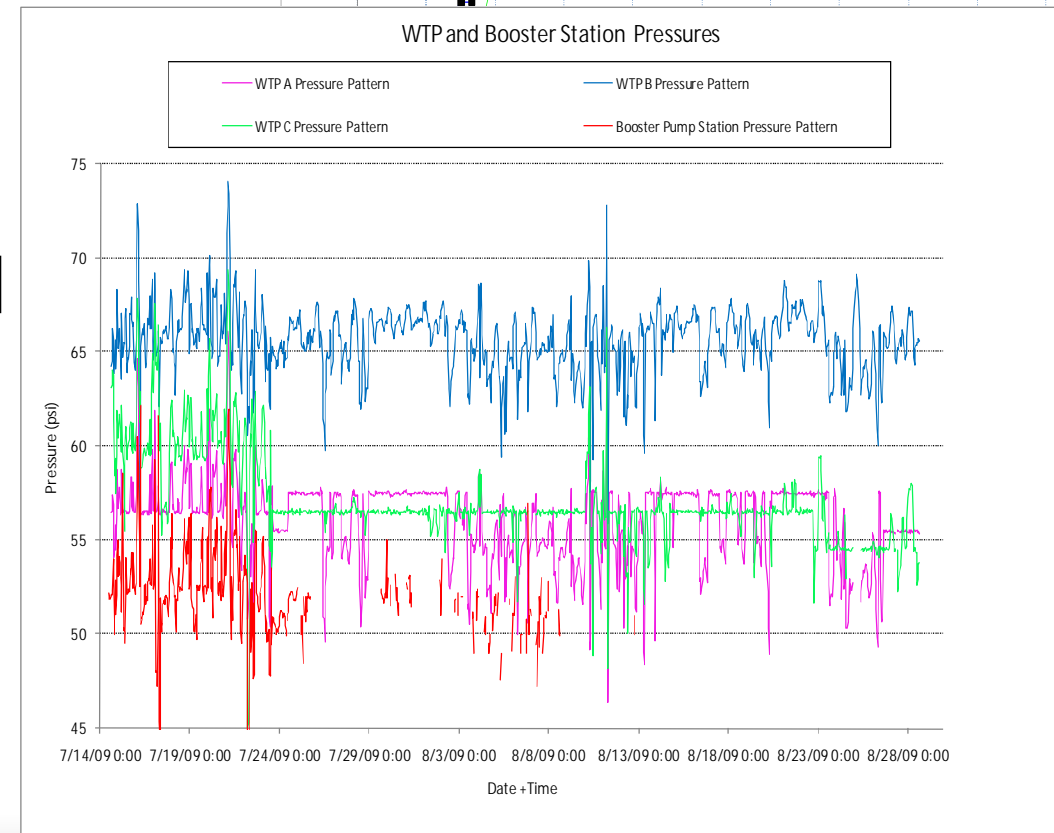
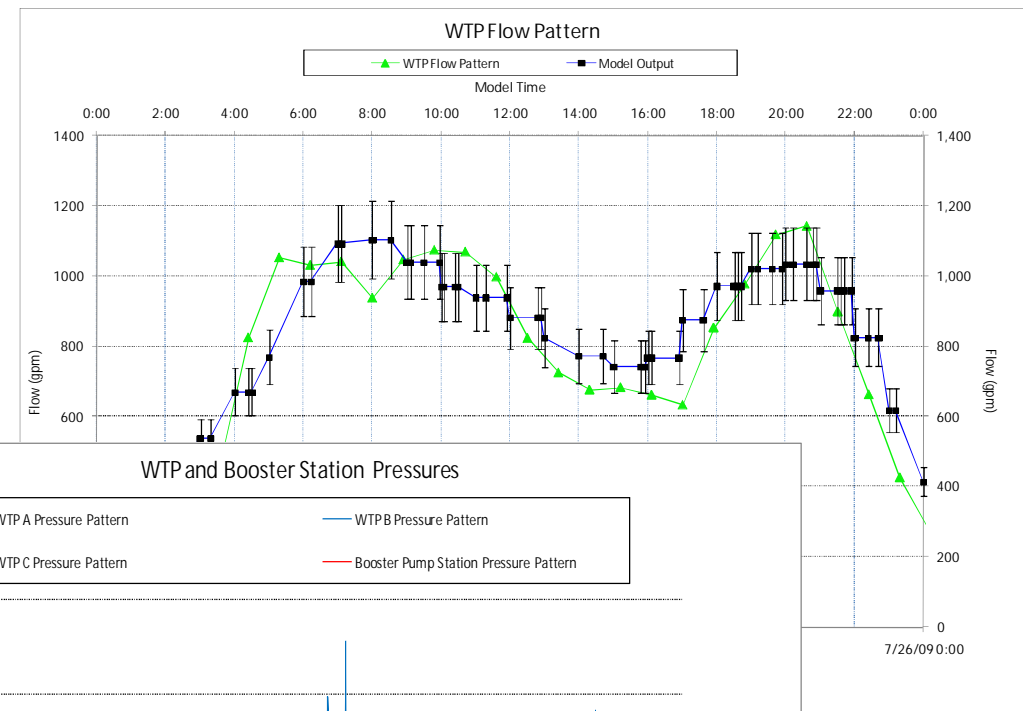
- Update Model
 - ✓ Pipe geometry and properties
 - Material, roughness coefficient, etc.
 - ✓ Connectivity
 - ✓ Update pump, tank, reservoirs
 - ✓ Allocate demands



Hydraulic Modeling - Calibration

What do we need?

1. Updated pump curves
2. Standard Operating Procedures
3. POE, Booster station & elevated tank flows and pressures
4. Distribution system remote pressures
5. Pump status



Develop Scenario

- Use ADF Scenario
- Set UDF constants
- Associate assets with model pipes

Flush Zone Manager

Flush Zones

ID	Description
SECTION_1037	
SECTION_1038	
SECTION_1039	
SECTION_1040	
SECTION_1041	
SECTION_1042	
SECTION_1043	

Flush Zone Characteristics

Minimum Flush Velocity: 3

Maximum System Velocity:

Maximum Flush Volume:

Maximum Flush Length:

Minimum Residual Pressure: 20

Minimum System Pressure:

Maximum System Pressure:

Minimum Shear Stress: 0.001

Flush Area:

Highlight Color: Highlight Reset

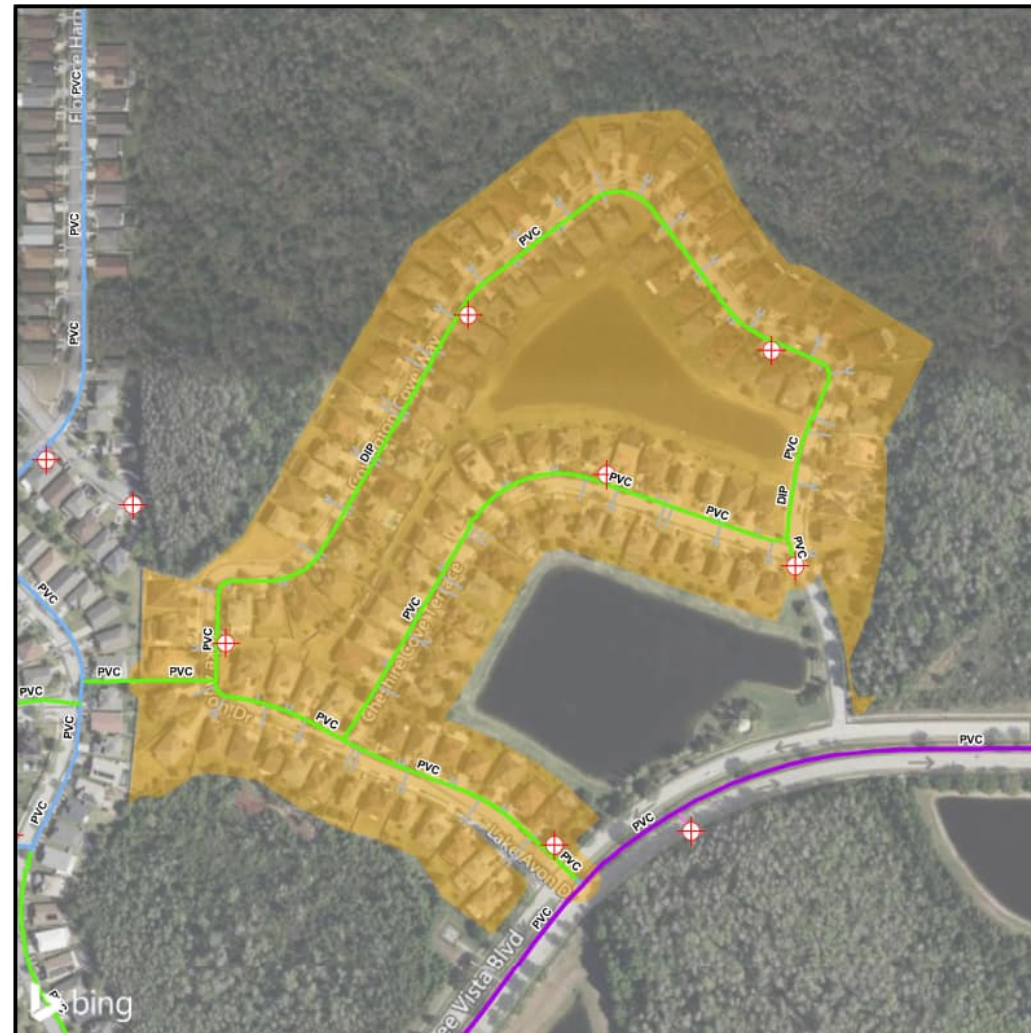
Closed Zone Isolation Valves:


Develop Designs

- Establish design criteria
- Establish target mains and clean sources
- Develop zone boundaries



Orange County UDF Design Criteria

Default Description	Units	Diameter ≤12 -inch	Diameter >12-inch
Minimum Flush Velocity	fps	3	3
Target Flush Velocity	fps	5	3 – 4
Maximum Flush Volume	Gallons	—	—
Maximum Flush Length	feet	—	—
Minimum Residual Pressure	psi	20	20
Target Residual Pressure	psi	35	35
Minimum System Pressure	psi	—	—
Desired Minimum No. of Turnovers	---	2	2
Desired Flush Time	Mins	—	—
Orifice Flow Coefficient	---	0.9	0.9
Hydrant Nozzle to Operate	---	2.5	2.5 (and 4.5 as noted in maps)




 Maps Not to Scale
AREA 7C
SECTION 1141
 Lee Vista Blvd and Lake Avon Drive

Legend

Symbols	Pipe Diameter
	< 6-inch
	6-inch
	8-inch
	12-inch
	16-inch
	20-inch
	24-inch
	>=30-inch
	Flushing Area

DIP: Ductile Iron Pipe
 GALV: Galvanized Iron
 HDPE: High Density Polyethylene
 PVC: Polyvinyl Chloride



Orange County Group 6 UDF Model V22 - ArcMap

File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help

1.883 Snapping

InfoWater+ InfoWater UDF - SECTION_1037 Sequence 1 Page Text - Editor - ArcGIS World Geocoding <Type an address...>

Table Of Contents

Layers

- OCU Water Structures
 - Pump Station
 - Treatment Plant
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- UDF Operation Valve (Closed)
- UDF Operation Valve (Open)
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- Flushing Pipe
 - Previous Sequence
 - Current Sequence
- Group_6_Active_Hydrant_and_Blowoff
- Hydrant Lateral
- Group_6_Active_Valves
- Pipe
 - RUN_DIAM
 - less than 1.00
 - 1.00 ~ 8.00
 - 8.00 ~ 18.00
 - 18.00 ~ 30.00
 - greater than 30.00
- FITTING
- Junction
 - PRESSURE
 - less than 20.00
 - 20.00 ~ 40.00
 - 40.00 ~ 60.00
 - 60.00 ~ 80.00
 - 80.00 ~ 90.00
- HYDRANT
- PRESSURIZEDMAIN
- SERVICELINE
- Hydroguard_Layer_Export_Data
- ADDRESS_RANGE_Group5

Flush Zone Manager

Flush Zones

ID	Description
SECTION_1037	
SECTION_1038	
SECTION_1039	
SECTION_1040	
SECTION_1041	
SECTION_1042	

Flush Zone Characteristics

Minimum Flush Velocity: 3
 Maximum System Velocity:
 Maximum Flush Volume:
 Maximum Flush Length:
 Minimum Residual Pressure: 20
 Minimum System Pressure:
 Maximum System Pressure:
 Minimum Shear Stress: 0.001

Flush Area:
 Highlight Color: Highlight Reset
 Closed Zone Isolation Valves:

Flush Sequence Manager

Sequences

Sequence	Description
1	Sequence 1
2	Sequence 2
3	Sequence 3
4	Sequence 4
5	Sequence 5
6	Sequence 6
7	Sequence 7

General Operations Parameters Pipe Results Critical Junctions Notes High Pre

Flush Zone ID: SECTION_103
 Date:
 Start Flush Time:
 Desired Flush Time
 No. of Turnovers: 2
 Total Flush Time: 30

Zoom Extent
 Extent of the Sequence Data
 Users Defined

Target Pipe(s)
 PWP364714
 PWP364715
 PWP365036
 PWP365049

Pipe: Add

Highlight Target Pipes

Model Explorer

EXISTINGADFCP_Existing A -

Active Refresh Output

Steady State

PPE: PWP312144

(ID) PWP312144

Description

Geometry Reverse
 Start Node J75658897
 End Node EJ2842

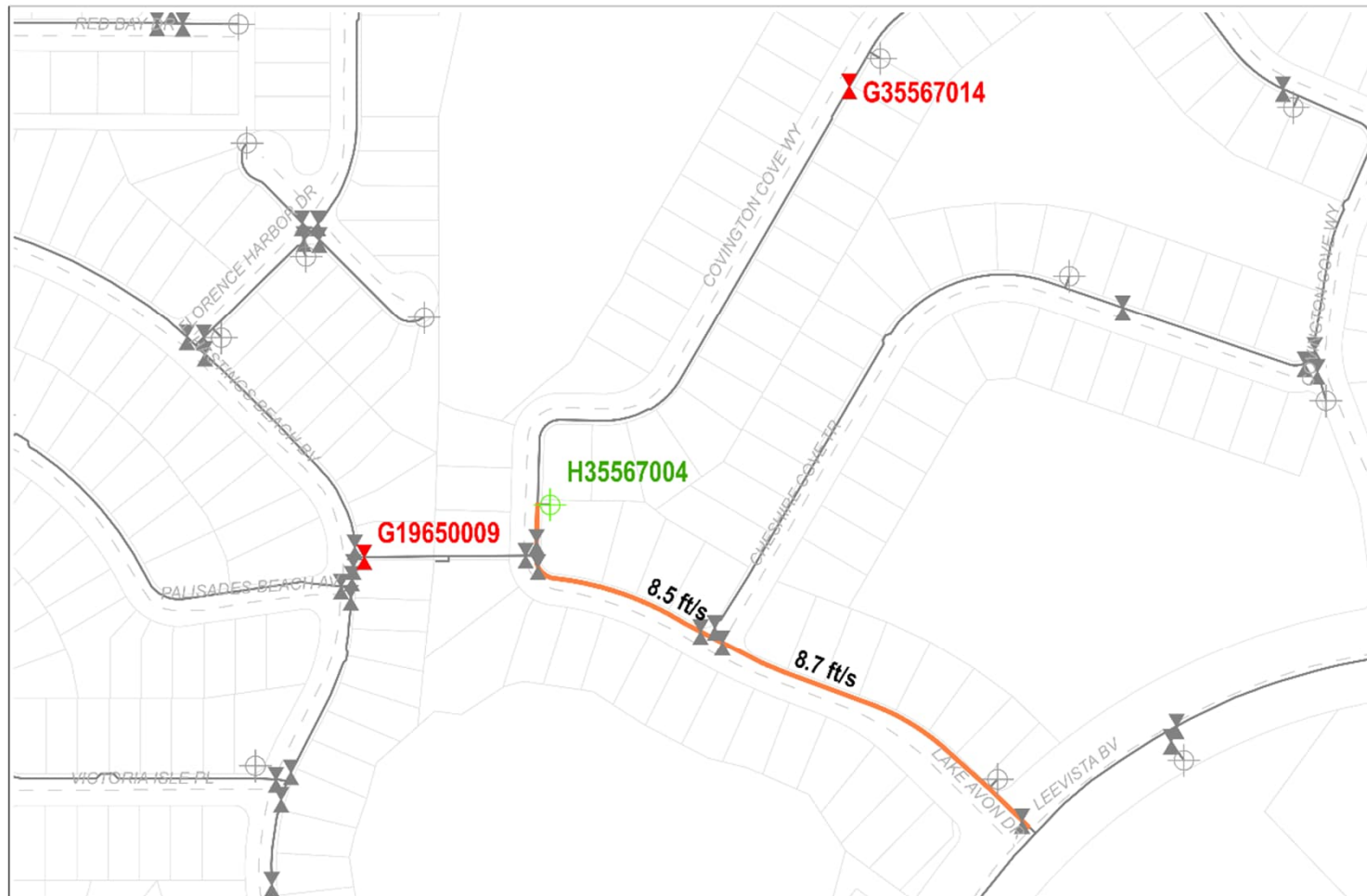
Modeling
 Length (ft) 493.68
 Diameter (in) 8.00
 Roughness 120.00
 Minor Loss 0.00
 Totalizer No
 Check Valve No

Information
 Year of Installation
 Year of Retireme

Zone 5
 Material PVC
 Lining Existing
 Cost ID
 Phase 5
 REI_PROJEC
 SERVICEARE South
 COMMENTS
 NOM_DIA 8
 DATE_ADDED
 GIS_UPDATE
 STATUS Active

Output
 Flow 1.45 gpm
 Flow Direction Forward
 Velocity 0.01 ft/s
 Headloss 0.00 ft
 HL/1000 0.00 ft-ft
 Status Open
 Flow Reversal 0
 Type Pipe
 From Node J75658897
 To Node EJ2842
 Length 493.68 ft
 Diameter 8.00 in
 Roughness 120.00
 Minor Loss 0.00
 Bulk Coefficient 0.00
 Wall Coefficient 0.00



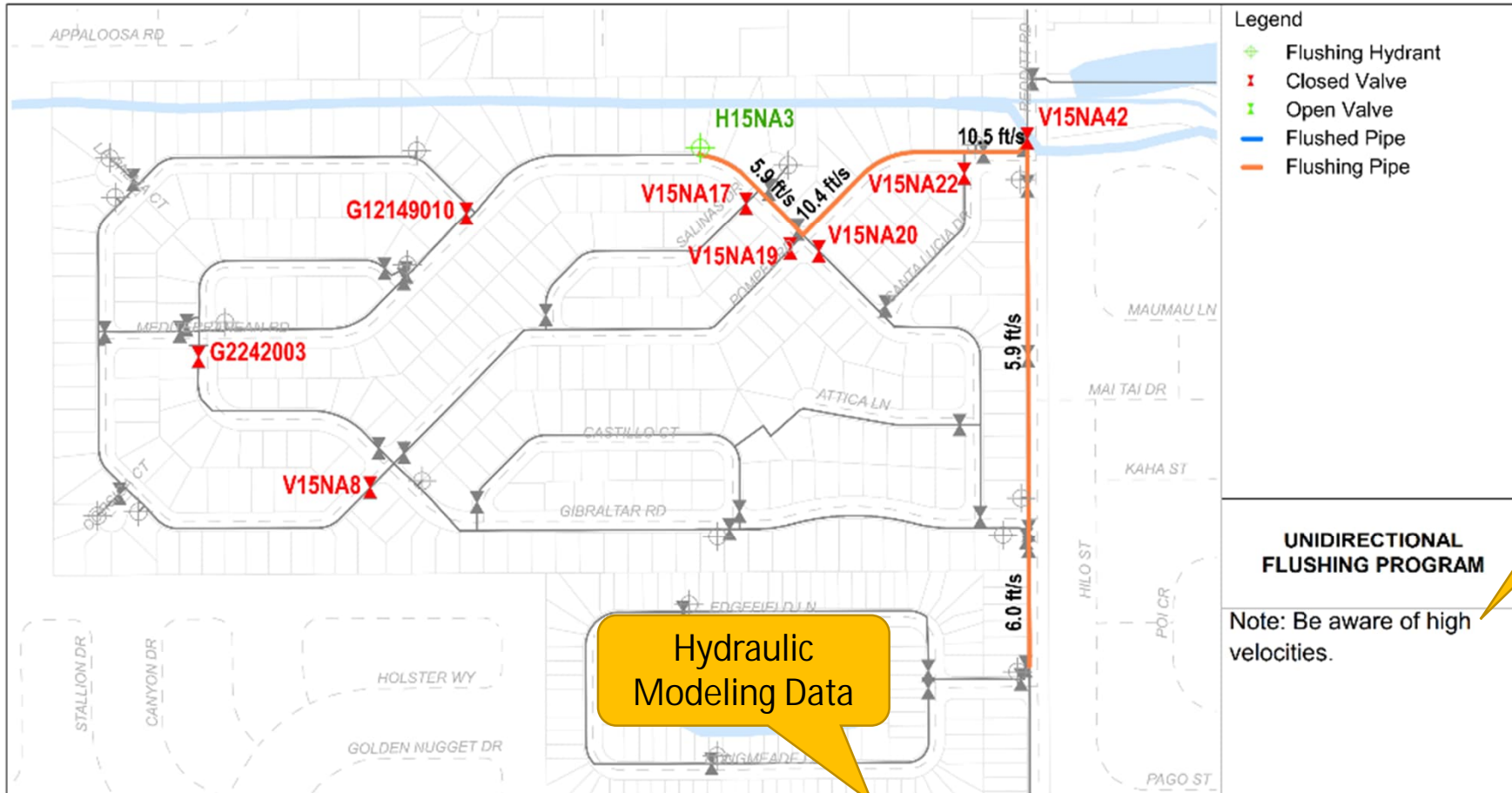


- Legend**
- Flushing Hydrant
 - Closed Valve
 - Open Valve
 - Flushed Pipe
 - Flushing Pipe

**UNIDIRECTIONAL
FLUSHING PROGRAM**

Note:

Zone	SECTION_1141	Sequence	1	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	79.06 psi				
Duration	3.9 min.	Open Hydrant	H35567004	Res. Pressure	61.06 psi		Turbidity		
Valves to Open				Discharge Flow	1,313.04 gpm		Disinf. Res.		
				Available Flow	2,553.28 gpm		pH		
Valves to Close	G19650009, G35567014			Total Pipe Len.	1,000.0 ft		Iron		
				Min Flushing Vol	2,539.71 gal		Odor		
Pipes to Flush	PWPM193492,PWPM330530,PWPM330531,PWPM330532,PWPM330554,PWPM330498			Desired Flushing Vol	5,079.43 gal		HPC		
				Min Flushing Time	1.9 min.		Color		
				Desired Flushing Time	3.9 min.		Other		



- Legend**
- Flushing Hydrant
 - Closed Valve
 - Open Valve
 - Flushed Pipe
 - Flushing Pipe

UNIDIRECTIONAL FLUSHING PROGRAM

Note: Be aware of high velocities.

Custom Notes

Hydraulic Modeling Data

Water Quality Data

Zone	SECTION_1169	Sequence	1	Hydraulics	Model	Field	Water Quality	Initial Value	Final Value
Date of Flush		Start Time		Static Pressure	73.24 psi		Turbidity		
Duration	12.3 min.	Open Hydrant	H15NA3	Res. Pressure	28.97 psi		Disinf. Res.		
Valves to Open				Discharge Flow	904.19 gpm		pH		
				Available Flow	1,001.94 gpm		Iron		
Valves to Close	V15NA42, V15NA22, V15NA20, V15NA17, V15NA19, G12149010, V15NA8, C2242003			Total Pipe Len.	2,473.5 ft		Odor		
				Min Flushing Vol	5,540.00 gal		HPC		
Pipes to Flush	PWPM303271, PWPM303272, PWPM303285, PWPM303324, PWPM412715, P1886, PWPM303284			Desired Flushing Vol	11,080.00 gal		Color		
				Min Flushing Time	6.1 min.		Other		
				Desired Flushing Time	12.3 min.				

Water Quality Analysis

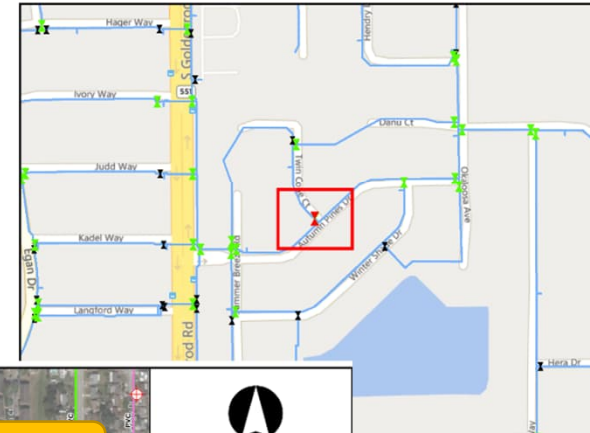
Parameter	Effects / Indicators	Desired Observation
Chlorine residual	Microbial protection (disinfection)	Increase
pH	Water chemistry	6.5 – 8.5 std. units
Turbidity	Cloudiness in water (filtration effectiveness)	Decrease
Color (Apparent)	Aesthetic effects	<15 color units
Iron (Total)	Corrosion indicator	Decrease
Heterotrophic plate counts (HPC)	Distribution system health indicator; No health effect (Naturally occurring)	< 500 CFU/ml (the lower the better)
Odor	Aesthetic effects	< 3 TON



Additional Considerations

- Mapbook Covers
- Valve and Hydrant Assessment and Repair Plan
- Public Notification Plan
- Sampling and Analysis Plan

PART 1 GENERAL



ation program will serve the following purposes:
 ability of large and critical valves in the water distribution activities.
 yze locational, operational and physical information of these gh professional services activities, including by- pass valves. tance.
 nent of large critical valves
 ty Utilities maintenance crews

lop, plan and execute a valve operation, evaluation, information Management program that uses the County's aintenance Management System as the data repository. This following activities:

lves
 s

s as directed
 butes

ort the County to further develop the County's valve lose coordination with the County Field Services Division to work with the County Hydraulic Modeling Group to for each valve in the system and analyze the results of the water and reclaimed water distribution and wastewater

ll labor, equipment, and materials to implement the valve in. The following scope of services details specific functions tractor.

County, the Contractor may be required to prioritize the on the size of the valves and their locations.

Location Identifiers

Maps Not to Scale
AREA 7E SECTION 1169
 Redditt Road, Gibraltar Rd

Legend

Symbols	Pipe Diameter
Hydrant	< 6-inch
Blowoff	6-inch
	8-inch
	12-inch
	16-inch
	20-inch
	24-inch
	>=30-inch
	Flushing Area

DIP: Ductile Iron Pipe
 GALV: Galvanized Iron
 HDPE: High Density Polyethylene
 PVC: Polyvinyl Chloride

VALVE ID: G195001

- Valve to be Assessed
- UDF Valve
- Valves not found
- Non UDF Water Valves
- Hydrants & Blowoffs
- Water Mains

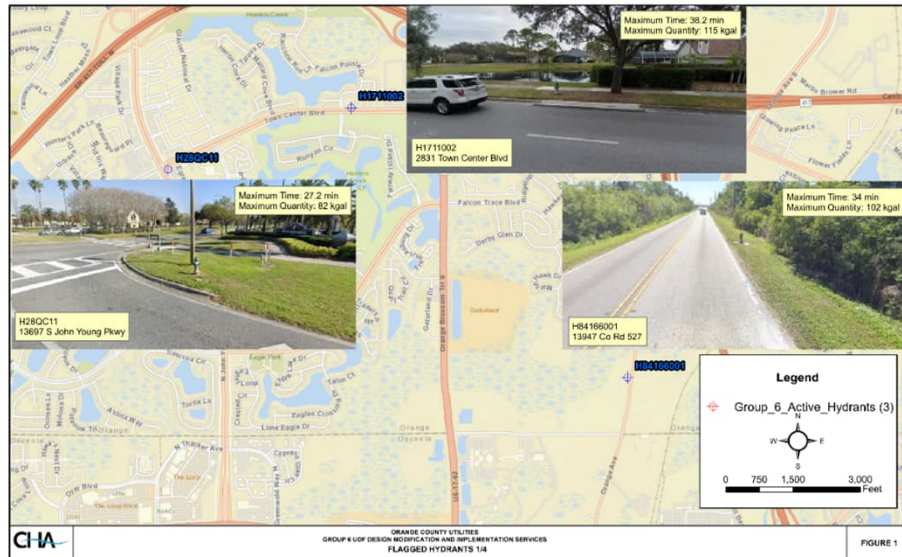
UTILITIES
 EMENTATION SERVICES
FIELD MAPS

ORANGE COUNTY
 GOVERNMENT
 FLORIDA



Additional Considerations

- Traffic Control Plan
- Drainage Plan
- Critical Customers Plan



SECTION 01570 MAINTENANCE OF TRAFFIC

PART 1 - GENERAL

1.01 DESCRIPTION

This section includes identifying safety hazards and then furnishing all necessary labor, materials, tools, and equipment including, but not limited to, signs, barricades, traffic drums, cones, flashers, construction fencing, flag persons, variable message boards, uniformed police officers, warning devices, temporary pavement markings, temporary sidewalk, delineators, etc., to maintain vehicular and pedestrian traffic through and adjacent to the project area. These measures and actions shall be taken to safely maintain the accessibility of public and construction traffic by preventing potential construction hazards. . All materials, work and incidental costs related to Maintenance of Traffic will be paid for at the contract lump sum price.

1.02 REQUIREMENTS

- The Traffic Control Plan shall conform to the following standards:
 - Standard Specifications for Road and Bridge Construction, latest edition including all subsequent supplements issued by the Florida Department of Transportation, (FDOT).
 - Manual on Uniform Traffic Control Devices for Streets and Highways by U.S. Department of Transportation, Federal Highway Administration.
 - Right-of-Way Utilization Regulations, Orange County, Florida, latest edition.
- All references to the respective agencies in the above referenced standards shall be construed to also include the municipality as applicable for this Work.
- Sequence the Work in a manner that will minimize disruption of vehicular and pedestrian access through and around the construction area.
- Traffic planning and control for the maintenance and protection of pedestrian and vehicular traffic affected by the Contractor's Work includes, but is not limited to:
 - Construction and maintenance of any necessary detour equipment and facilities.
 - Providing necessary facilities for access to residences and businesses.
 - Furnishing, installing, and maintenance of traffic control and safety devices (e.g. signage, barricades, barriers, message boards, etc.), and flag persons as appropriate during Construction.
 - Control of water runoff, dust and any other special requirements for safe and expeditious movement of traffic.

OCU Master CIP Technical Specifications

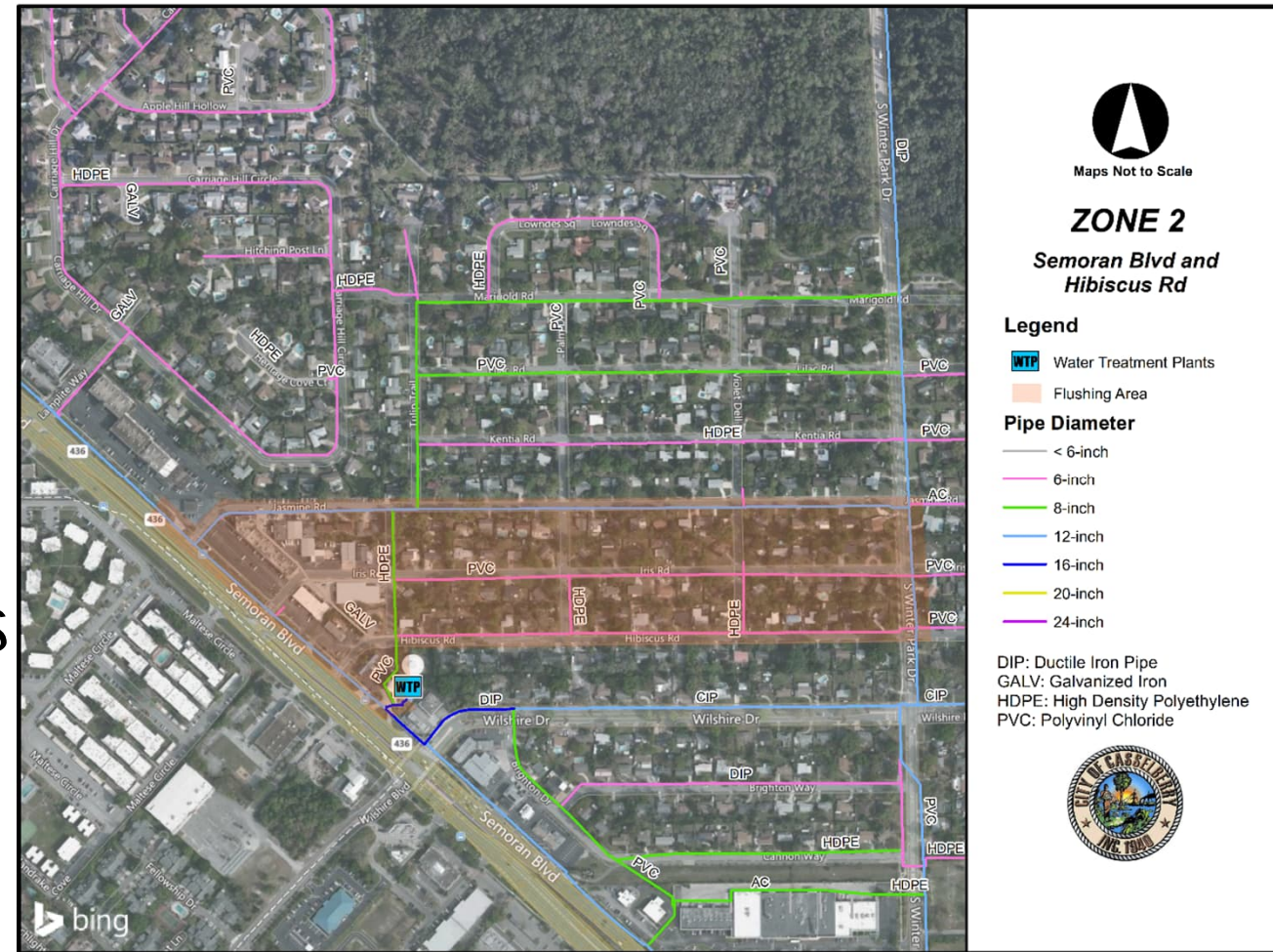
01570 - 1 of 6

rev: March, 2015



City of Casselberry, FL

- 220 miles of water mains
- Utilized existing designs and modified to flush in the opposite direction
- Increased water quality complaints (H₂S odor and particulates)
- Quick response to assist City in addressing water quality complaints



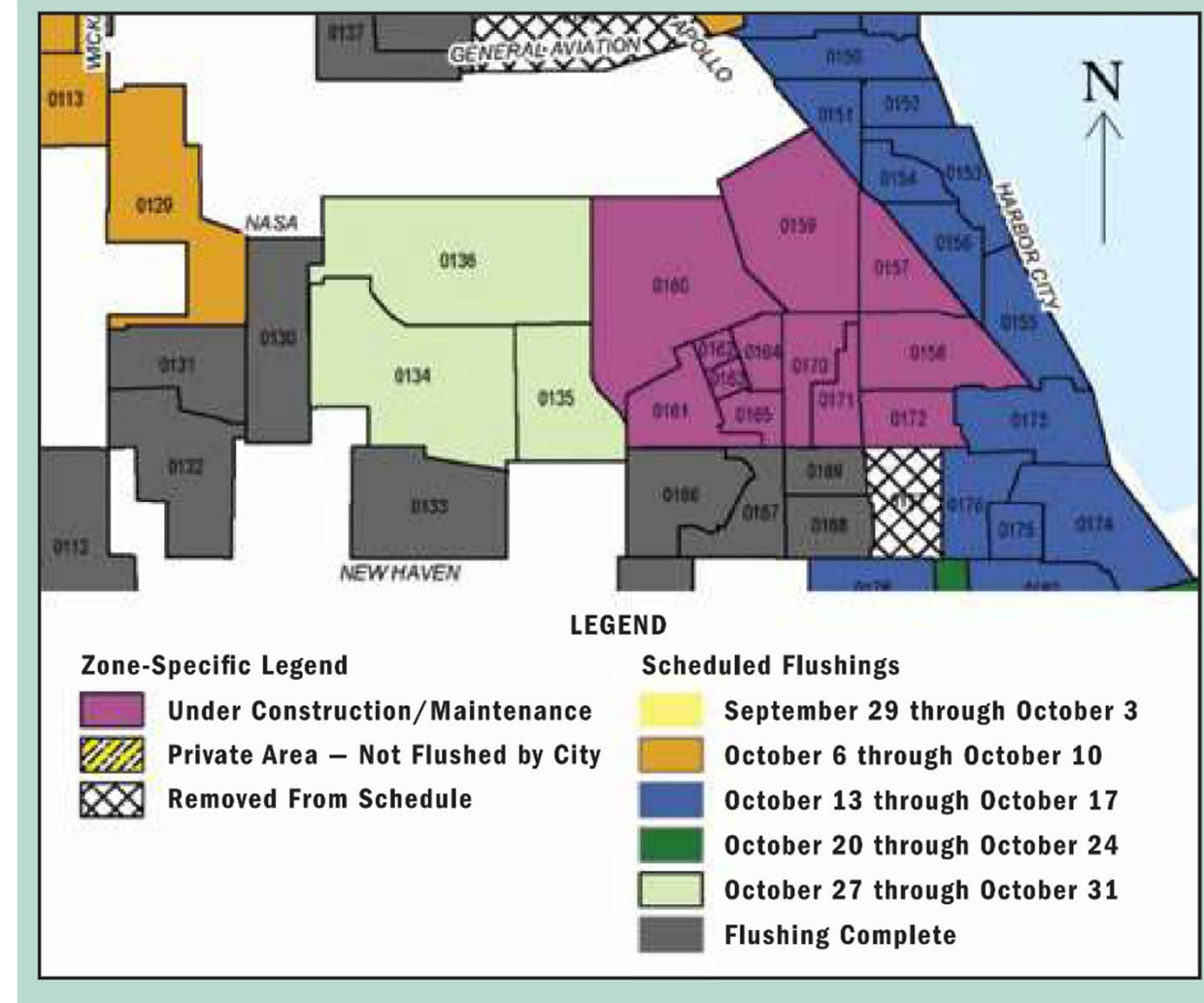
City of Casselberry, FL

- Customer notification assistance
- UDF field checklist
- UDF field support
- Successfully implemented by City's field staff



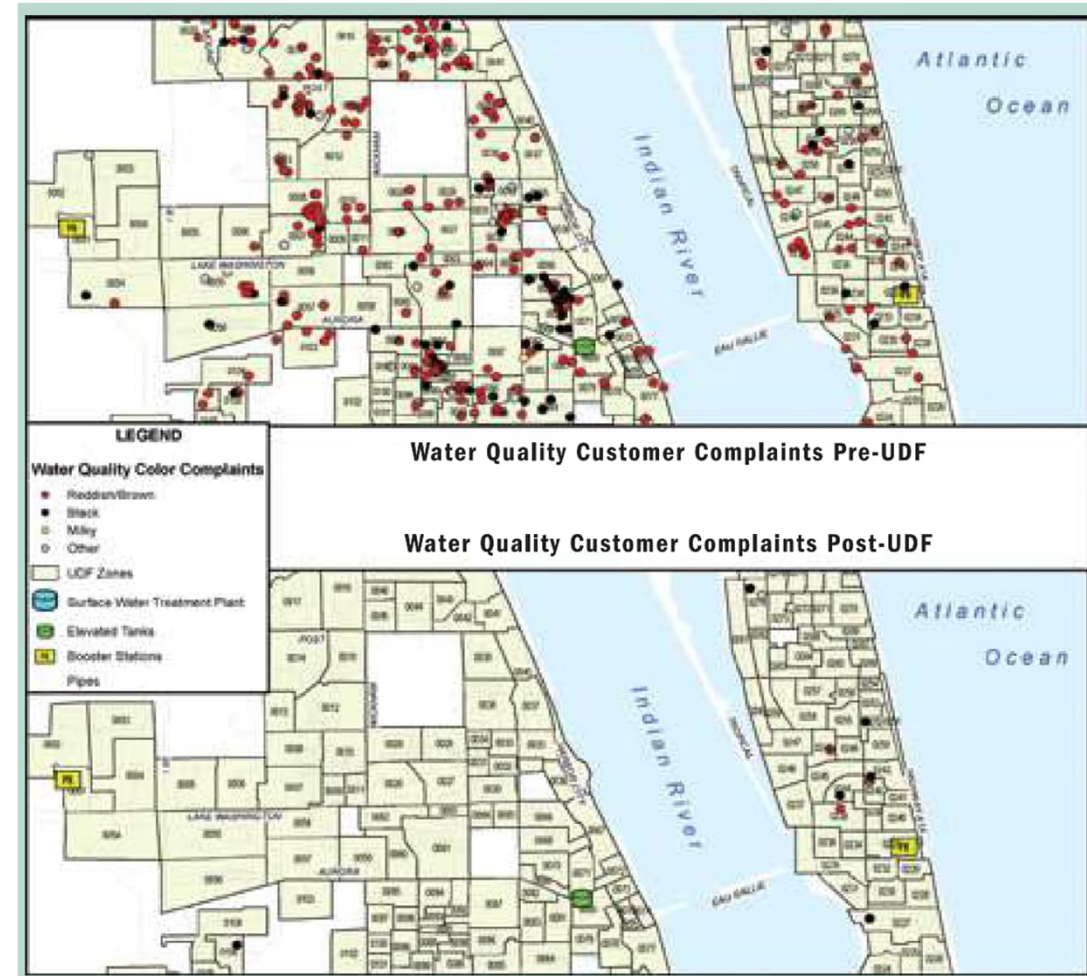
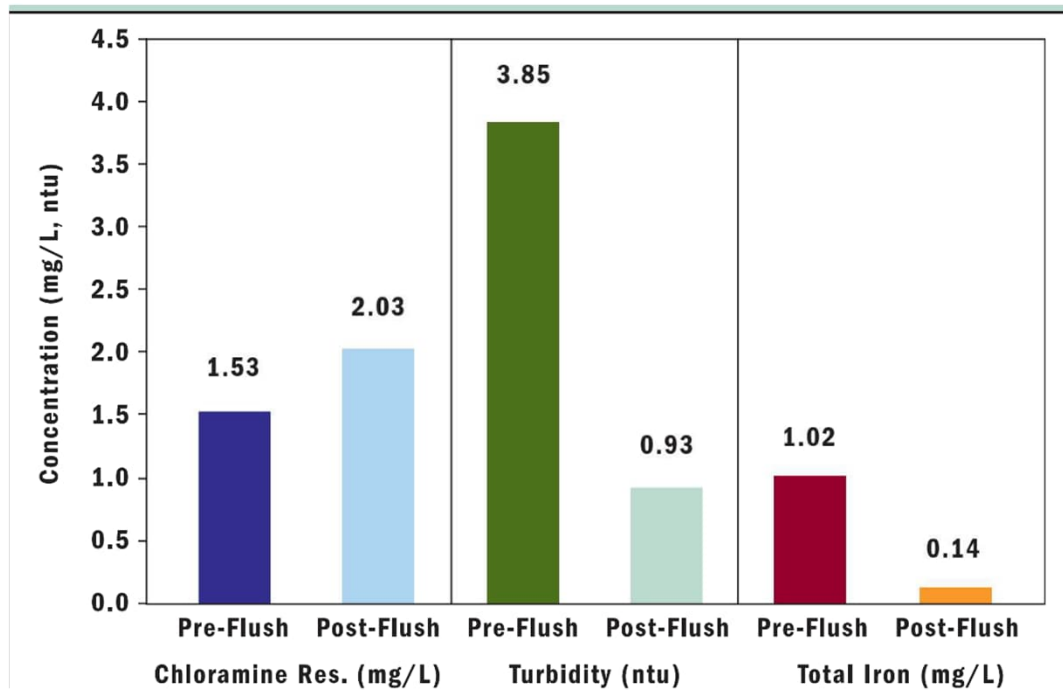
City of Melbourne, FL

- Historical water quality issues
- System wide implementation
- City field staff coordination



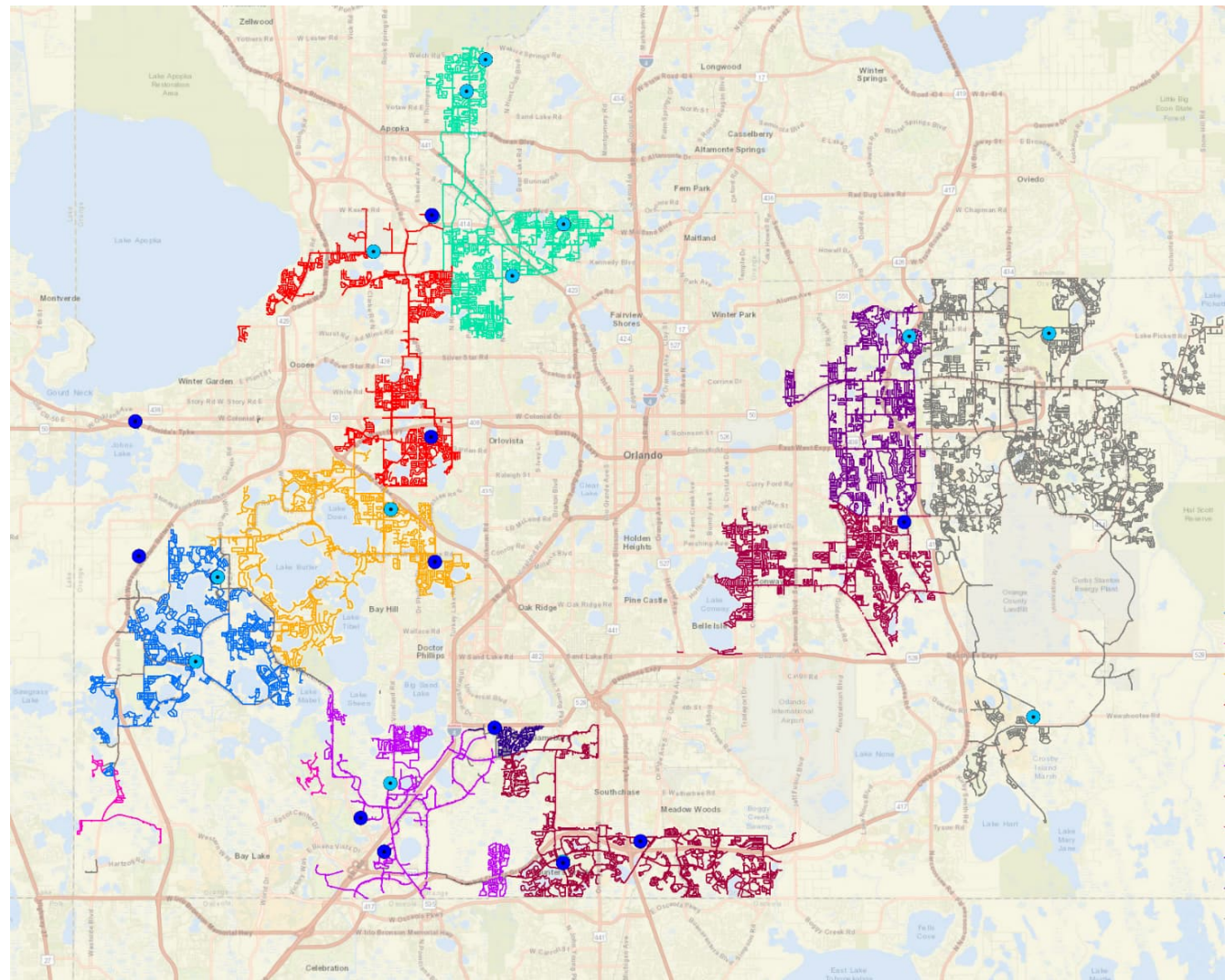
City of Melbourne, FL

- Testing pre- and post-implementation
- Water quality complaints decreased




Orange County, FL

- 3 regional water supply facilities
- Previous in-house UDF program
- Elected to outsource UDF program for additional support
- Initially reviewed existing UDF designs
- Completed new designs to optimize UDF



Orange County, FL

- Over 8.5 million feet of UDF designed to date
- 6- to 24-inch water mains
- UDF criteria developed
- Each group subdivided
 - ✓ Transmission Mains (>12")
 - ✓ Sections (≤12")
- Data collection
 - ✓ Pre and Post Flush


 ORANGE COUNTY UTILITIES
 Group 5 Unidirectional Flushing Design Modification and Implementation Services
 Map Viewing Guidelines

————	OCU pipeline
————	Road
□	Parcels
————	Flushing Pipe
————	Flushed Pipe
HYDRANT ID	Open valve/hydrant
VALVE ID	Close valve
HYDRANT ID	Flush using the 4.5-inch hydrant nozzle
(VALVE ID)	Do not operate valve - valve to remain closed
WTP	Water Treatment Plant
PS	Pump Station
×	Valve not found
⊕	Hydrant/Blowoff
I	Gate/Butterfly Valve
	Water body
	Flushing Area

Orange County UDF Design Criteria

Default Description	Units	Diameter ≤12 -inch	Diameter >12-inch
Minimum Flush Velocity	fps	3	3
Target Flush Velocity	fps	5	3 – 4
Maximum Flush Volume	Gallons	---	---
Maximum Flush Length	feet	---	---
Minimum Residual Pressure	psi	20	20
Target Residual Pressure	psi	35	35
Minimum System Pressure	psi	---	---
Desired Minimum No. of Turnovers	---	2	2
Desired Flush Time	Mins	---	---
Orifice Flow Coefficient	---	0.9	0.9
Hydrant Nozzle to Operate	---	2.5	2.5 (and 4.5 as noted in maps)

for transmission main areas not calculated. Sufficient flow then flushing during existing average flow conditions using Western Regional WSF.

Velocity over 10 feet/second (ft/s)

which exhibited severe concerns for MOT/drainage.

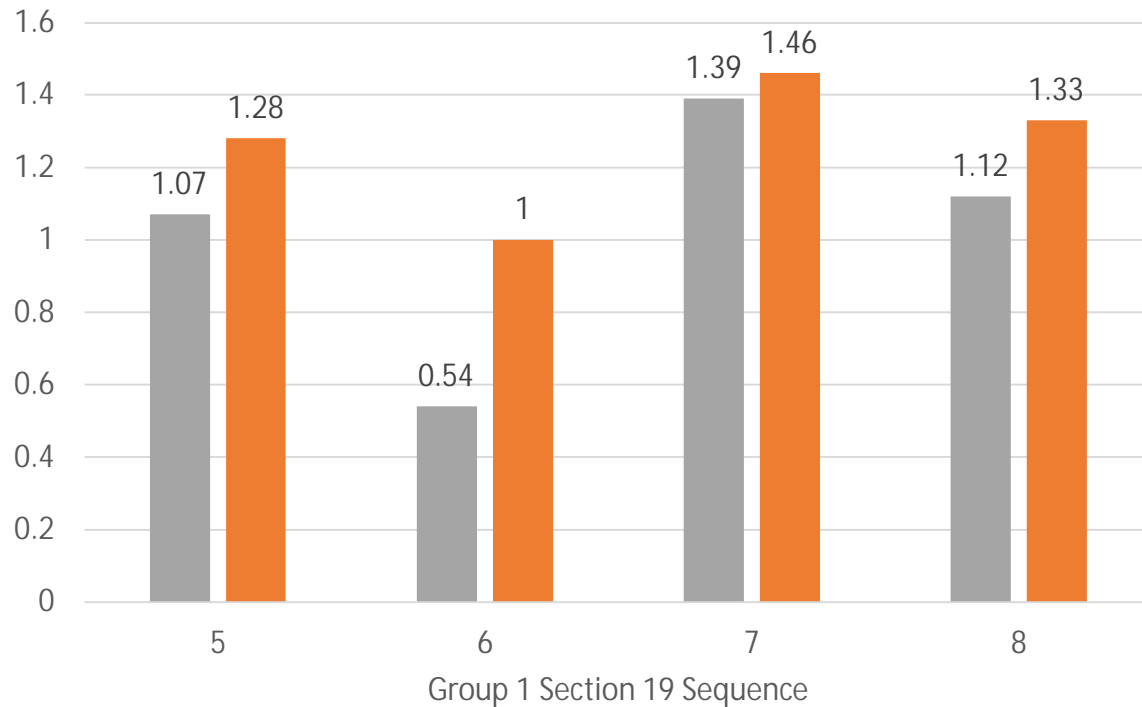
its were flagged for MOT/drainage but not as severe as the high priority flagged hydrant.

WSF). No other WSF were used as clean sources. used to 65 psi. used on existing model average flow conditions. Field pressure and flow conditions may vary. low, flushing information for blowoffs may not be accurate. Blowoffs will not achieve 1,000 ft runs clear. "Change Volume" as depicted in the flushing maps. See presented in the Table of Contents (TOC) included in this package.

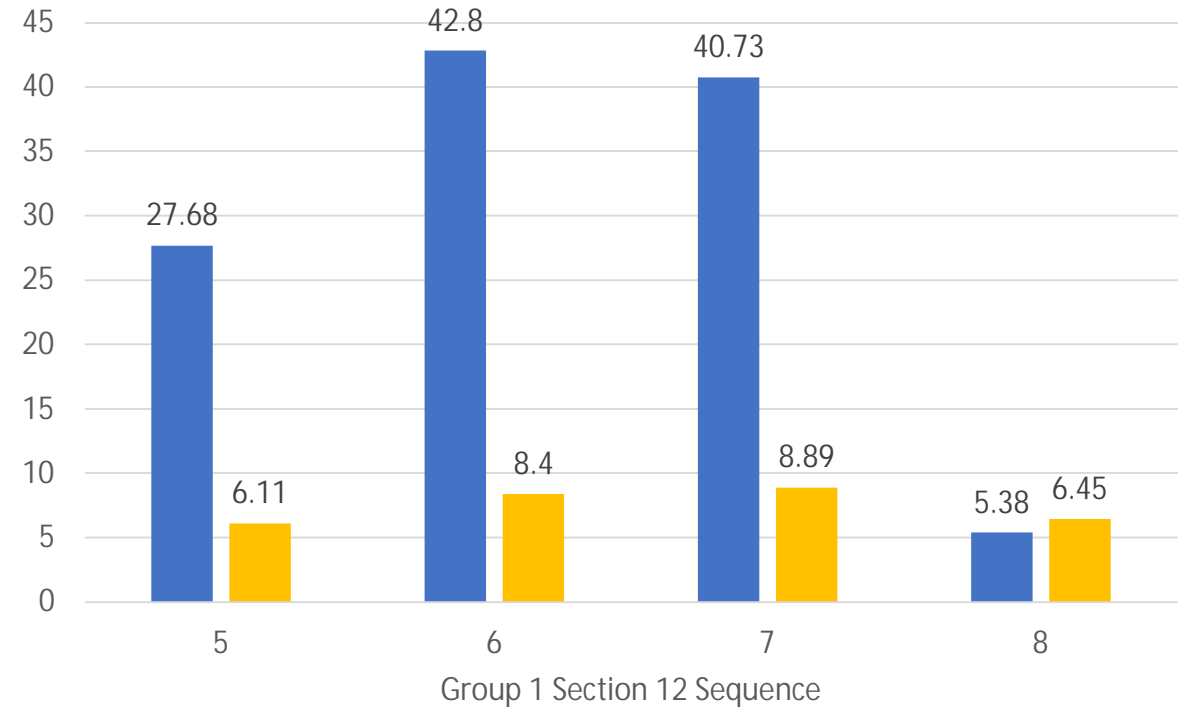


Orange County, FL – Water Quality Sampling

■ Initial Chlorine (mg/L) ■ Final Chlorine (mg/L)

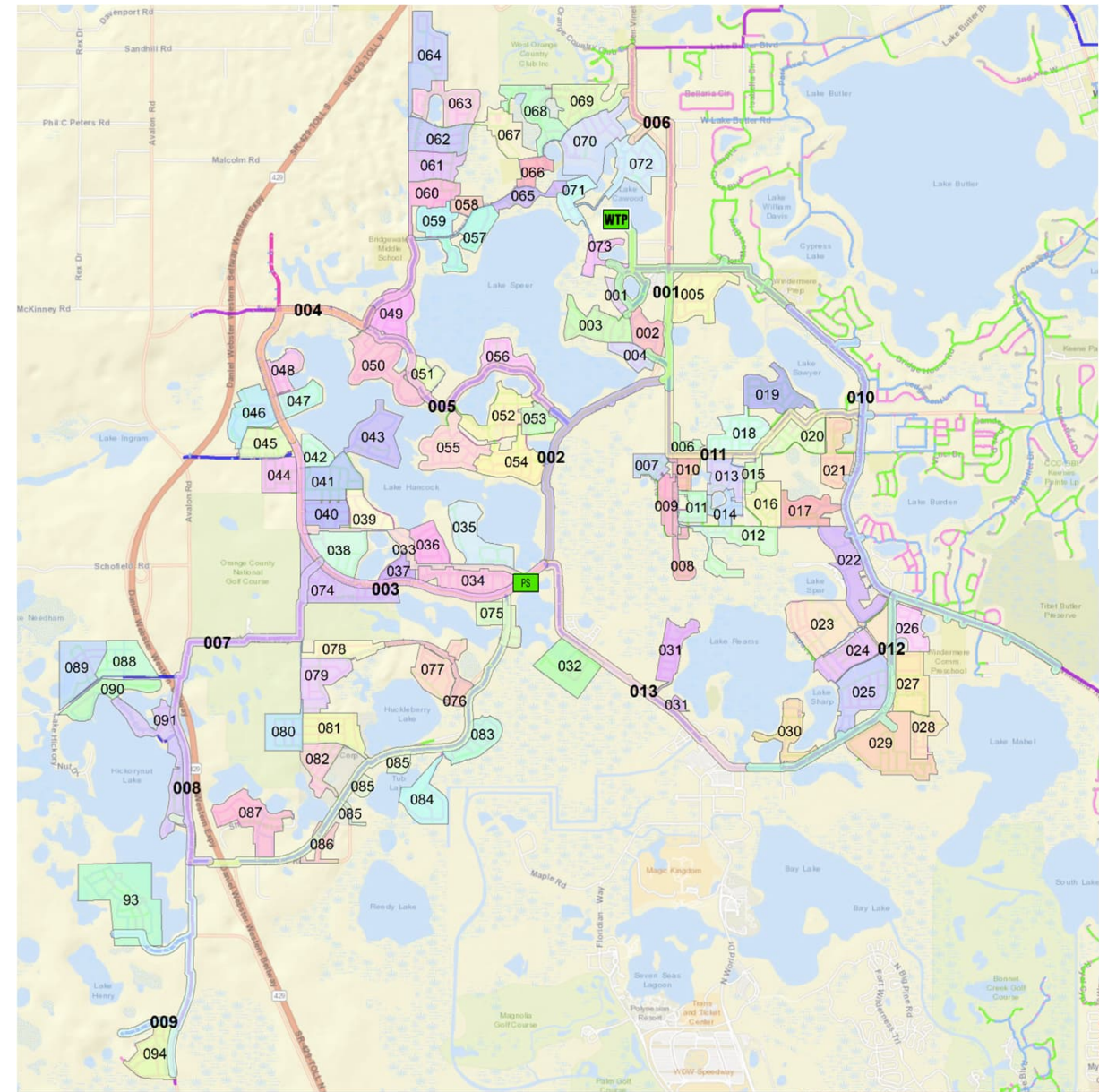


■ Initial Turbidity (NTU) ■ Final Turbidity (NTU)



Orange County, FL Lessons Learned

- Group 1 flushing completed
- Reviewed water quality data
- Developed protocol for water quality standards



Orange County, FL – Field Support



Conclusion - UDF Program

- UDF is method to efficiently flush
- Long-term program system maintenance or solve specific water quality issues
- Elements of success:
 - ✓ Team Communication
 - ✓ Design Development
 - ✓ Field Oversight
 - ✓ Water Quality Evaluation
 - ✓ Data Implementation



Thank you

- City of Casselberry, FL
- City of Melbourne, FL
- Orange County Utilities, FL



Questions?

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