Geosyntec consultants

Investigation of Fecal Sources Impacting an Urban Creek

By: Mike Hardin, PhD, PE, CFM – Geosyntec Consultants, Inc.
Lisa Lotti – City of Orlando, Stormwater Compliance Manager

SeSwA Southeast Stormwater Association

Annual Conference
October 6 – 8, 2021

CITY OF ORLANDO

Presentation Outline

- Introduction
- Background of Issue
- Project Purpose
- Data Collection Design
- Results
- Conclusions
- Recommendations

Acknowledgements

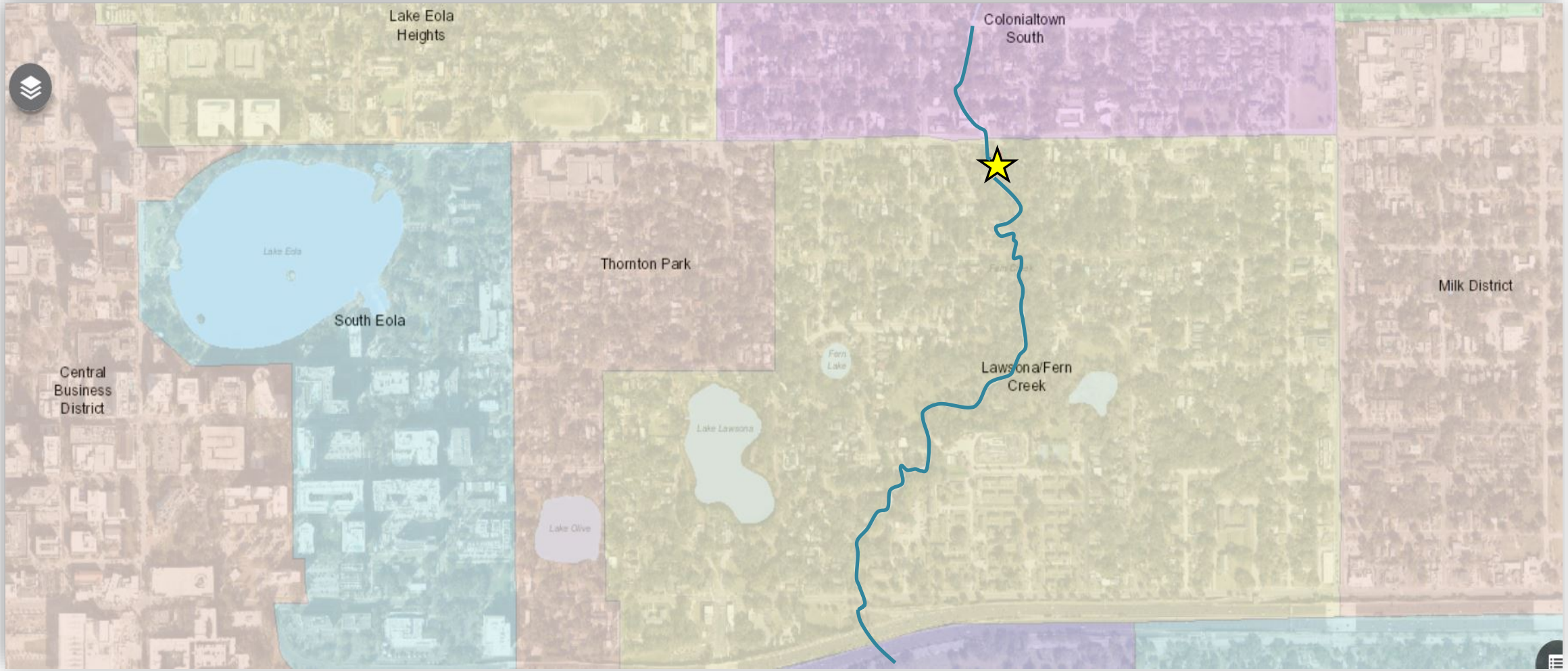
- City of Orlando
  - Jim Hunt, PE – Former City Engineer
  - Susan Ussach, PE – City Engineer
  - Howard Elkin – Streets and Stormwater Division Manager
  - Nicki Wesson, PE – Project Manager II
  - Jessica Goodstein – Former Environmental Specialist II
- Geosyntec project team
  - Nick Hartshorn, PE – project engineer
  - Mark Ellard, PE, CFM, D.WRI, ENV. SP – project director
  - Jared Ervin, PhD – project engineer
- Field sampling subconsultant – Barnes, Ferland and Associates, Inc. (BFA)
  - John Watson – field sampling
  - Benjamin Stormont, PG – field sampling
  - Katie Ballew – field sampling
- Source Molecular
  - Performed DNA marker analysis
- Southern Research Laboratories
  - Performed fecal coliform analysis

Introduction

Geosyntec consultants

Introduction - Location

- Fern Creek located in Downtown Orlando

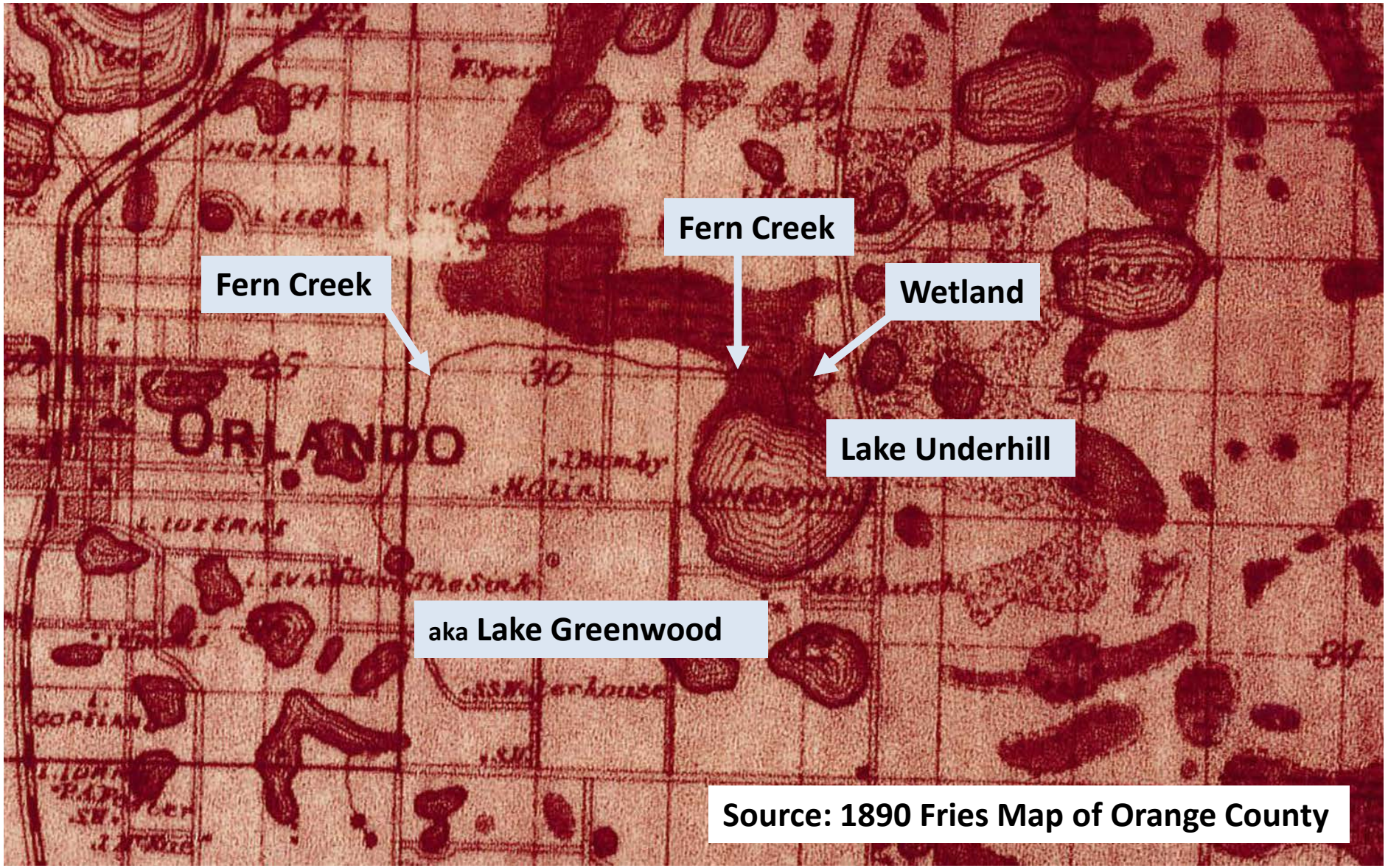


Introduction - Location

Nearby Landmarks

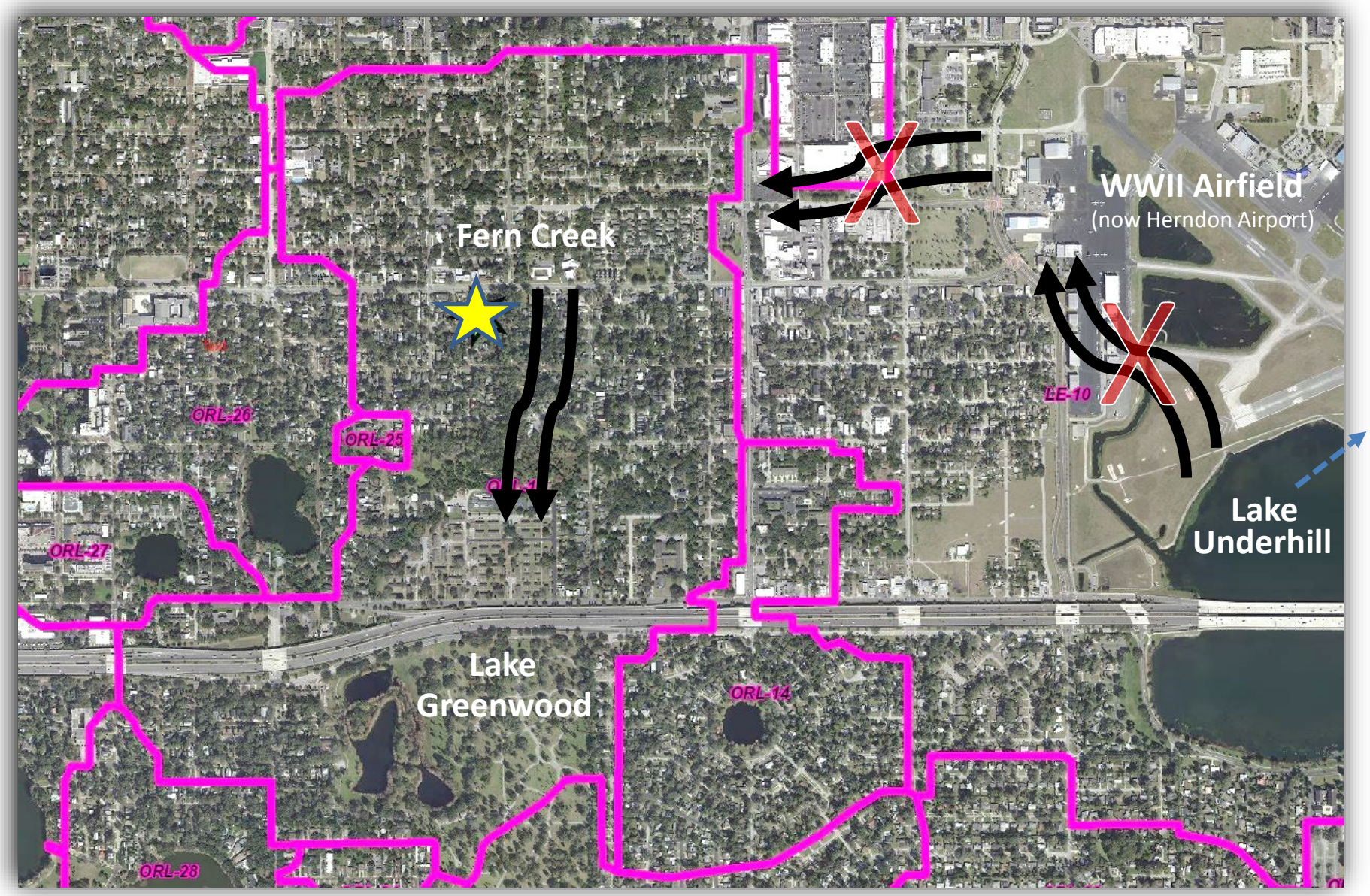
Introduction - Conditions

Historic Drainage Pattern



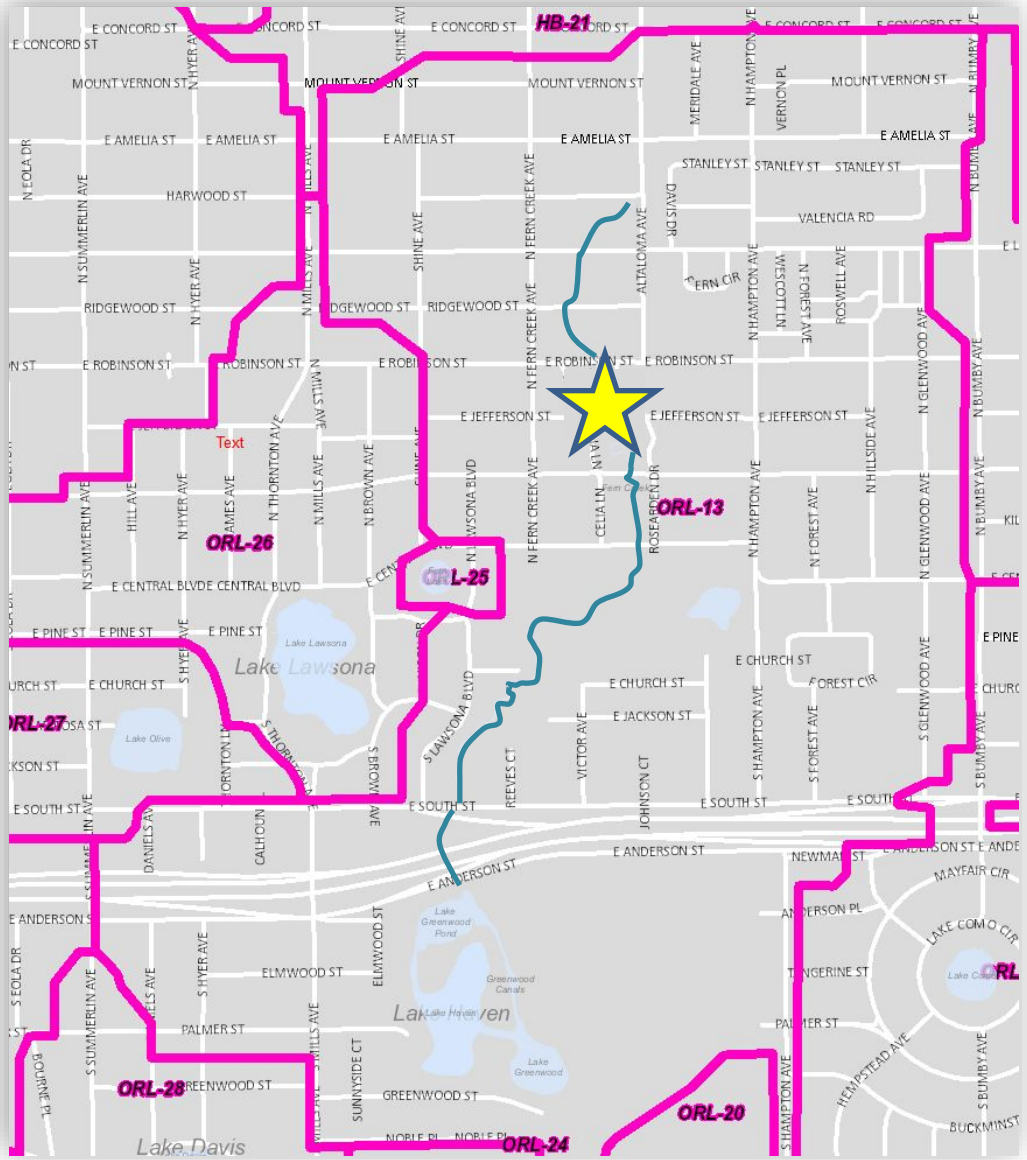
Introduction - Conditions

- Historic Drainage Altered
  - During WWII wetland removed to build airfield
  - Wetland/Lake Underhill hydraulic connection to fern creek eliminated
  - Baseflow to Fern Creek minimized



Introduction - Conditions

- Current Drainage Basin
  - Total of 421 acres of ultra urban contributing area
  - Discharges to Lake Greenwood
    - Lake Greenwood has 5 drainwells
  - Upstream portions and downstream portions have been piped
  - Project area is open creek (public park)
    - Bank height varies between 8 – 14 ft
    - Portion of banks armored with walls built in 1920's
    - Minimal baseflow contributes to flashy system and erosion issues
  - DRMP 1996 report*
    - Peak flow varies from 215 – 490 cfs



** "Fern Creek Flood Protection & Erosion Control" report for City of Orlando; Dyer, Riddle, Mills & Precourt, Inc., December 1996*

Introduction - Conditions

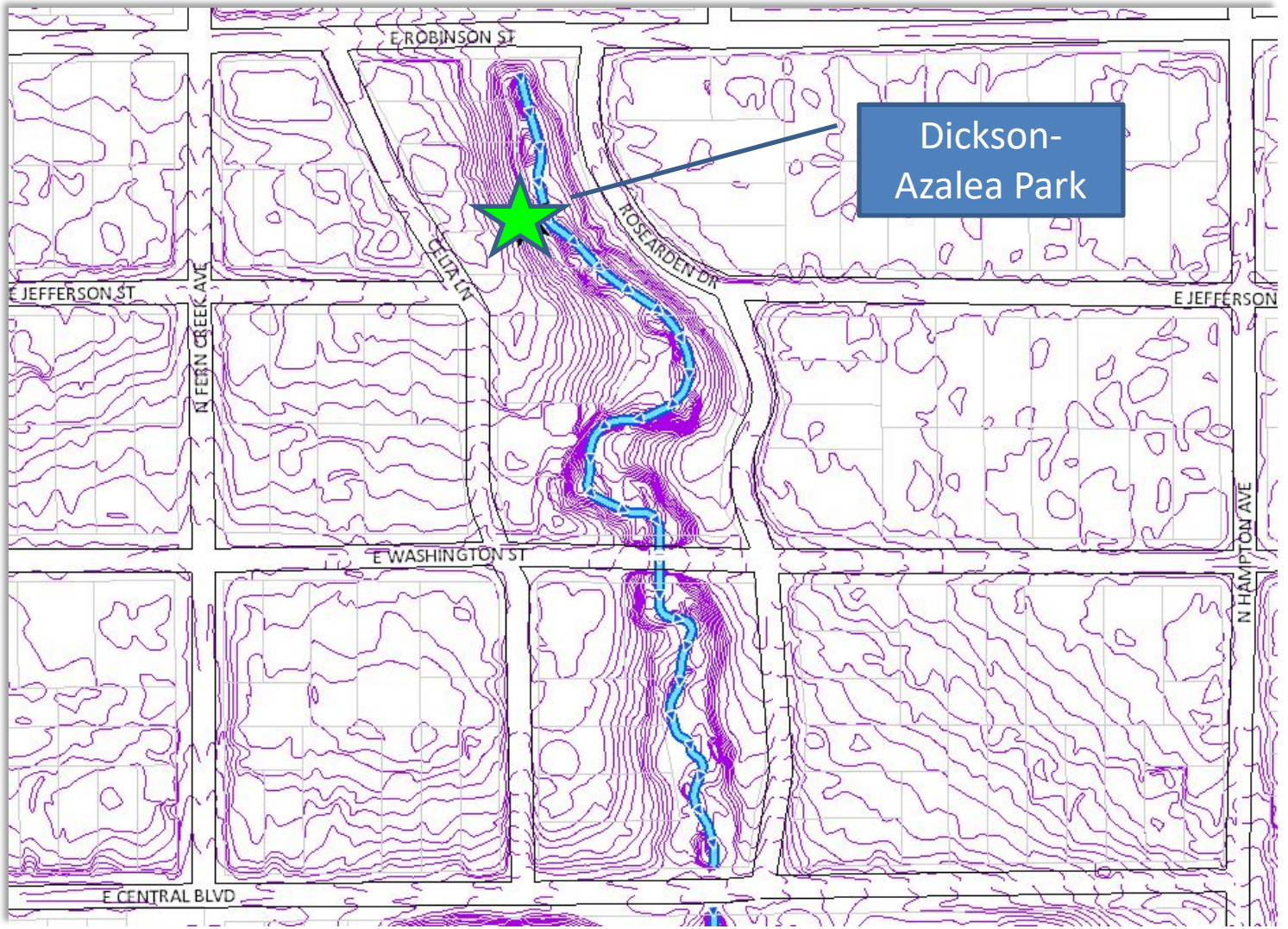
Introduction - Conditions

Background of Issue

Geosyntec consultants

Background of Issue – Study Area

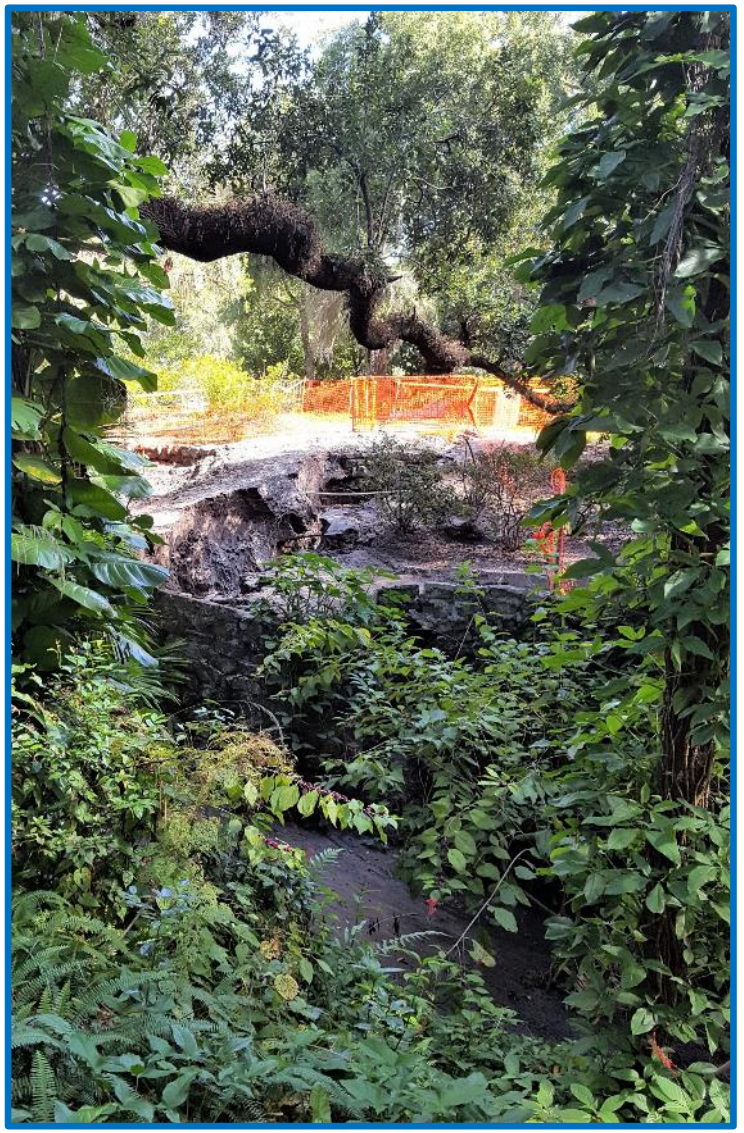
- Receiving area for this portion of Fern Creek basin = 203 acres
- 54” RCP upstream in creek
- DRMP 1996 report*:
  - Avg velocities = 4.8 fps
  - Modeled peak flow = 128 cfs
- Contours display steep banks which also meander
- Elevation changes within 1000 feet
  - Ground: 104 feet to 84 feet MSL
  - Pipe invert: 84 feet to 76 feet MSL
- Some tree roots present, but not as much vegetation to stabilize banks



** ”Fern Creek Flood Protection & Erosion Control” report for City of Orlando; Dyer, Riddle, Mills & Precourt, inc., December 1996*

Background of Issue – Collapsed Wall

- Rainfall Prior to Wall Collapse:
  - Dec 9 = 1.16”
  - Dec 15 = 0.83”
  - ➢ **Dec 20 = 2.83” over 10 hours**



Background of Issue – Collapsed Wall

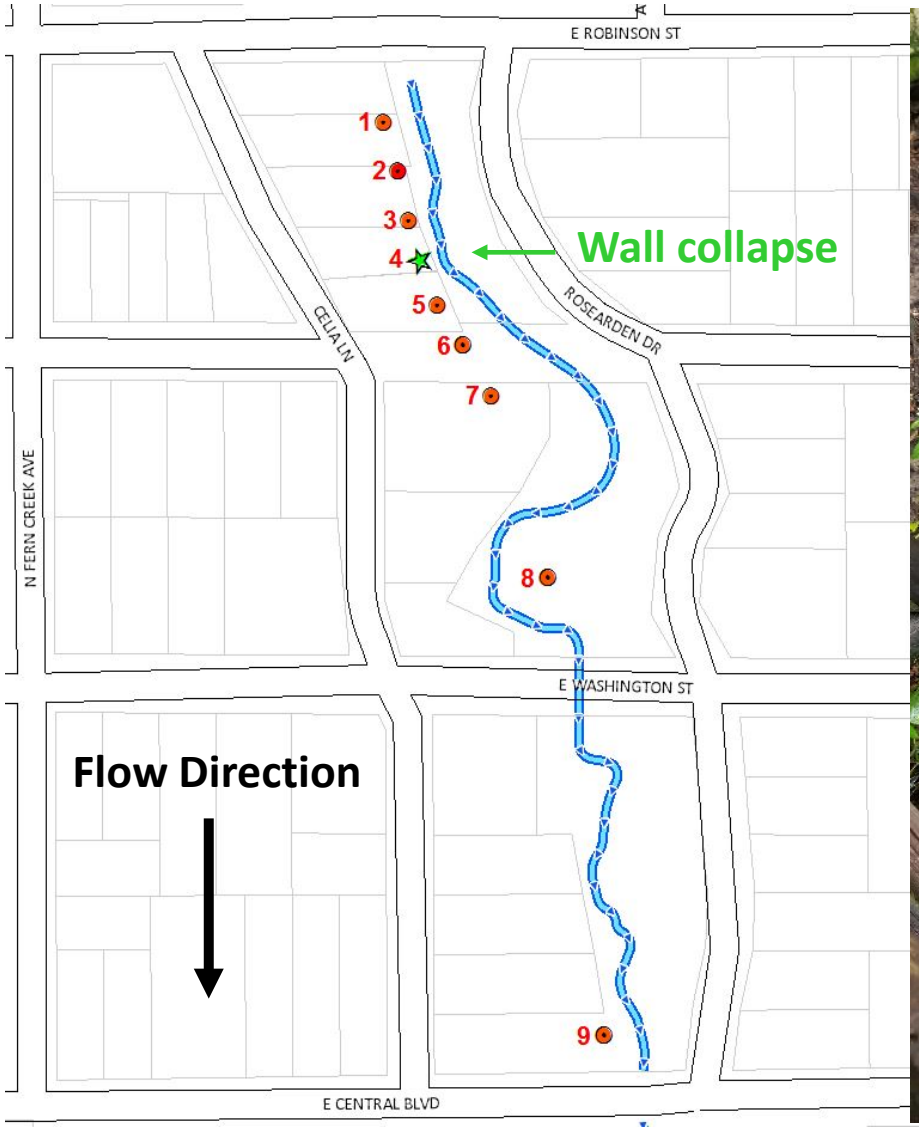
Sediment deposition into creek

Background of Issue – Collapsed Wall Surrounding Area

- Steep terrain
- Terraced, but stabilization still an issue
- Wall present in immediate area, but overland flow caused undermining behind wall

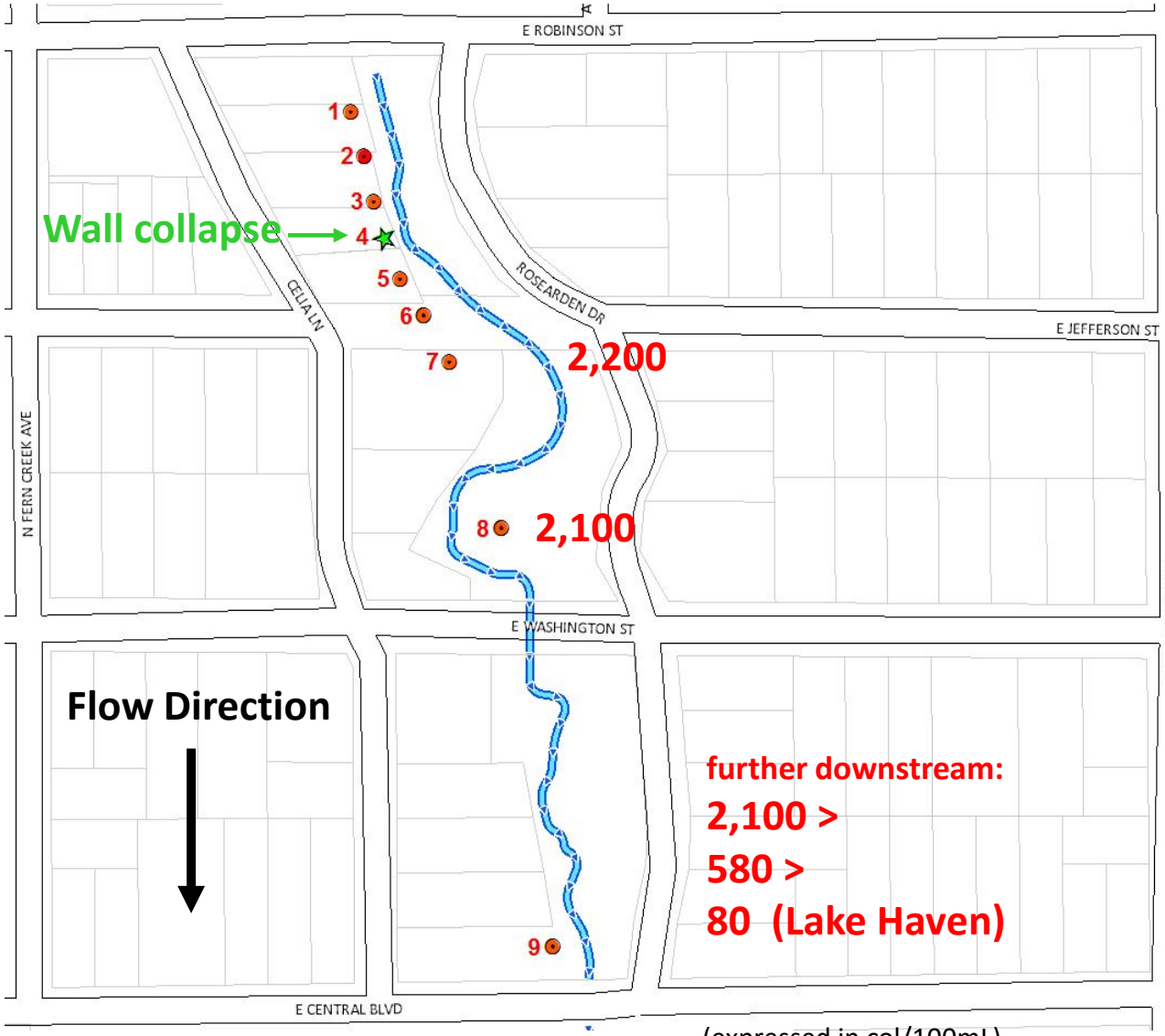
Background of Issue – Collapsed Wall

Background of Issue – City Bacteria Sampling

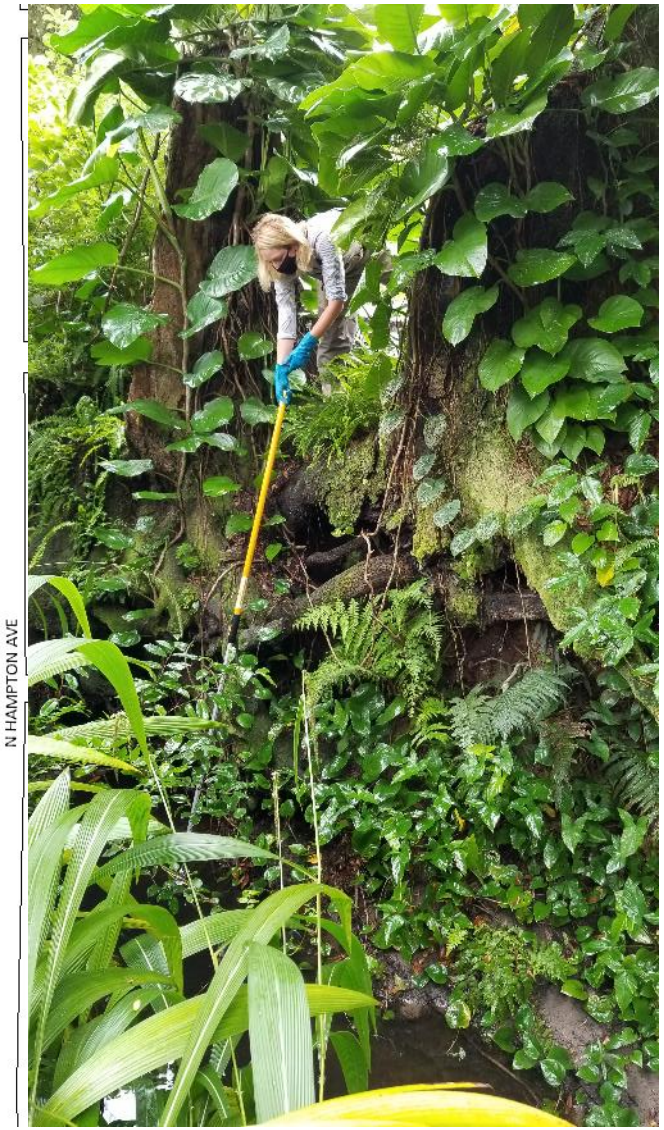


Background of Issue – City Bacteria Sampling

- Fecal Coliform Sampling on 12/27/2018
- 7 Days after collapse
  - No rain within last 7 days

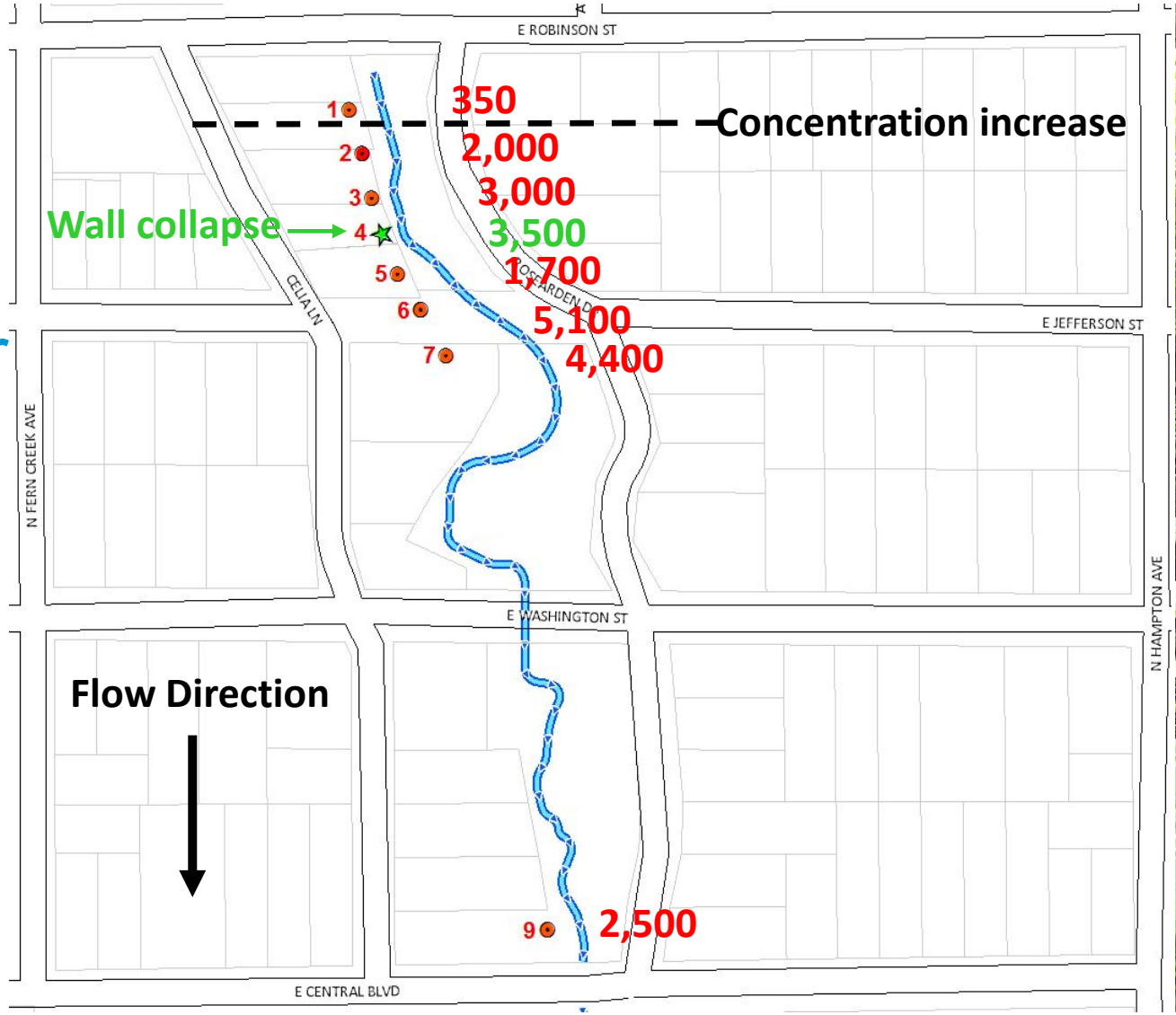


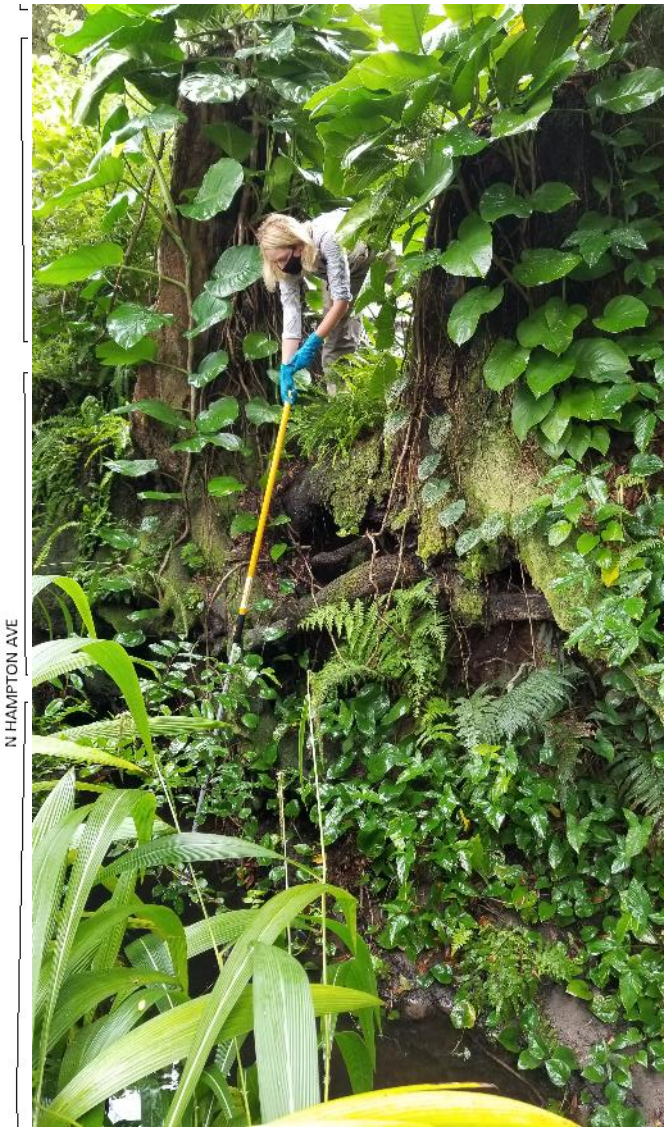
(expressed in col/100mL)



Background of Issue – City Bacteria Sampling

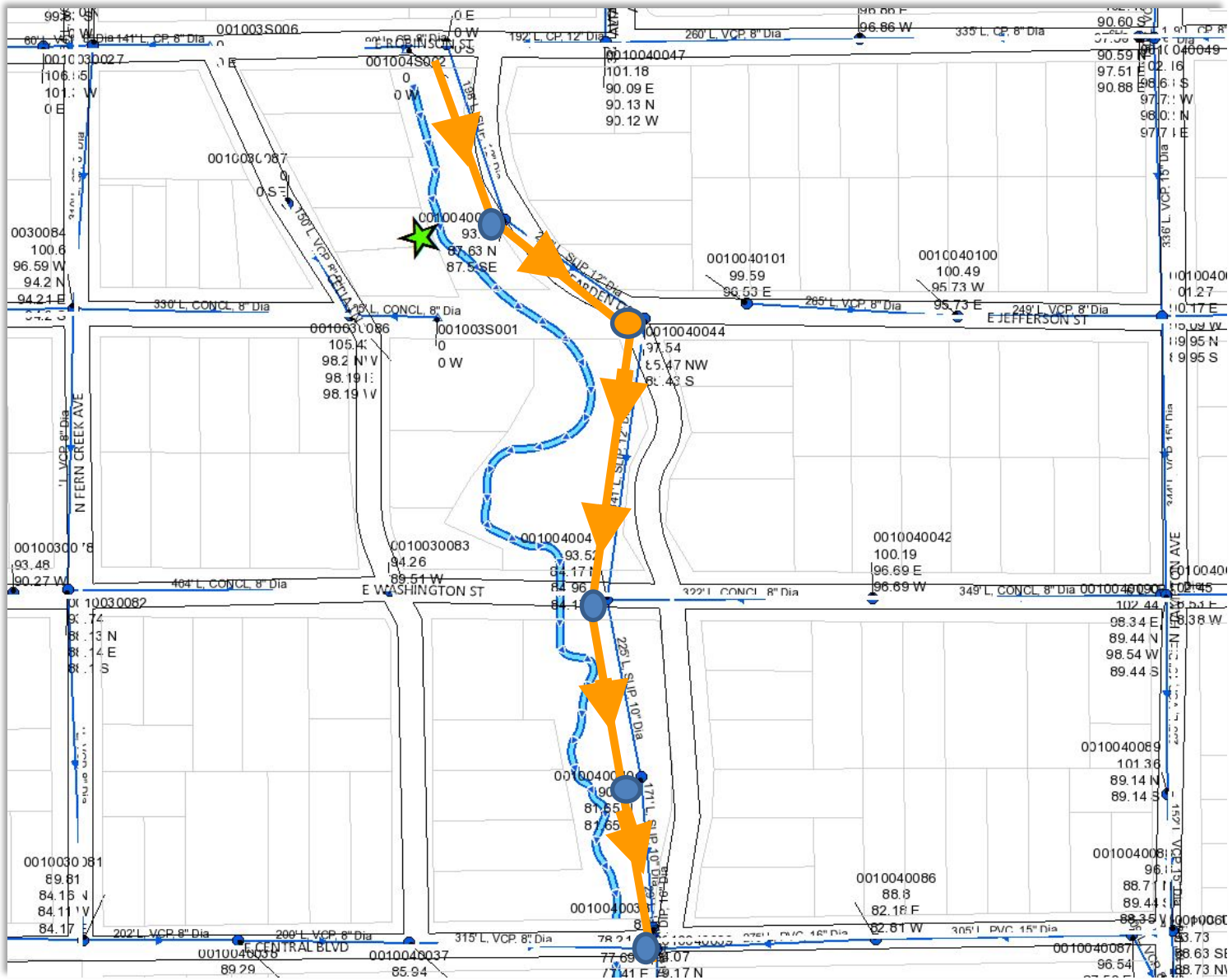
- Fecal Coliform Sampling on 1/4/2019
- 15 Days after collapse
  - No rain within last 15 days
  - Assistance requested by Water Reclamation





Background of Issue – City Bacteria Sampling

- Nearby sanitary system impacts to the creek
  - Performed slip lining of pipes and manholes
  - Occurred prior to wall collapse

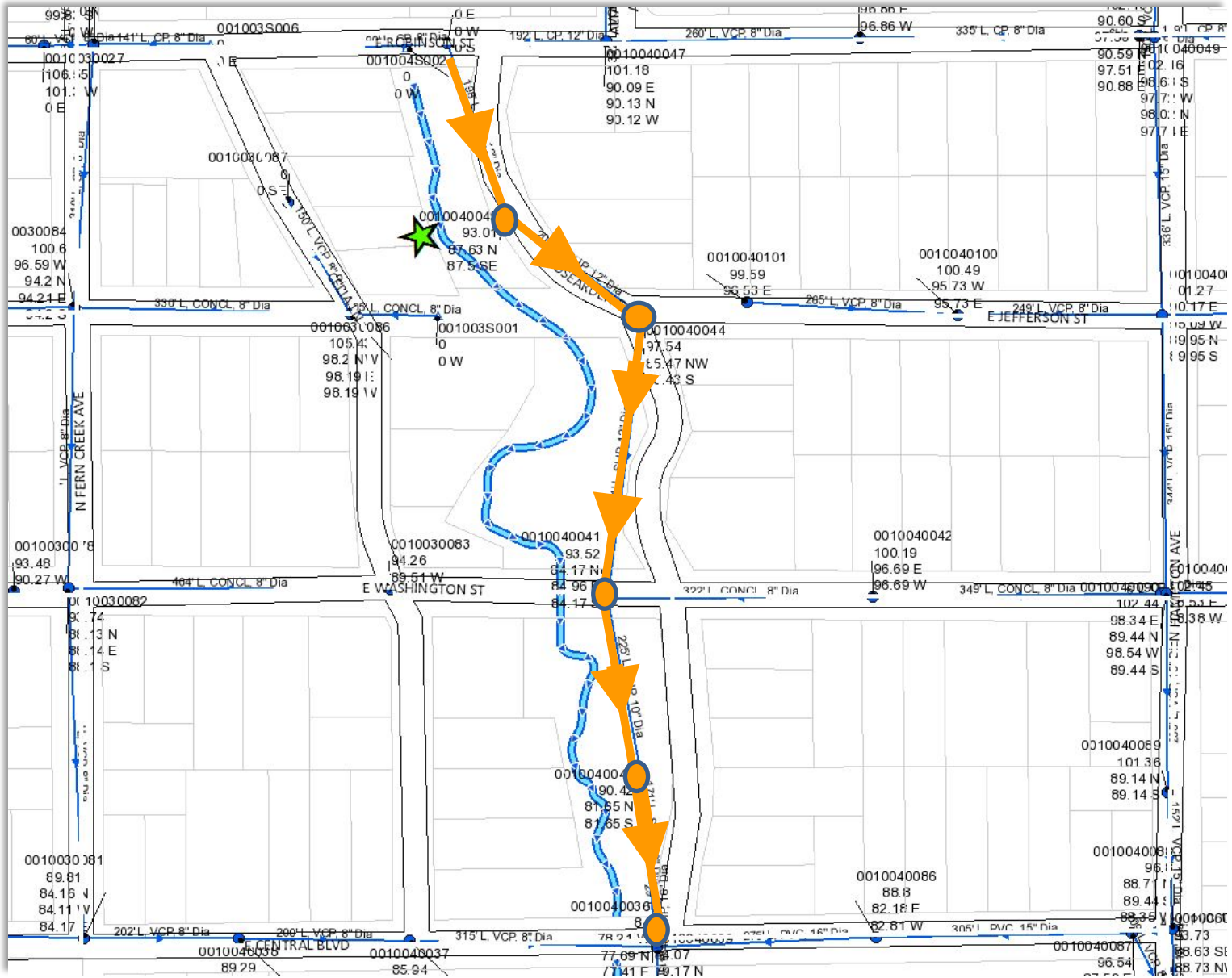


= Sanitary pipes sliplined

= Manhole

Background of Issue – City Bacteria Sampling

- Nearby sanitary system impacts to the creek
  - Finished sliplining the manholes after wall collapse

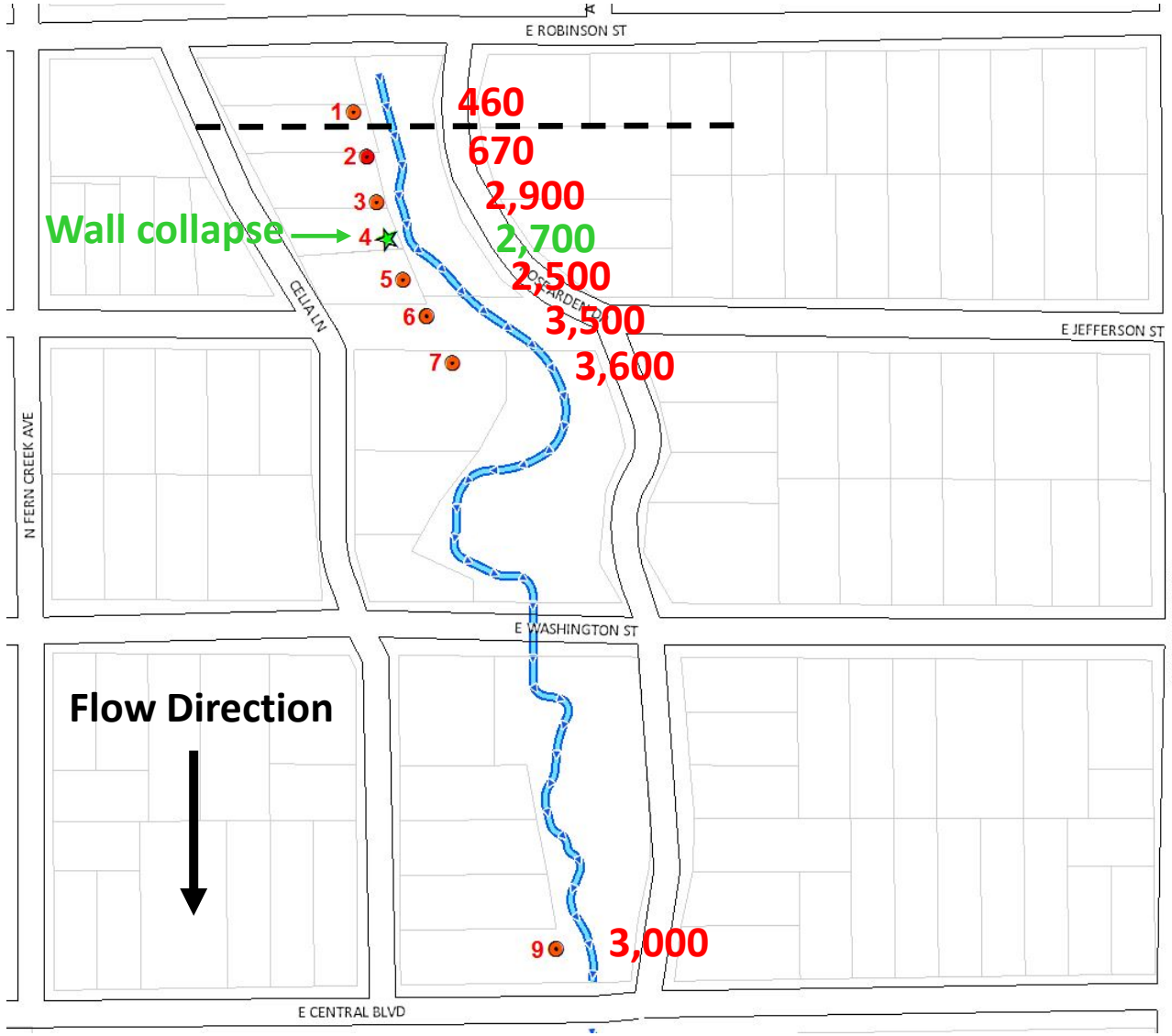


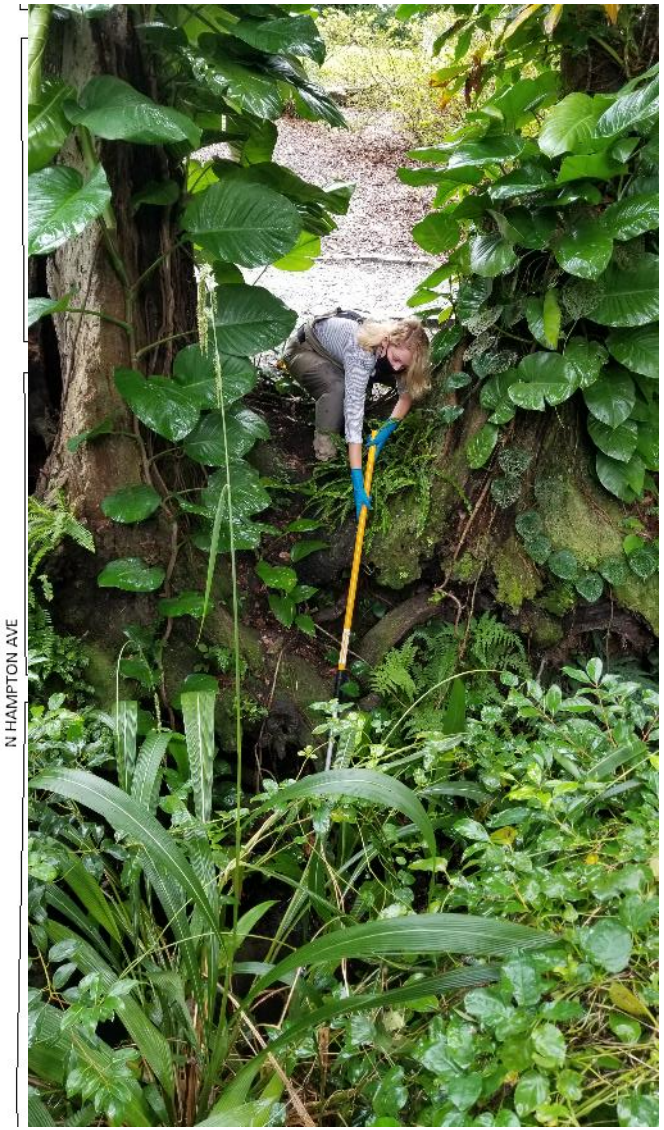
= Sanitary pipes sliplined

= Manholes sealed

Background of Issue – City Bacteria Sampling

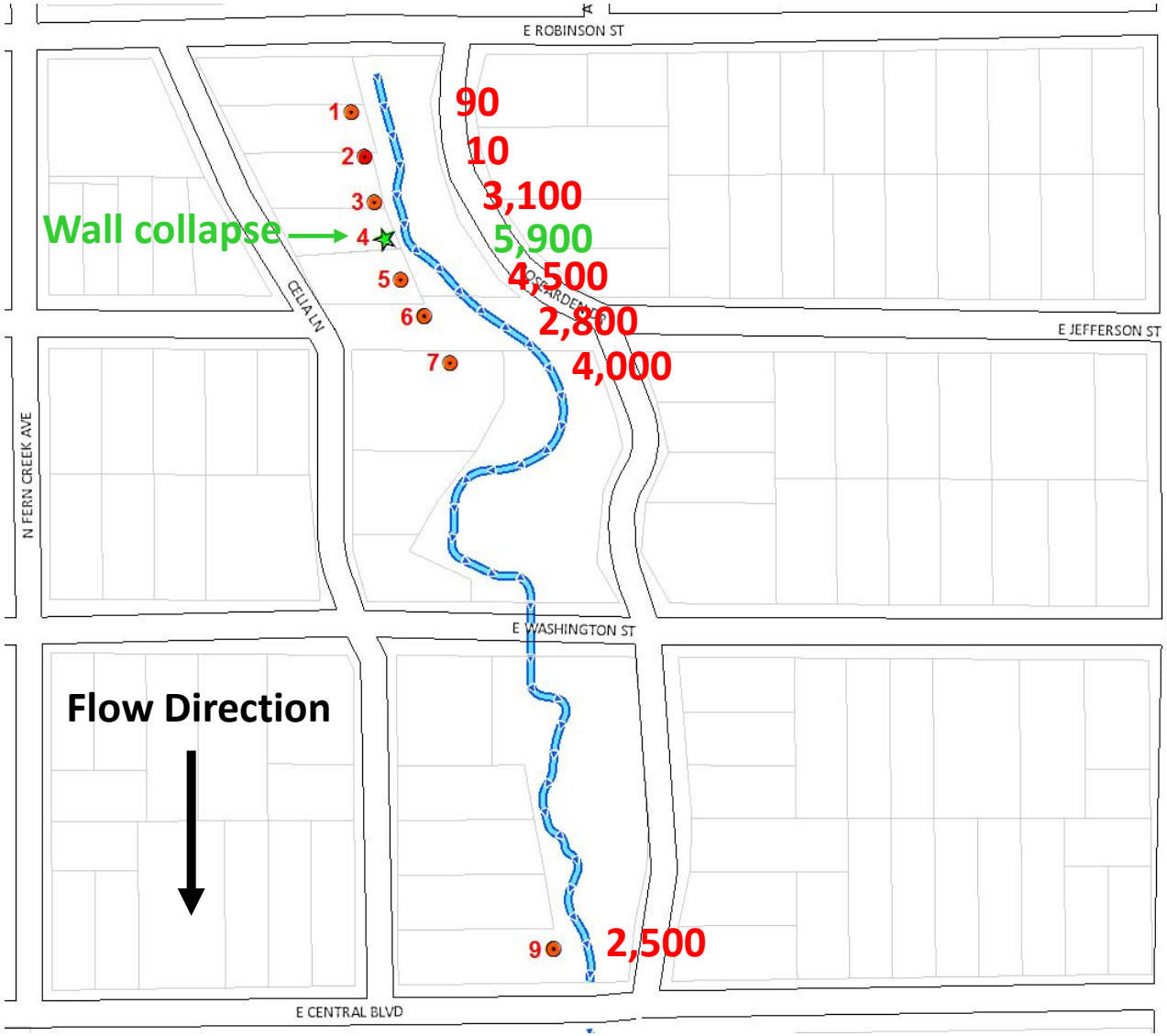
- Fecal Coliform Sampling on 1/30/2019
- 40 Days after collapse
  - 2.14 inches of rain within last 3 days
  - Dredging efforts ongoing for three weeks
  - Sanitary manholes lined one week prior to sampling
  - 26 days since previous sampling event





Background of Issue – City Bacteria Sampling

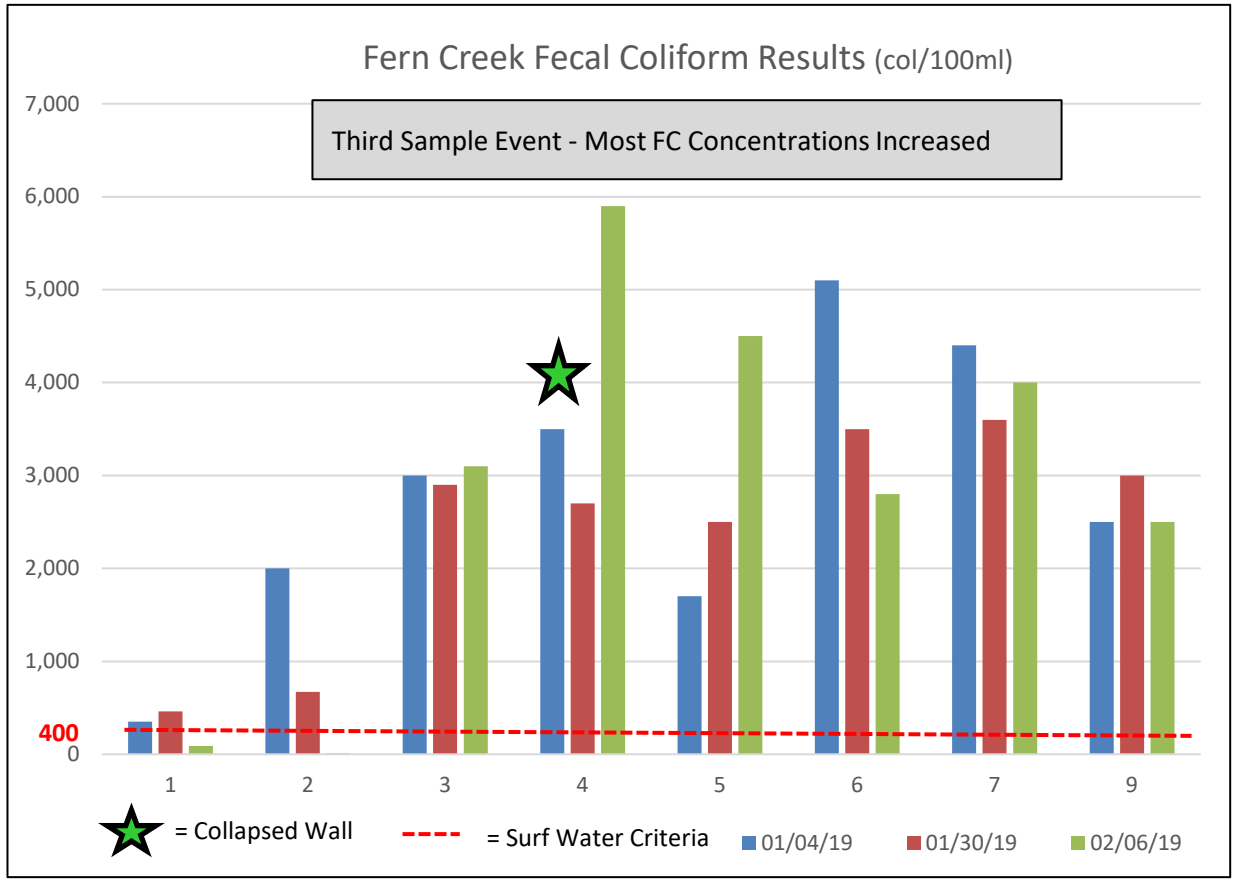
- Fecal Coliform Sampling on 2/6/2019
- 47 Days after collapse
  - No rain within last 7 days
  - Dredging efforts completed
  - Additional assistance requested by Water Reclamation



Background of Issue – City Bacteria Sampling

Station	01/04/19	01/30/19	02/06/19
1	350	460	90
2	2,000	670	10
3	3,000	2,900	3,100
4	3,500	2,700	5,900
5	1,700	2,500	4,500
6	5,100	3,500	2,800
7	4,400	3,600	4,000
9	2,500	3,000	2,500

* **Fecal coliform must remain less than 400 colonies/100ml** per *Surface Water Quality Standards*, Rule 62-302.530, F.A.C., for predominately fresh waters to maintain a healthy, well-balanced population of fish and wildlife



Upstream → **Downstream**

Background of Issue – City Bacteria Sampling

- Nearby sanitary system impacts to the creek
  - Checked lateral lines along creek for integrity

= Lateral lines checked for integrity

= Direction of flow for sanitary gravity line

Background of Issue – City Bacteria Sampling

- Nearby sanitary system impacts to the creek
  - Performed dye testing to identify illicit connections
  - **None observed**

Project Purpose

Geosyntec consultants

Project Purpose

- Help determine the origins of elevated bacterial concentrations measured in the creek
  - Appears to be a source of fecal bacteria within the park area
- Several potential sources
  - Leaky sanitary sewer from unlined or improperly lined mains
  - Legacy bacteria loads from prior unlined sanitary conditions
    - Potentially significant release with wall collapse
  - Direct human waste into the creek
  - Direct dog waste into the creek
  - Direct wildlife waste into the creek
  - Stormwater transporting bacteria from other parts of the watershed

Project Purpose

- Assess the origin and spatial locations of fecal contamination
- Develop recommendations to address the fecal contamination based on origin / source

Source: https://www.wrcbtv.com/story/42167966/florida-wildlife-park-introduces-social-distancing-skunk-ape-mascot

Source: https://theconversation.com/brexit-wisdom-of-crowds-proves-effective-predictor-of-britains-chaotic-eu-departure-119906

Source: https://nbc-2.com/news/science/2020/09/24/opossums-squirrels-and-more-taken-into-florida-wildlife-refuge-after-hurricane/

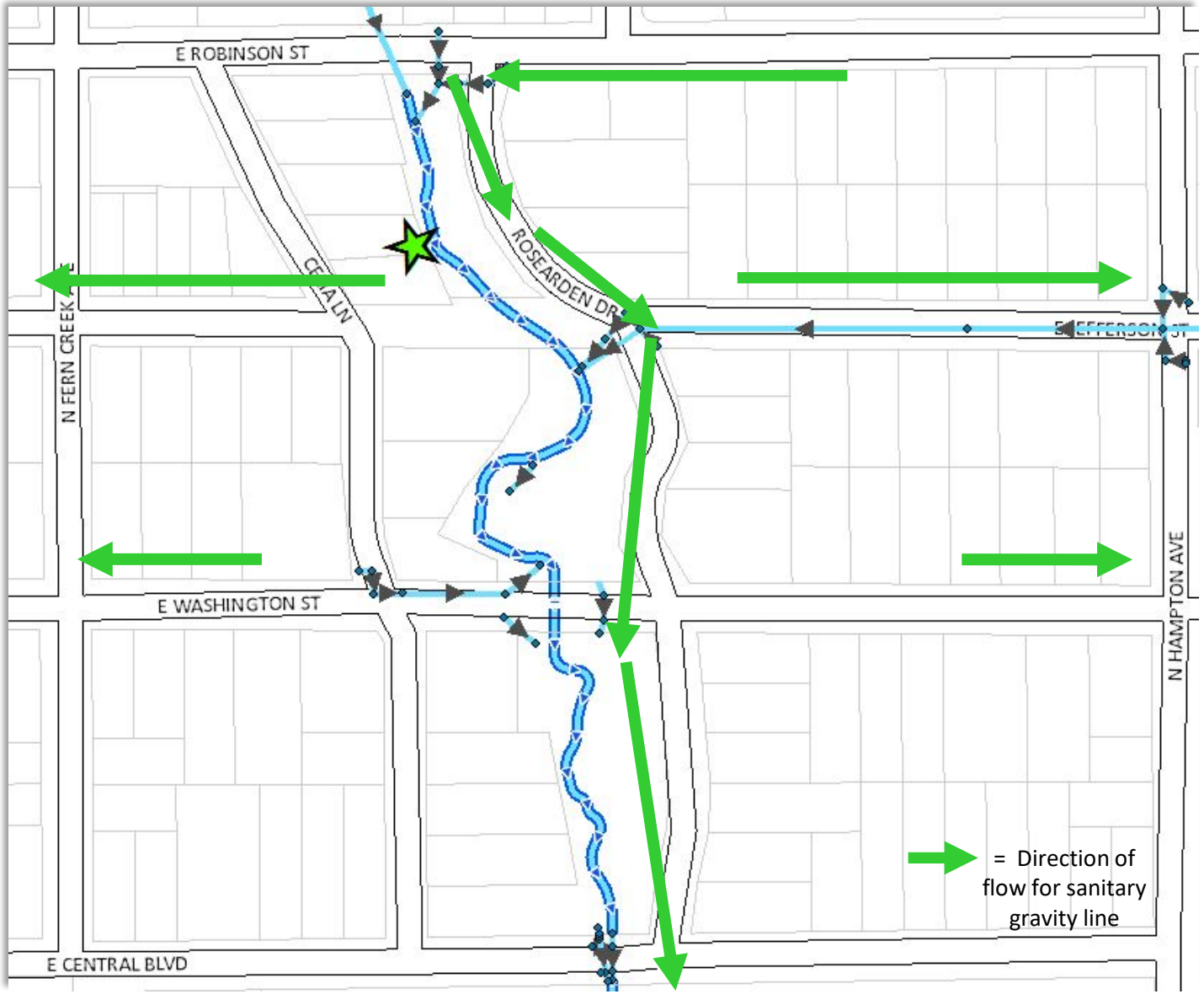
Source: https://www.familyhandyman.com/article/should-you-pick-up-your-dogs-poop/

Data Collection Design

Geosyntec consultants

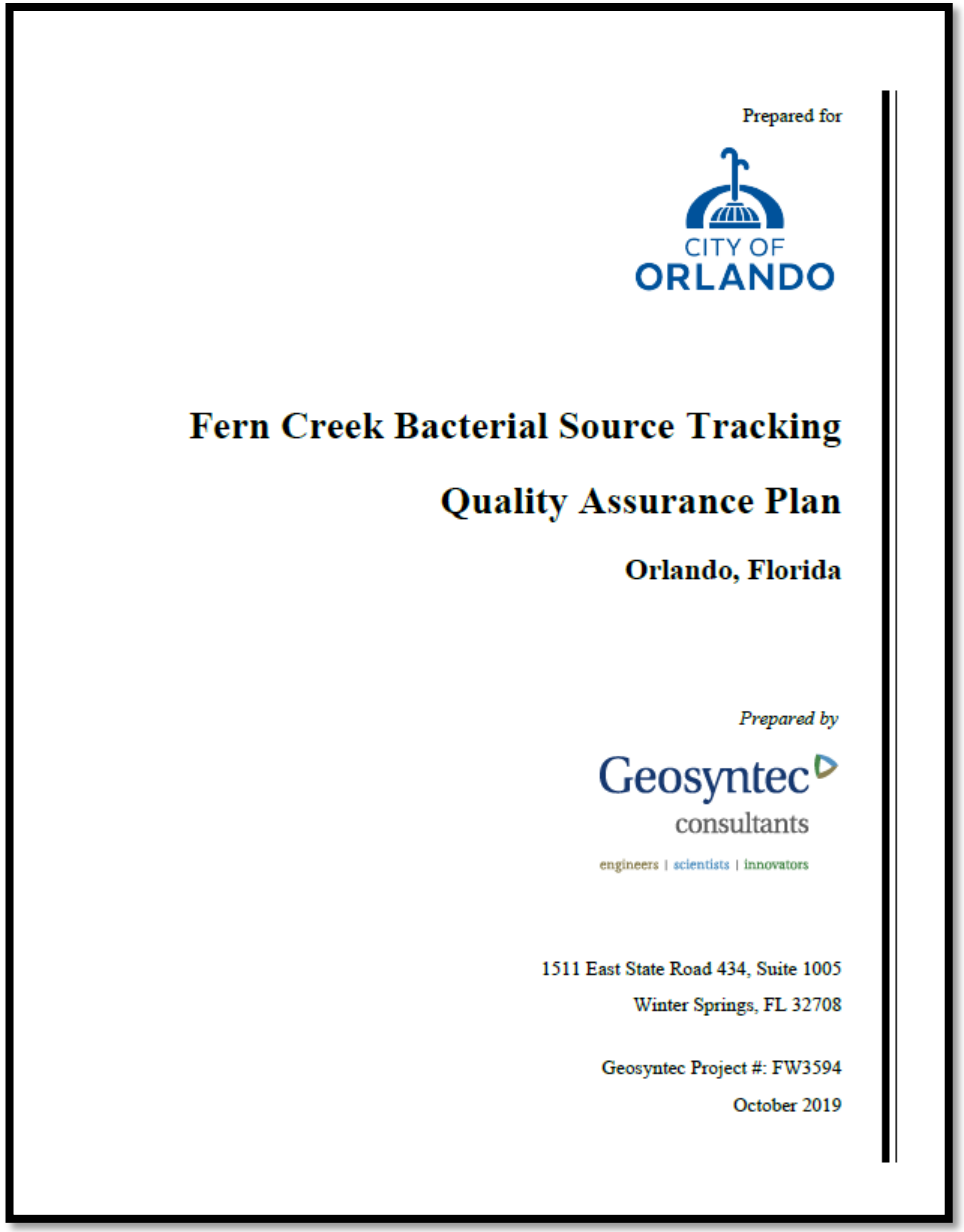
Data Collection Design

- Based on City sampling, bacteria source appears to be persistent
  - Not dependent on rainfall events
  - Appears to be generated within the creek
    - Most upstream locations lower concentrations
    - Downstream locations consistently high concentrations
- Interested in dry stormwater inflows due to potential sanitary impacts
  - Proximity to sanitary
  - Older infrastructure
  - Stormwater infrastructure could transport to creek



Data Collection Design

- Design sampling approach to use data-driven approach to identify sources of fecal contamination
  - Human marker (HF183)
  - Dog marker (BacCan)
- Develop a Quality Assurance Plan (QAP)
  - Most important document for sampling projects
    - Identifies all responsible parties
    - Clearly identifies responsibilities for each party
    - Defines project sampling protocols and procedures
    - Identify and get buy-in on non-standard testing procedures
    - Acts as project sampling plan



Prepared for

CITY OF ORLANDO

Fern Creek Bacterial Source Tracking

Quality Assurance Plan

Orlando, Florida

Prepared by

Geosyntec consultants

engineers | scientists | innovators

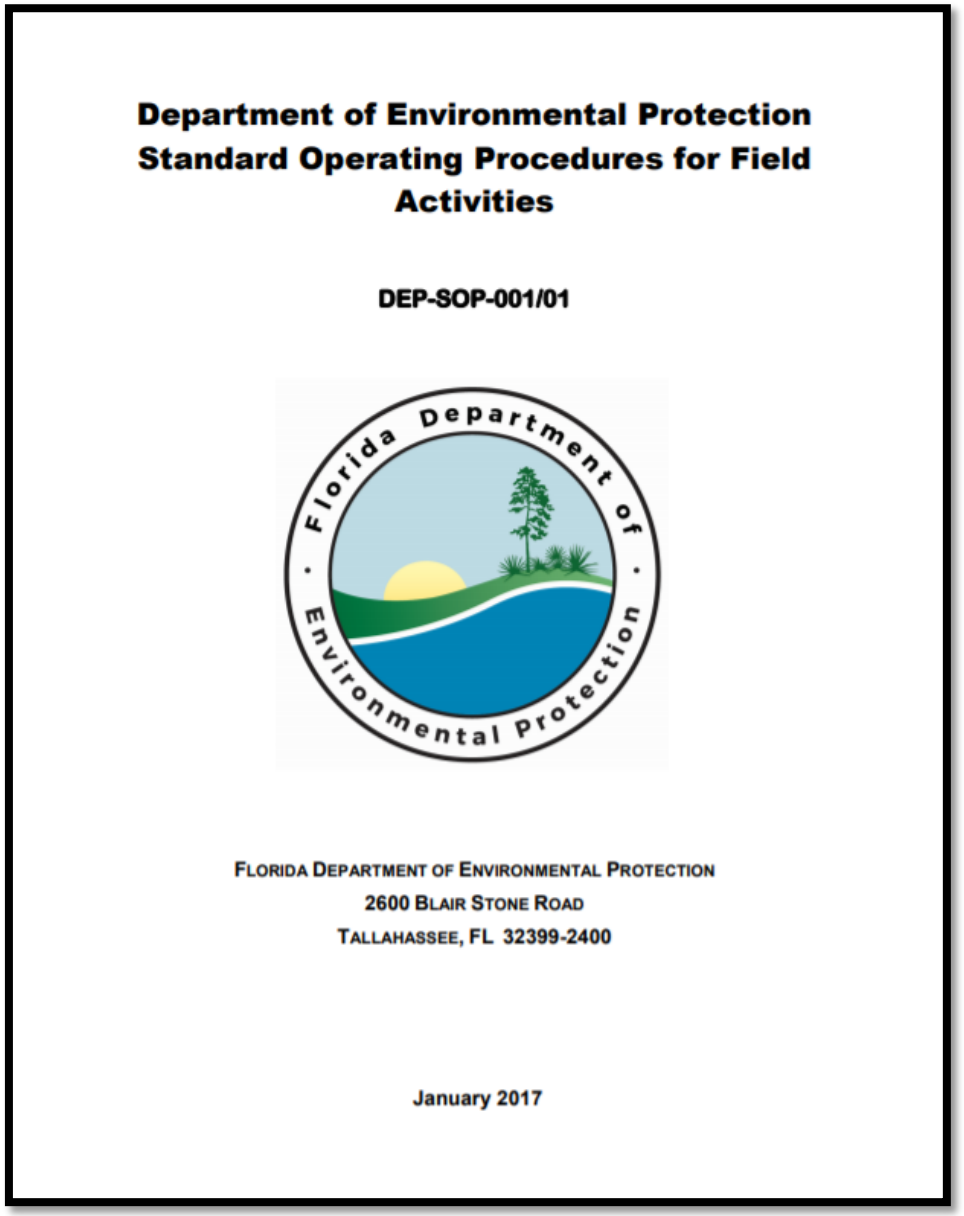
1511 East State Road 434, Suite 1005
Winter Springs, FL 32708

Geosyntec Project #: FW3594

October 2019

Data Collection Design

- Sampling followed FDEP sampling procedures
  - FC1000 Cleaning / Decontamination Procedures
  - FD1000 Documentation Procedures
  - FQ1000 Field Quality Control Requirements
  - FS1000 General Sampling Procedures
  - FS2000 General Aqueous Sampling
  - FS2100 Surface Water Sampling
  - FS4000 Sediment Sampling
- DNA sampling required specific SOP
  - Need to be extra careful to not contaminate the sample
  - Requires sterilized sample bottles (no intermediate bottles unless sterile)
  - Samples stored on ice in the dark and shipped overnight to analysis laboratory
  - Make observations during sampling
    - Color
    - Odor
    - Fecal sources observed during sampling (dogs, wildlife, etc.)



Department of Environmental Protection
Standard Operating Procedures for Field Activities

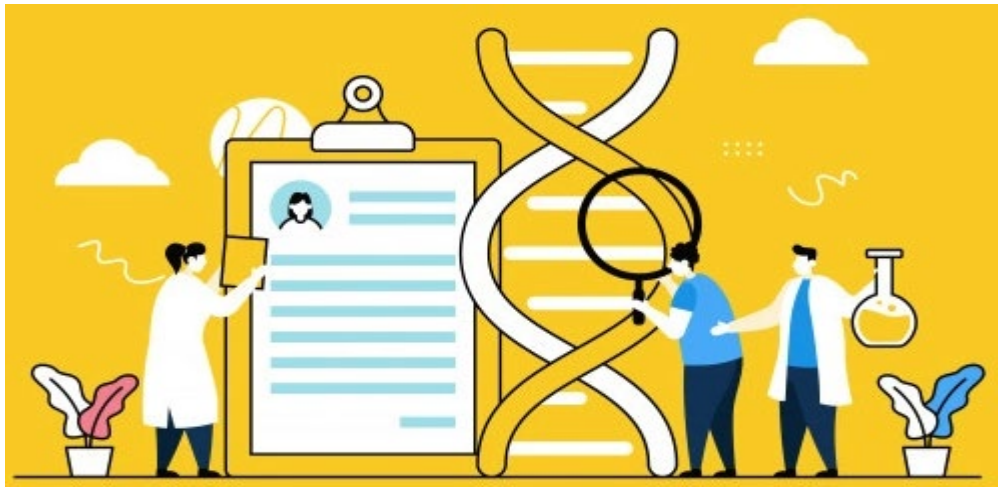
DEP-SOP-001/01

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
2600 BLAIR STONE ROAD
TALLAHASSEE, FL 32399-2400

January 2017

Data Collection Design

- Sampling plan with hypothesis driven approach
- Interested in identifying the source
  - Location of contamination
  - Human
  - Dog
  - Sediments
  - Other

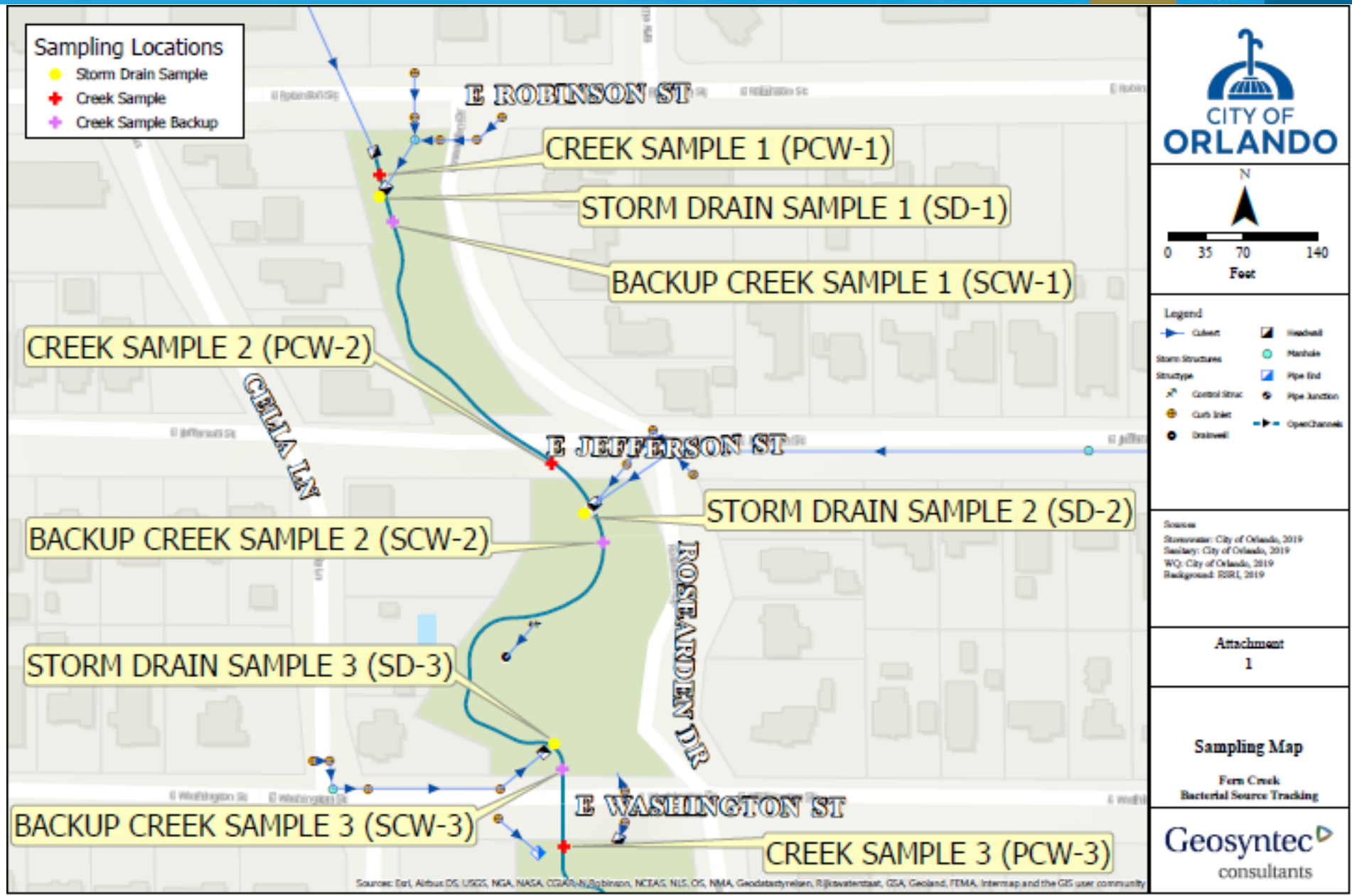


Source: https://www.freepik.com/search?dates=any&format=search&page=1&query=Scientist%20magnifying%20glass%20dna&sort=popular

- 4 Hypotheses were developed
  - H1 Human waste is a significant source of bacteria to Fern Creek
  - H2 Human waste is a significant source of bacteria to storm drain outfalls in Fern Creek
  - H3 Dog waste is a significant source of bacteria to Fern Creek
  - H4 Creek sediments contain a reservoir of bacteria that are a significant source to the water flowing in Fern Creek

Data Collection Design

- 3 creek sample locations
- 3 storm drain sample locations
- 3 backup creek sample locations
- Sampled
  - Creek water
  - Dry flow from storm drains
  - Creek sediments



Results

Geosyntec consultants

Results

- Performed 3 dry sampling events
- H1: Human waste was a significant source of bacteria to Fern Creek during dry weather
  - Only one location / event showed human marker present
    - Very low levels (MDL = 20 copies/100mL)
  - Detected in most upstream sample location
  - **Not significant**
- H2: Human waste is a significant source of bacteria to dry weather storm drain discharges in Fern Creek
  - No storm drain samples collected
  - **Not significant**

Event (Date)	Location	Human Marker (copies/100mL)	Dog Marker (copies/100mL)	Fecal Coliform (CFU/100mL)	TSS (mg/L)
Event 1 (10/24/2019)	PCW-1	36	ND	200	< 2.5
	SCW-1	ND	ND	77	< 2.5
	PCW-2	ND	1,620	290	< 2.5
	SCW-2	ND	1,040	520	< 2.5
	SCW-3	ND	1,860	34	< 2.5
	PCW-3	ND	627	55	< 2.5
Event 2 (11/19/2019)	PCW-1	ND	ND	8,100	< 2.5
	SCW-1	ND	526	740	< 2.5
	PCW-2	ND	2,720	370	< 2.5
	SCW-2	ND	992	570	< 2.5
	SCW-3	ND	712	250	< 2.5
	PCW-3	ND	817	210	< 2.5
Event 3 (1/2/2020)	PCW-1	ND	506	39	< 2.5
	SCW-1	ND	DNQ	24	< 2.5
	PCW-2	ND	DNQ	88	< 2.5
	SCW-2	ND	DNQ	52	2.6
	SCW-3	ND	ND	27	< 2.5
	PCW-3	ND	ND	1,100	< 2.5

ND = Not Detected, DNQ = Detected Not Quantified (detected below the quantification limit)

Results

- H3: Dog waste was a significant source of bacteria to Fern Creek during dry weather
  - Frequently detected at elevated concentrations
    - Present in 13 of 18 samples
    - Detected above 500 copes/100 mL in 10 samples
  - Higher at mid and downstream locations
  - Highest at PCW-2
  - **Significant**

Event (Date)	Location	Human Marker (copies/100mL)	Dog Marker (copies/100mL)	Fecal Coliform (CFU/100mL)	TSS (mg/L)
Event 1 (10/24/2019)	PCW-1	36	ND	200	< 2.5
	SCW-1	ND	ND	77	< 2.5
	PCW-2	ND	1,620	290	< 2.5
	SCW-2	ND	1,040	520	< 2.5
	SCW-3	ND	1,860	34	< 2.5
	PCW-3	ND	627	55	< 2.5
Event 2 (11/19/2019)	PCW-1	ND	ND	8,100	< 2.5
	SCW-1	ND	526	740	< 2.5
	PCW-2	ND	2,720	370	< 2.5
	SCW-2	ND	992	570	< 2.5
	SCW-3	ND	712	250	< 2.5
	PCW-3	ND	817	210	< 2.5
Event 3 (1/2/2020)	PCW-1	ND	506	39	< 2.5
	SCW-1	ND	DNQ	24	< 2.5
	PCW-2	ND	DNQ	88	< 2.5
	SCW-2	ND	DNQ	52	2.6
	SCW-3	ND	ND	27	< 2.5
	PCW-3	ND	ND	1,100	< 2.5

ND = Not Detected, DNQ = Detected Not Quantified (detected below the quantification limit)

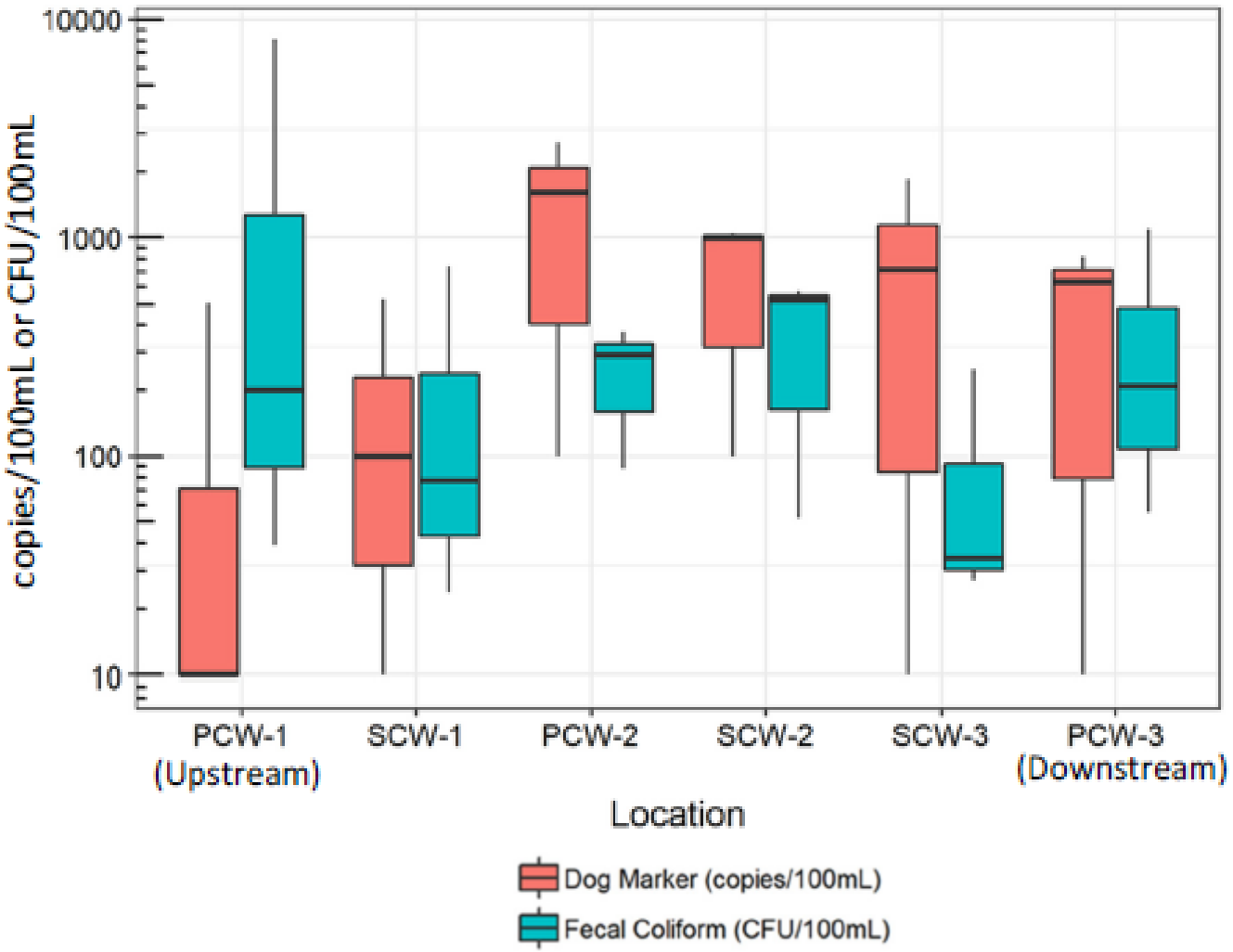
Results

- H4: Creek sediments contain a reservoir of bacteria that are a significant source to the water flowing in Fern Creek during dry weather
  - Relatively low concentrations
  - TSS concentrations very low (typically at or below laboratory detection limits)
  - **Not significant**

Event (Date)	Location	Fecal Coliform (CFU/g)	% Moisture
Event 1 (10/24/2019)	CS-1	30	19.1
	CS-2	145	21.1
	CS-3	110	18.2

Results

- Compared dog marker to fecal coliform concentrations
  - No significant correlation observed
  - Other non-human sources likely contributing fecal bacteria
    - Birds
    - Racoons
    - Other



Conclusions and Recommendations

Geosyntec consultants

Conclusions

- Fern Creek an urban creek
  - Project area is public park
- Wall collapsed in Fern Creek
  - Complaints of odor prompted fecal bacteria sampling
  - Older sanitary system in area
    - Was due to be sliplined
  - Significant amount of sediments discharged into creek
  - Since been repaired and sediments removed
- City performed extensive sampling during dry weather conditions
  - Extremely elevated fecal bacteria concentrations observed
  - Appeared to be a source within Fern Creek
    - South of East Robinson Street and north of East Jefferson street
- Developed a detailed QAP which also acted as the sampling plan

Conclusions

- Performed targeted dry weather bacterial sampling
  - Creek baseflow
  - Creek sediments
  - Dry storm drain flows (non observed during sampling)
- DNA marker sampling to identify source of fecal bacteria
  - Dog marker (BacCan)
  - Human marker (HF183)
- Source of fecal bacteria to Fern Creek based on the sampling and analysis conducted
  - Human waste ruled out
  - Storm drain discharges during dry events ruled out (non observed during sampling)
  - Sediments ruled out
  - **Dog waste identified as significant contributor**
- Lack of correlation between dog marker and fecal coliform concentration indicated other non-human sources contributing to fecal bacteria
  - Cats
  - Birds
  - Racoons
  - Other

Recommendations

- Implement dog waste outreach program / expand current program
  - Additional signage
  - Additional pet waste stations
  - Enforcement of local ordinances
  - Targeted door to door outreach campaign
    - Mail flyers
    - Radio adds
    - TV adds
- Perform additional dry weather sampling to assess effectiveness of program
- Perform additional wet weather sampling to examine stormwater impacts

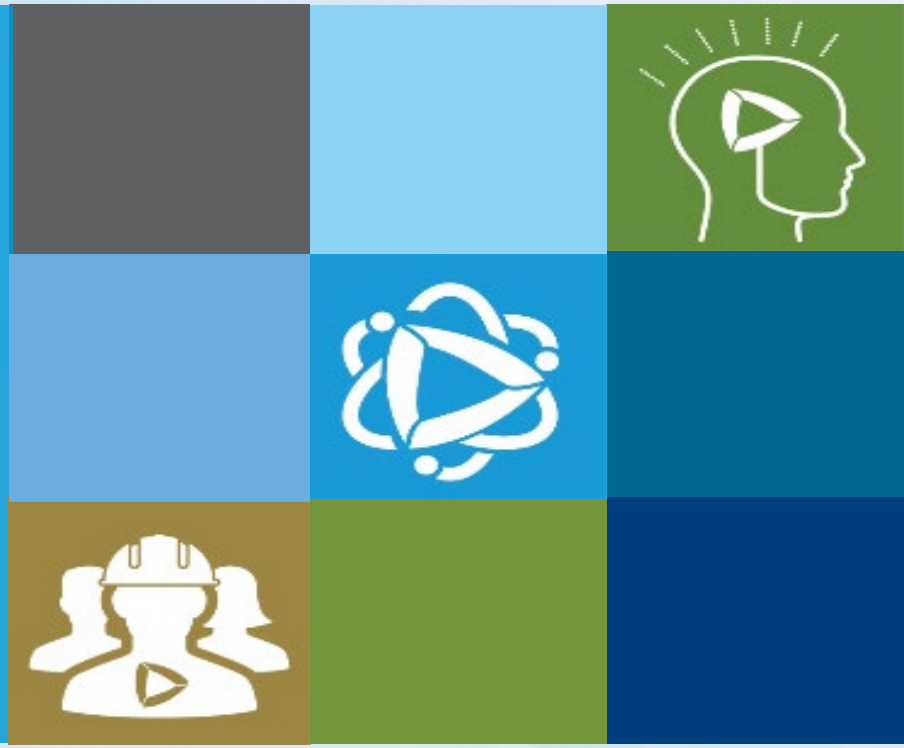
Source: https://www.petwasteeliminator.com/e802pc.html

Source: https://www.alachuacounty.us/depts/epd/waterresources/stormwaterpollutionandsolutions/pages/pet-waste.aspx

Source: https://cooperator.com/article/the-artful-dodger/full

Geosyntec consultants

Thank You!
Questions?



Mike Hardin, PhD., PE, CFM – Senior Engineer
mhardin@geosyntec.com

3504 Lake Lynda Drive, Suite 155
Orlando, FL 32817
(407)321-7030

Lisa Lotti – Stormwater Compliance Program Manager
Lisa.lotti@cityoforlando.net

Streets and Stormwater Division
(407)246-2037

CITY OF ORLANDO