

# Modeling I&I: Non-Traditional Tools for City-Wide Reduction Solutions







UNDERGROUND CONSTRUCTION TECHNOLOGY  
THE UNDERGROUND UTILITIES EVENT | February 7-9, 2023 | Orlando, FL

1

## Agenda

- City of Houston Background
- Need for Program
- Program Overview
- Program Development/Execution



UNDERGROUND CONSTRUCTION TECHNOLOGY  
THE UNDERGROUND UTILITIES EVENT | February 7-9, 2023 | Orlando, FL

2

## Houston Unique Qualities

- Diverse Community with Diverse Cultures
- Slew of varied restaurants
- No Formal Zoning Regulations/Laws
- Flat Terrain



UNDERGROUND CONSTRUCTION TECHNOLOGY  
THE UNDERGROUND UTILITIES EVENT | February 7-9, 2023 | Orlando, FL

3

**Houston Area: 669 Square Miles**

39 Permitted WRRFs

- 239 MGD actual (5yr avg)
- 565 MGD permitted

3 Wet Weather Facilities

383 Lift Stations

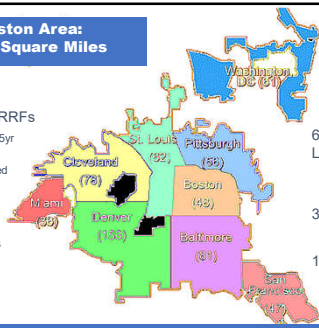
6,200 mi. Collection Lines

- 2 round trips: Houston to Los Angeles


325 mi. Force Mains

- Houston to Wichita Falls

127,400 Manholes



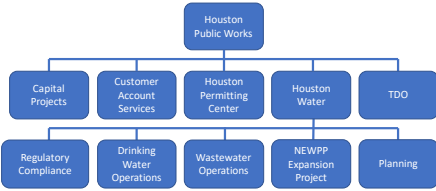
The land area of all these cities COMBINED would fit within Houston's land area.




UNDERGROUND CONSTRUCTION TECHNOLOGY  
THE UNDERGROUND UTILITIES EVENT | February 7-9, 2023 | Orlando, FL

4


## Organizational Structure






UNDERGROUND CONSTRUCTION TECHNOLOGY  
THE UNDERGROUND UTILITIES EVENT | February 7-9, 2023 | Orlando, FL

5



## Opportunities

- Consent Decree with EPA. April 2021
- Inspect entire system in 10 years
- Rehabilitate ~ 2.5% mains each year
- I/I Predictive Modeling on inspection data




UNDERGROUND CONSTRUCTION TECHNOLOGY  
THE UNDERGROUND UTILITIES EVENT | February 7-9, 2023 | Orlando, FL

6

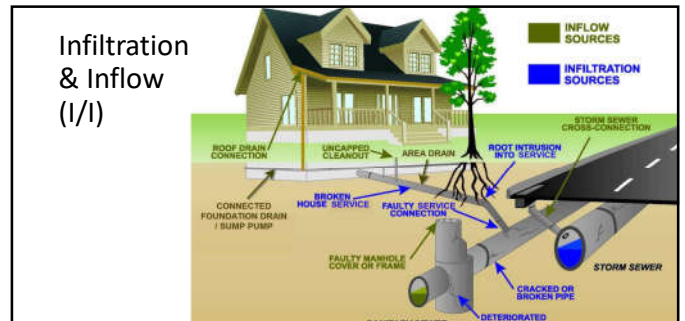

### Project Objective

- Tool to predict I/I sources
- Generate estimates
- Accurately budget
- Immediate rehabilitation efforts to reduce I/I



7

### Infiltration & Inflow (I/I)

8

### Project Approach

**Phase 1 – Desktop Study**

- Analytical analysis
- Trend forecasting

**Phase 2 – Beta Tool Development**


- Apply rehab methods
- Develop cost estimates

**Phase 3 – Calibration**

- Houston specific data
- Condition assessment

**Phase 4 – Application**

- Integrate with Asset Management Programs
- Develop long range O&M and CIP Plans



9



### Phase 1: Desktop Study

**Determine Available Data**

- Houston GIS attribute data
- Existing Houston condition data
- Similar regional data

**Asset Classifications**

- Gravity mains
- Service laterals
- Manholes

10

### Gravity Main Components

**Diameter**



- 0-8 inch
- 10-24 inch
- 25 and larger

**Material**

- Concrete
- VCP
- Plastic/Fiberglass
- Metal
- CIPP/Slipped Line
- UNK

**Age Range**

- 2006-Present
- 1991-2005
- 1976-1990
- 1975 and Under
- Year UNK

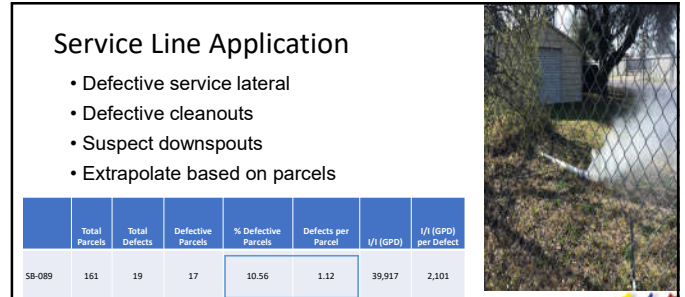
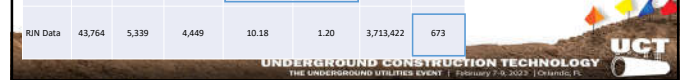



11

### Service Line Application

- Defective service lateral
- Defective cleanouts
- Suspect downspouts
- Extrapolate based on parcels


	Total Parcels	Total Defects	Defective Parcels	% Defective Parcels	Defects per Parcel	I/I (GPD)	I/I (GPD) per Defect
SR-089	161	19	17	10.56	1.12	39,917	2,101
RUN Data	43,764	5,339	4,449	10.18	1.20	3,713,422	673

12

## Manhole Components

- Age
- Ponding depth
- I/I location
  - Inflow
    - Covers (pickholes)
    - Frame, frame seals, frame to cover fit
    - Chimney, adjustment
  - Infiltration
    - Cone, wall
    - Bench, channel, pipe seals



UNDERGROUND CONSTRUCTION TECHNOLOGY  
THE UNDERGROUND UTILITIES EVENT | February 7-9, 2023 | Orlando, FL

13

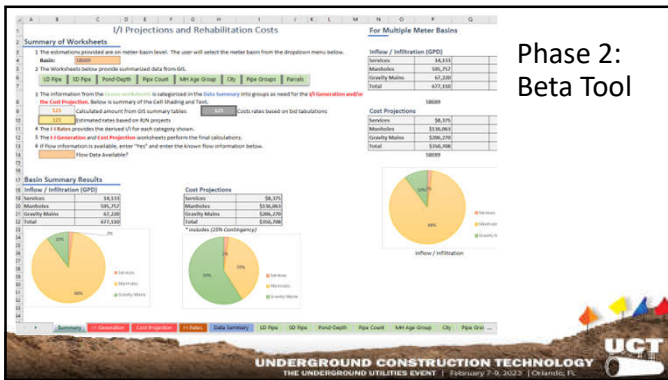
## Remedial Measures

Gravity Mains	Service Lines	Manholes
<ul style="list-style-type: none"> <li>• Point repair</li> <li>• CIPP</li> <li>• Pipe bursting</li> <li>• Open cut</li> <li>• Large vs small diameter</li> </ul>	<ul style="list-style-type: none"> <li>• Replace cleanout</li> <li>• Replace cleanout cap</li> <li>• Replace lateral</li> </ul>	<ul style="list-style-type: none"> <li>• Replace frame and cover</li> <li>• Cementitious lining</li> <li>• Epoxy lining</li> <li>• Rehabilitation of bench and invert</li> </ul>

UNDERGROUND CONSTRUCTION TECHNOLOGY  
THE UNDERGROUND UTILITIES EVENT | February 7-9, 2023 | Orlando, FL

14

## Phase 2: Beta Tool




UNDERGROUND CONSTRUCTION TECHNOLOGY  
THE UNDERGROUND UTILITIES EVENT | February 7-9, 2023 | Orlando, FL

15

## Phase 3: Calibration

**8 study areas**

- 196,071 LF gravity mains
- 735 manholes
- 164,394 LF CCTV
- 179,908 LF smoke testing
  - 392 observations
- 559 manhole inspections




UNDERGROUND CONSTRUCTION TECHNOLOGY  
THE UNDERGROUND UTILITIES EVENT | February 7-9, 2023 | Orlando, FL

16

## Gravity Mains

Projected/Prorated	Field Observed
<ul style="list-style-type: none"> <li>• 196,071/164,394 LF CCTV</li> <li>• 4.280/3.486 MGD I/I</li> </ul>	<ul style="list-style-type: none"> <li>• 164,394 LF CCTV (84%)</li> <li>• 2.458 MGD I/I (57%/71%)</li> </ul>




UNDERGROUND CONSTRUCTION TECHNOLOGY  
THE UNDERGROUND UTILITIES EVENT | February 7-9, 2023 | Orlando, FL

17

## Service Laterals


Projected	Field Observed
<ul style="list-style-type: none"> <li>Defective Parcels: 335</li> <li>Defects: 363</li> <li>I/I: 1.016 MGD</li> <li>• 2,800 GPD/defect</li> </ul>	<ul style="list-style-type: none"> <li>Defective Parcels: 335</li> <li>Defects: 392</li> <li>I/I: 1.032 MGD</li> <li>• 2,600 GPD/defect</li> </ul>




UNDERGROUND CONSTRUCTION TECHNOLOGY  
THE UNDERGROUND UTILITIES EVENT | February 7-9, 2023 | Orlando, FL

18

### Manholes



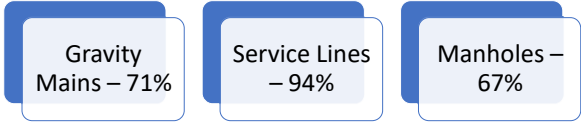
- Projected**
  - 735 inspections
  - 13.745 MGD I/I
- Field Observed**
  - 559 inspections
  - 8.538 MGD I/I



**UCT**  
UNDERGROUND CONSTRUCTION TECHNOLOGY  
THE UNDERGROUND UTILITIES EVENT | February 7-9, 2023 | Orlando, FL

19

### Prediction vs Field Findings






- Gravity Mains – 71%
- Service Lines – 94%
- Manholes – 67%

**UCT**  
UNDERGROUND CONSTRUCTION TECHNOLOGY  
THE UNDERGROUND UTILITIES EVENT | February 7-9, 2023 | Orlando, FL

20

### Next Steps

-  Determine if other factors can contribute to basin uniqueness
-  Adjust projection estimates to increase accuracy for independent basins
-  Continuous Improvement

**UCT**  
UNDERGROUND CONSTRUCTION TECHNOLOGY  
THE UNDERGROUND UTILITIES EVENT | February 7-9, 2023 | Orlando, FL

21

### Questions



-  Fazle Rabbi, PE  
Fazle.Rabbi@houston.tx.gov
-  Jason Maldonado, CFM  
jmaldonado@rjnmail.com
-  Tristan Nickel, PE, AWAM  
tnickel@rjnmail.com

**UCT**  
UNDERGROUND CONSTRUCTION TECHNOLOGY  
THE UNDERGROUND UTILITIES EVENT | February 7-9, 2023 | Orlando, FL

22