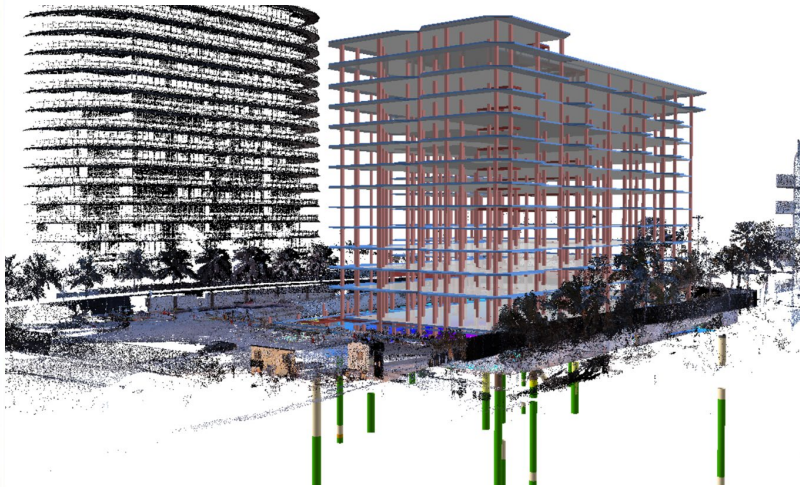


NCST Investigation of the Champlain Towers South Collapse

3D Visualization of Evidence



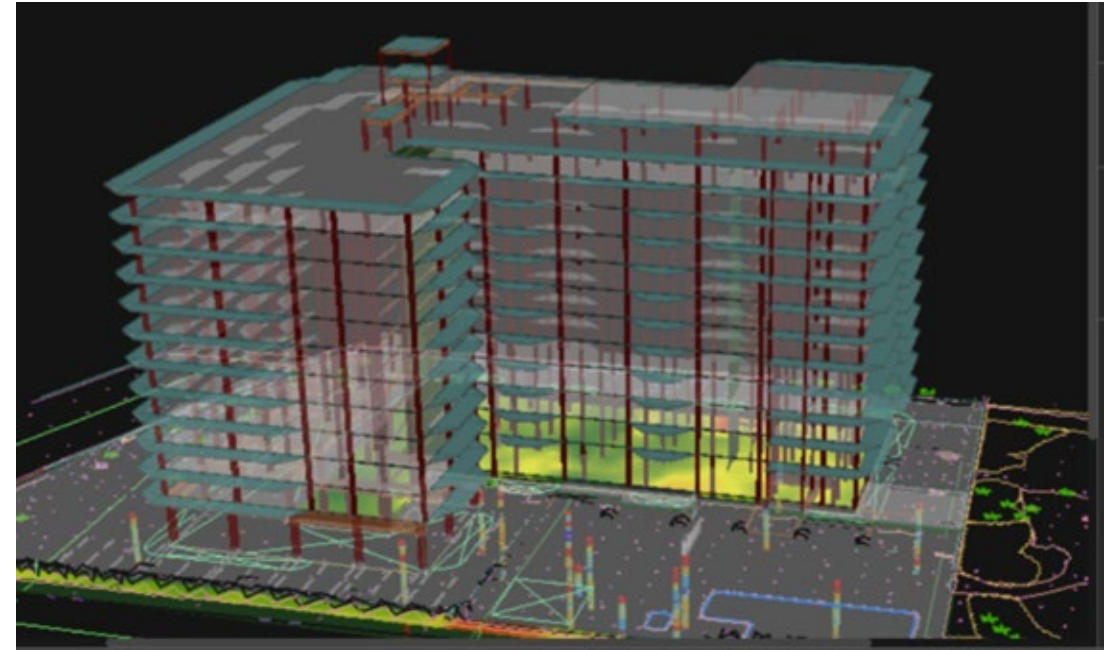
David G. Goodwin Jr., Ph.D.
*Project Leader, Evidence Preservation
Project*

Georgette Hlepas, Ph.D., PE
*Project Leader, Remote Sensing &
Visualization Project*



Evidence Management & Visualization Goals

- Collect, document, and centrally manage physical evidence
- Identify original location of evidence specimens in building prior to collapse
- Depict evidence specimens in a geospatial model

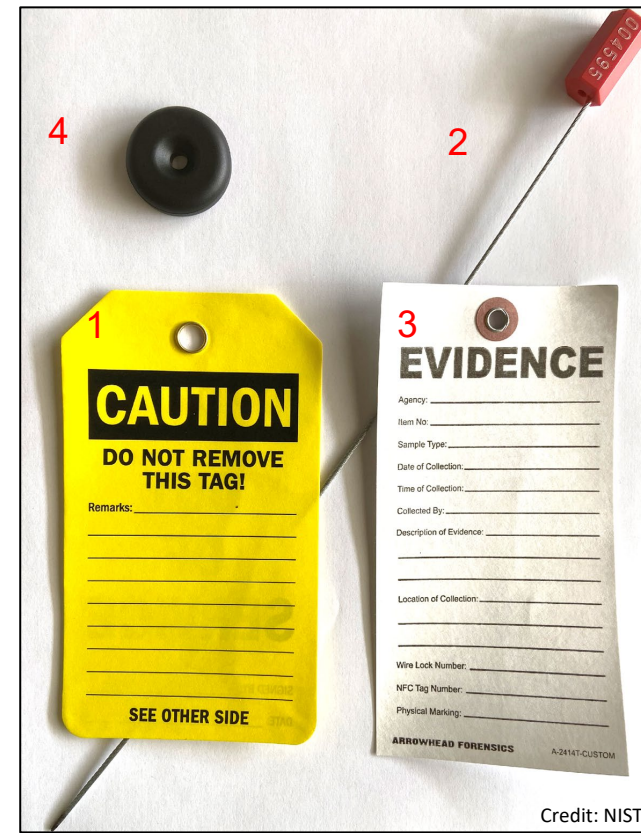


Physical Evidence Tagging

Physical evidence specimens were tagged with (1) paper tags and (2) wire lock tags

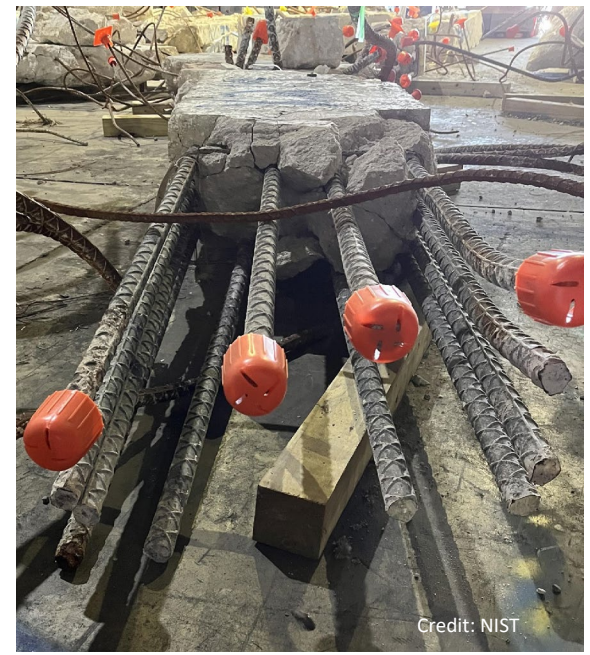
Physical evidence specimens were next tagged with (3) detailed paper tags and (4) radio-frequency induction (RFID) tags

NIST physical evidence database entries for specimens are securely accessed by reading RFID tags with a NIST mobile device.



Basic Structural Measurements and Documentation

Columns
and Beams



Credit: NIST

Slabs and
Walls



Credit: NIST

Structural Measurements: [Sample: 450 DEMO](#)

Column/Beam Overall Observations [↗](#)

Design Width	Design Depth	Sample height (column)/Sample length (beam)
13	12	120
☐ Multi story	Number of stories	
	Number of stories	

Cross Sections [↗](#)

Bottom of column is denoted as "i" and top of column is denoted as "j". If column is multi-story, select "i.#" for bottom and "j.#" for top of columns in individual stories. Faces of columns are labeled 1-4 clockwise from the top face with respect to "i".

Cross Section 1	Cross Section 2	Cross Section 3	Cross Section 4
Cross-Section Location	Number of Bars	Number of Splice Bars	Number of Nominal Splice Bars
i.2	4	Number of Splice Bars	Number of Nominal Splice Ba

Individual Longitudinal Reinforcing Bar Observations (1) [↗](#)

Start with top-left rebar and go clockwise labeling a-z.

Location	ASTM standard	Production mill	Steel type	Bar size
a	ASTM A615	8-	S	8.00000
Grade mark	Inner dia.	Outer dia.	Notes	
60.00000	0.93900	1.15300	Notes	

Identification Clues and Documentation

Sample: 450 DEMO



Identification Status

Probable location determined

Identification Clues

☐ Beige exterior paint

Description

☐ Waterproof membrane

Description

☐ Carpet tack strip or red carpet foam residue

Description

Combining Datasets to Determine Specimen Origin

Sample: 450 DEMO

Identification Status

Probable location determined

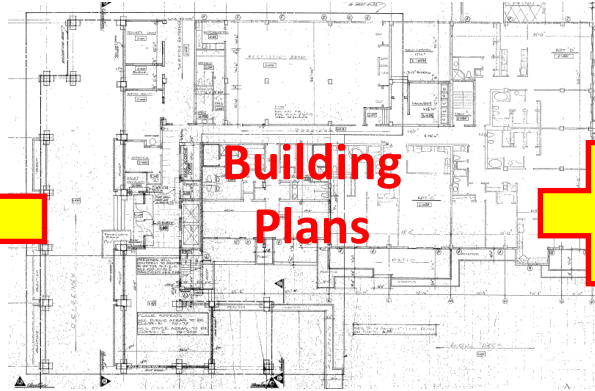
Identification Clues

☐ Beige exterior paint

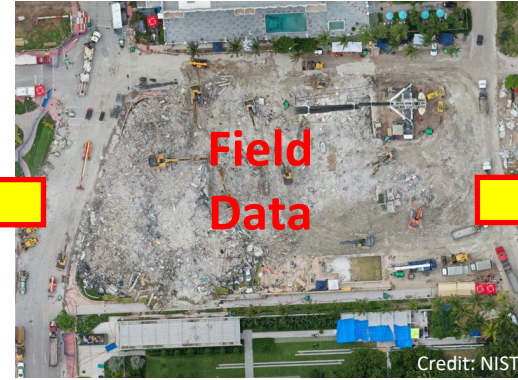
☐ Waterproof membrane

☐ Carpet tack strip or red carpet foam residue

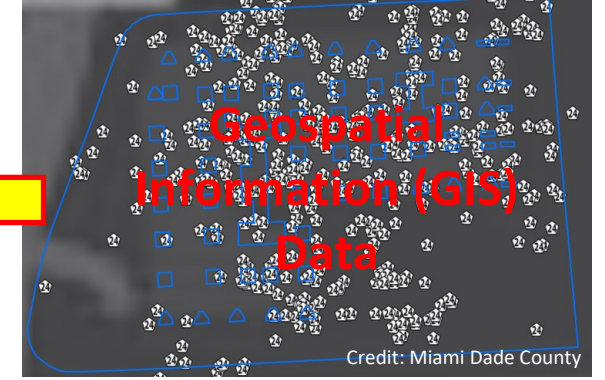
**Structural
Measurements
and
Identification
Clues**



**Building
Plans**



**Field
Data**

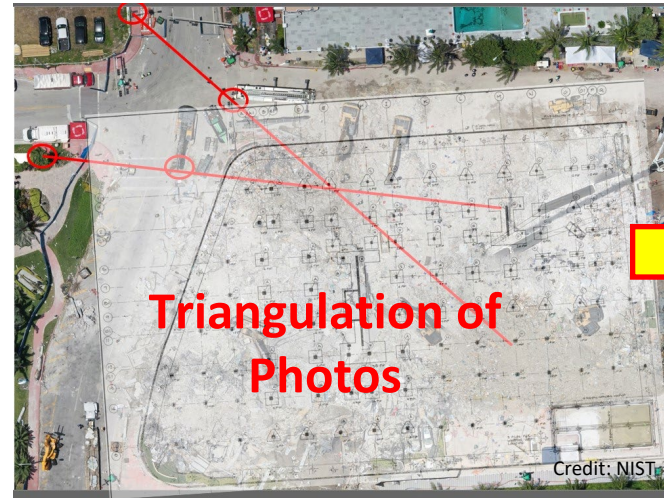


**Geospatial
Information (GIS)
Data**

Credit: Miami Dade County

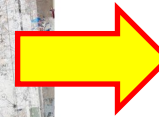


**Timeline of
Floor Level
Reached by
Responders**



**Triangulation of
Photos**

Credit: NIST



Original Location in Building

Sample type: Beam

Type of slab/shear wall

☐ Unknown

☐ Plaza (9.5 in)

☐ Balcony (8 in tapered to 7.25 in)

☐ Interior

☐ Interior Edge

☐ Foundation

☐ Roof Slab

☐ East Shear Wall

☐ West Shear Wall

☐ West Shear Wall Stem

Beam Type

Beam Type

☐ Transfer Girder Beam

Number of stories

Number of stories

Possible locations

Location

Building Floors

☐ Unknown

☐ Machine Rm. Roof

☐ Machine Rm. Floor

☐ Penthouse Roof

☐ 13th Floor (Penthouse)/Roof top

☐ 12th Floor

☐ 11th Floor

☐ 10th Floor

☐ 9th Floor

☐ 8th Floor

☐ 7th Floor

☐ 6th Floor

☐ 5th Floor

☐ 4th Floor

☐ 3rd Floor

☐ 2nd Floor

☐ 1st Floor/Lobby

☐ Parking Garage/Basement

Schedule Type(s)

☐ Unknown

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

☐ G

☐ H

☐ I

☐ J

☐ K

☐ L

☐ M

☐ N

☐ O

☐ P

☐ Q

☐ R

☐ S

☐ T

☐ X

☐ Y

☐ Z

Number of longitudinal bars

Longitudinal bar size

Possible Map Points (Show Map)

**Identification of
Specimen Origin
Documented in
Database**

Credit: NIST

Two-story column

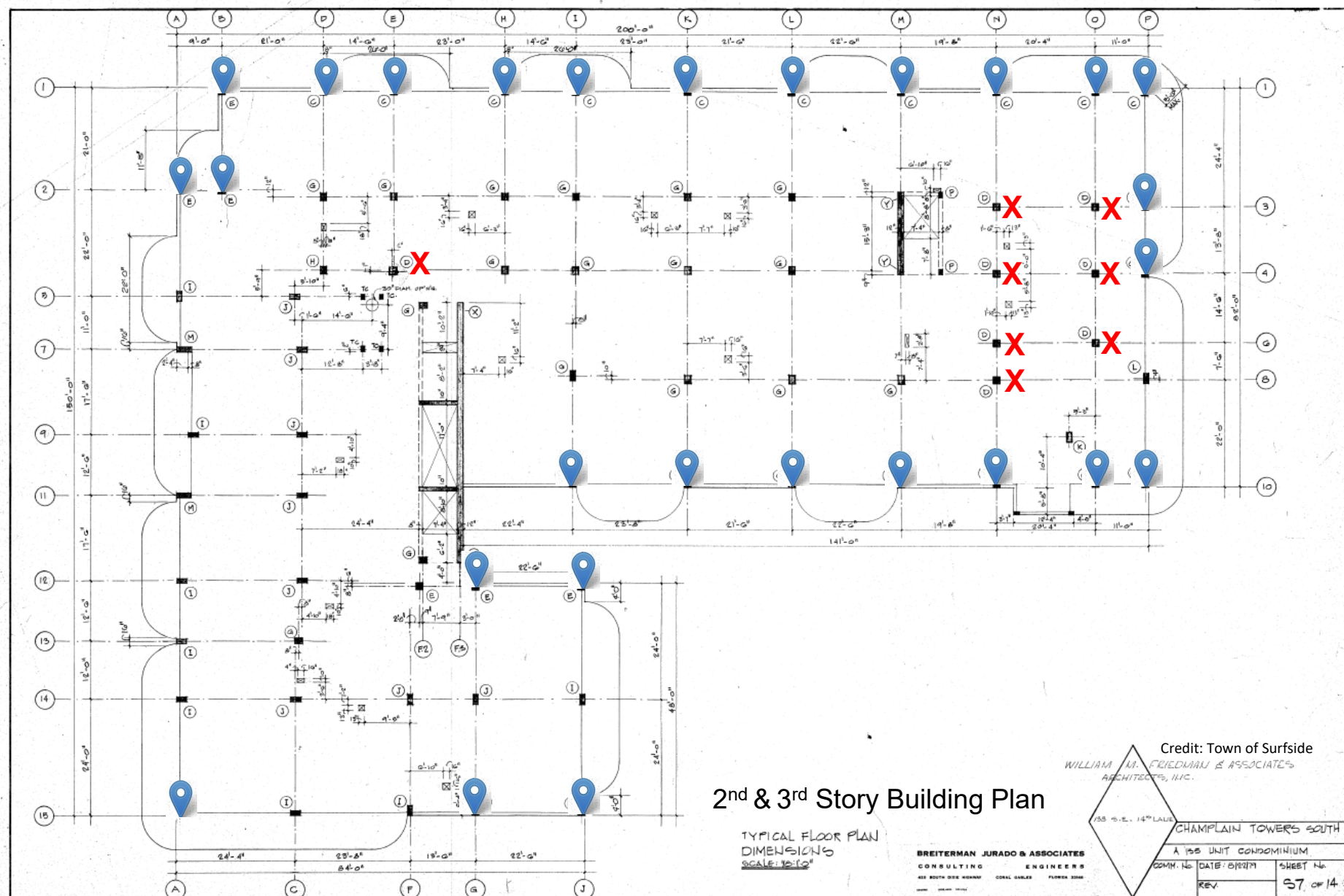


TYPE	(A)	(B)	(C)	(D)	(E)
SIZE	24' x 24'		16' x 16'	16' x 16'	16' x 16'
MACH. RM. ROOF	+139'-0"				
MACH. RM. FLOOR	+130'-0"				
ROOF	+124'-0"		4#8	4#8	4#8
12TH FLOOR (PENTHOUSE)	+119'-4"				
11TH FLOOR	+108'-0"				
10TH FLOOR	+94'-8"				
9TH FLOOR	+88'-10"				
8TH FLOOR	+80'-0"			4#8	4#8
7TH FLOOR	+71'-0"			6#8	6#9
6TH FLOOR	+62'-4"			8#8	8#9
5TH FLOOR	+53'-0"			8#8	8#9
4TH FLOOR	+44'-8"			8#8	8#9
3RD FLOOR	+35'-0"			8#9	8#10
2ND FLOOR	+27'-0"			8#10	8#11
LOBBY PL.	+13'-4"	12#10 4 EF.		8#11 3 EF.	12#11 4 EF.
BASAMENT PL.	+0'-2"	12#10 4 EF.			
				COL. E-4 UP TO EL. +105'-6"	

Credit: William M. Friedman & Associates

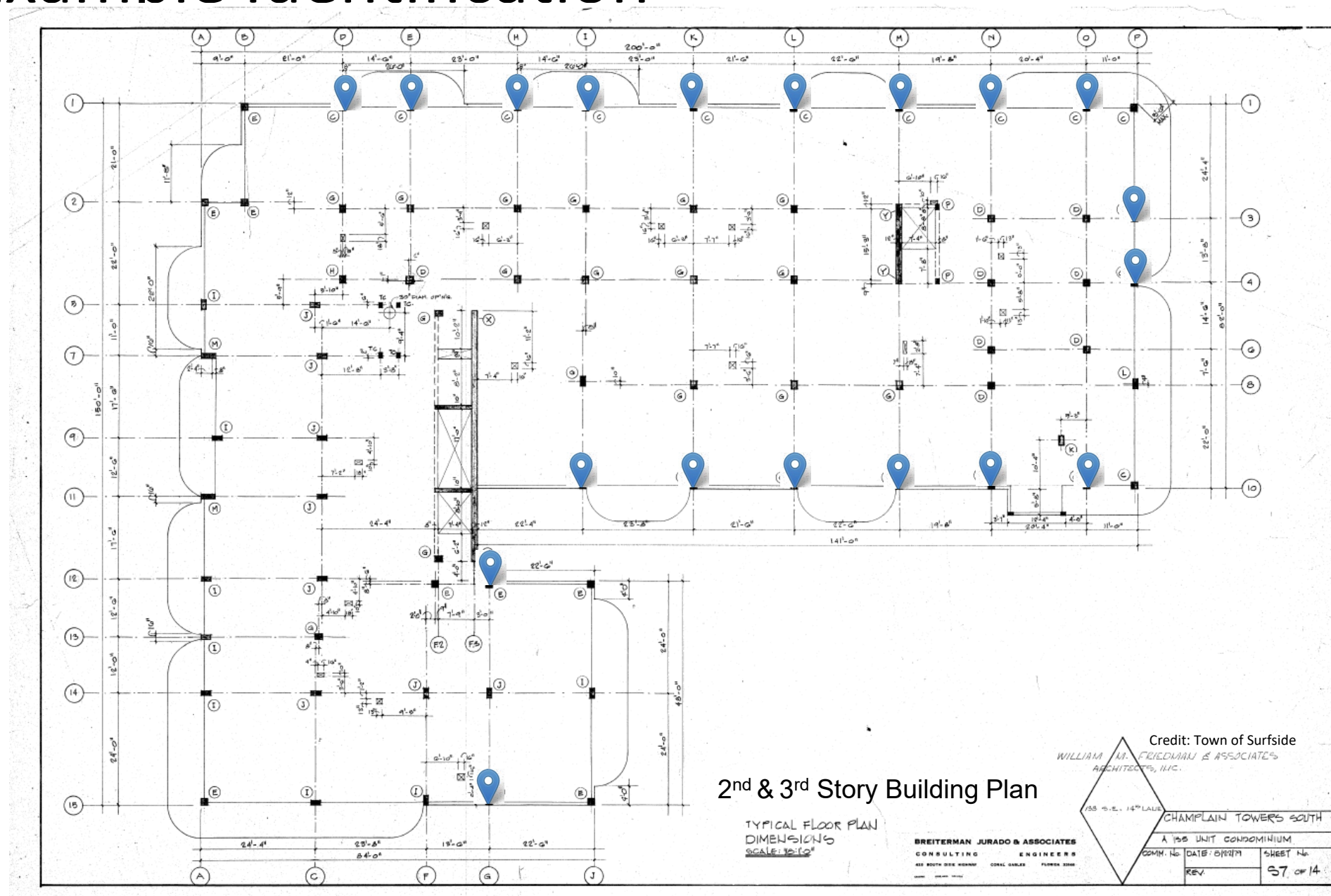
Example Identification

Blue = Location Possible



Example Identification

Blue = Location Possible

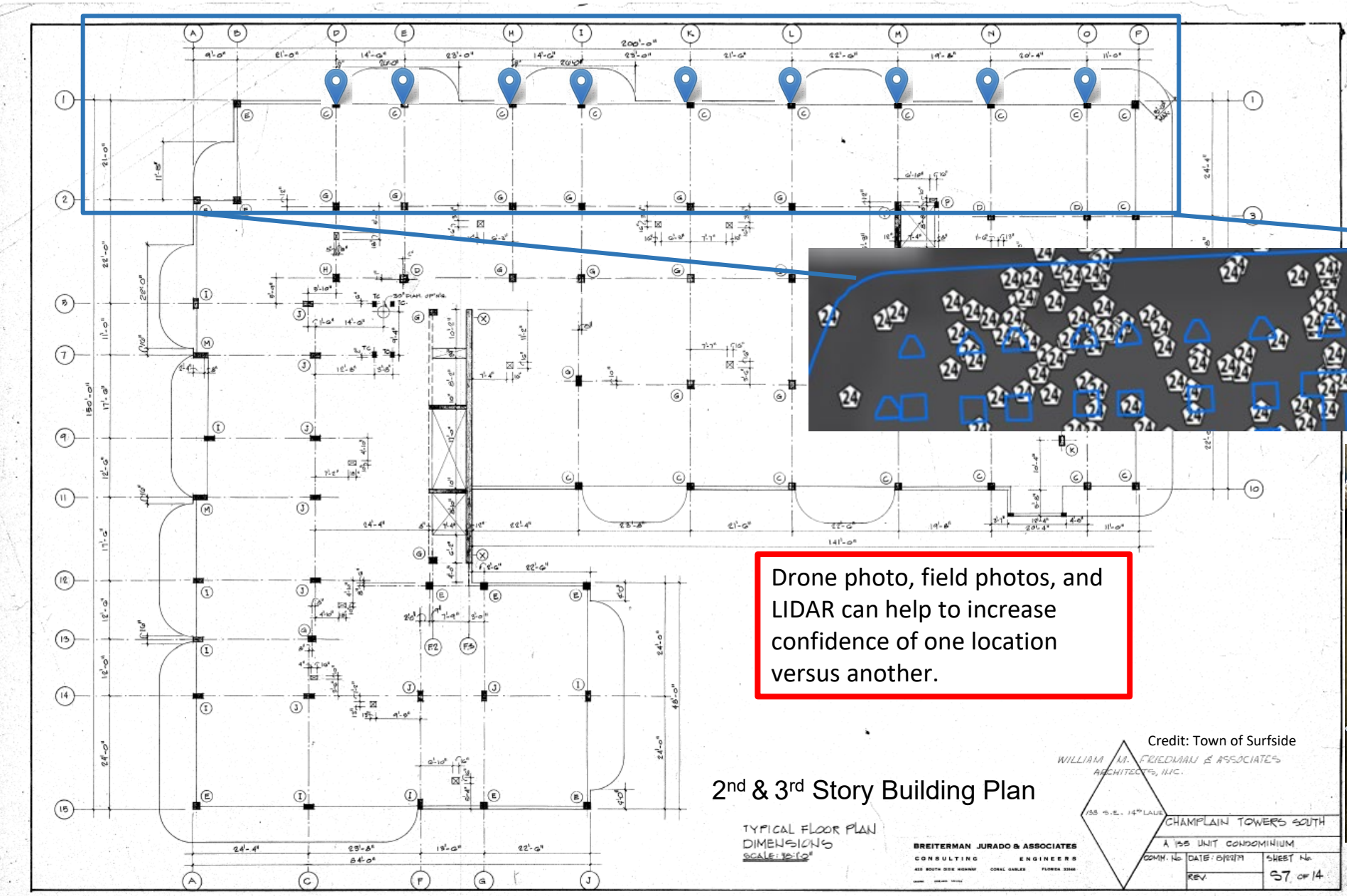


Example Identification

Blue = Location Possible

Geospatial Information System (GIS) Data

 = GIS point



Drone photo, field photos, and LIDAR can help to increase confidence of one location versus another.



3D Geospatial Model

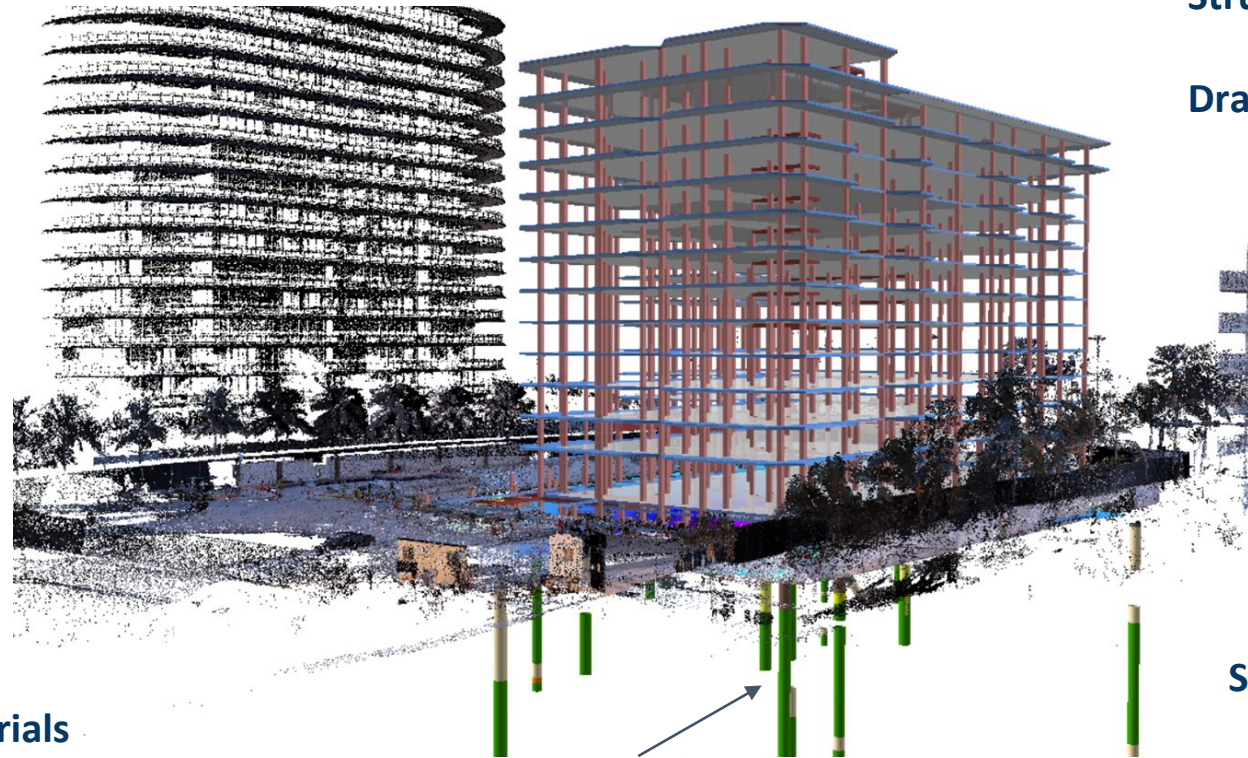
Why a 3D Model?

Data Compilation, Access, Visualization, Communication

Remote Sensing Data
Aerial Images
Surface Measurements
Photos & Videos

Site History Data
Historical Images
Building Records

Evidence
Building Materials
Interviews/Focus Groups
Audio recordings (911 calls)



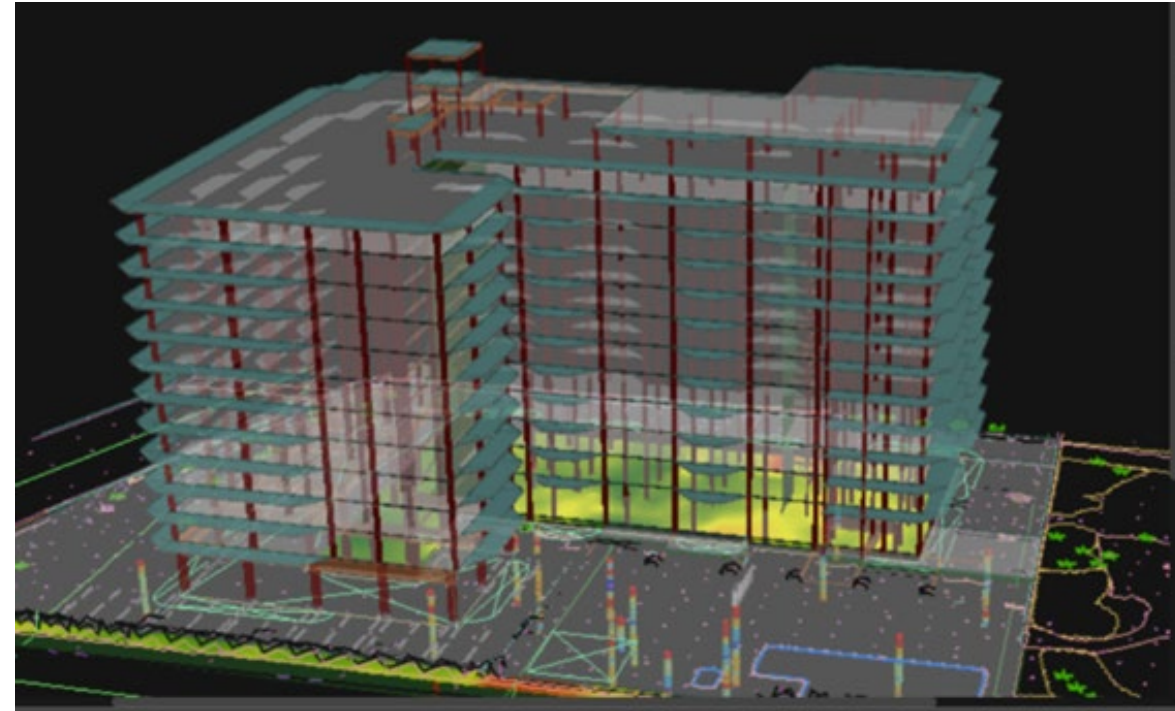
Structural Elements
Plans/Design
Drawings
Inspection reports

Material Testing
Non-Destructive
Destructive

Subsurface
Soil and Rock
Utilities
Groundwater

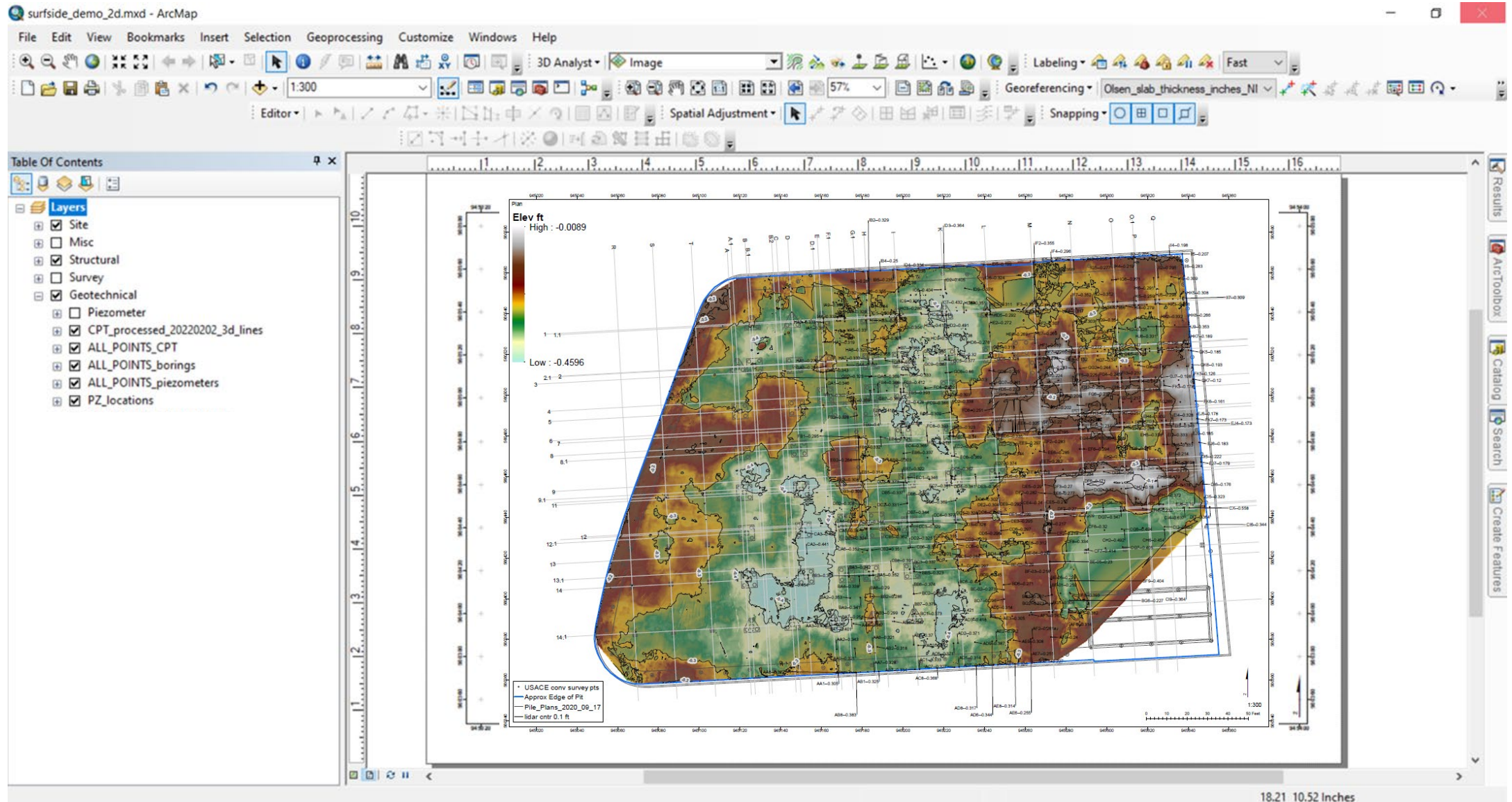
Evidence Visualization Model

- Base model developed based on Plan Drawings
- Additional data added to the model as it is obtained
- Data grouped in layers that can be turned on/off
- Features can be selected to see additional data



Preview Model Animation

14



Current Status of Visualization Efforts

Current Model Includes

Structural Elements

Subsurface Investigation Data

Survey and Remote Sensing Data

Historical Aerials and Maps

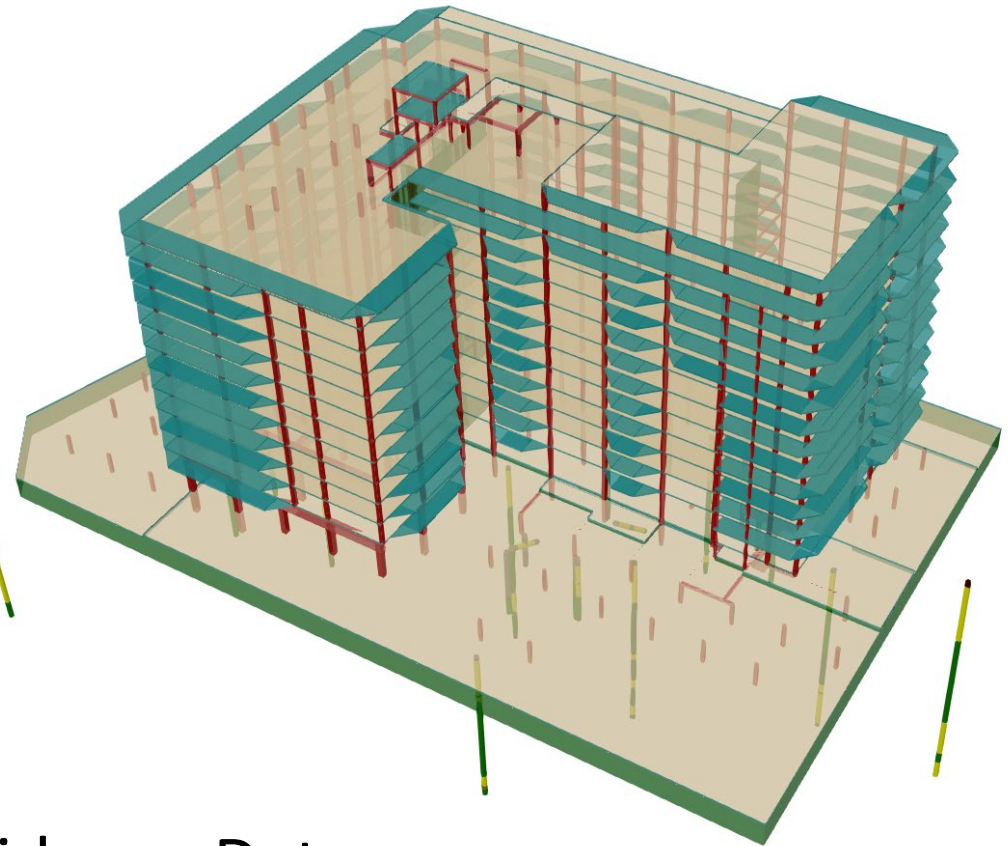
Work-in Progress

Adding additional data

- Material Test Results & Evidence Data

- Add Additional Photos, Imagery, and Recordings

Modifying Team Data Accessibility



Future Work - Video Animations of Failure Scenarios

Visualization of Failure Scenarios

Clear and concise presentation

Communication tool

Current Status

Scope of Work Development

Coordination with All Teams

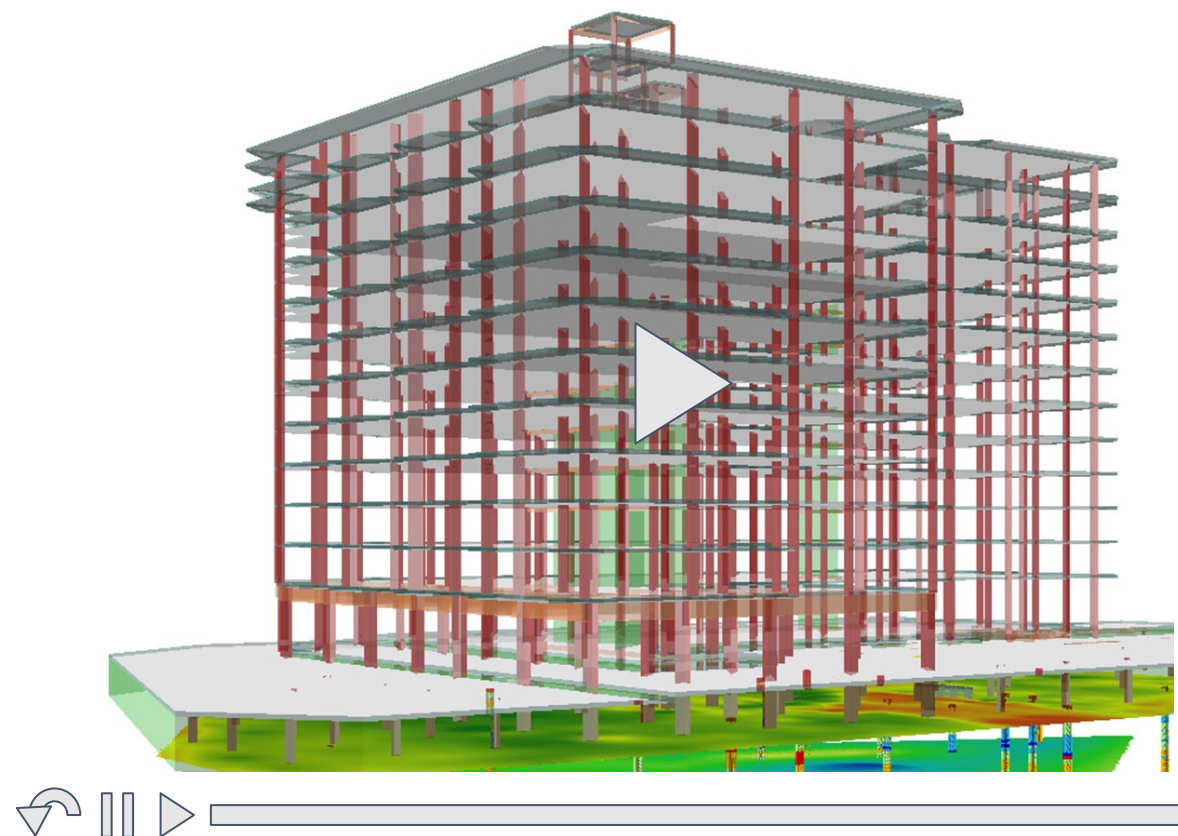


Illustration of Animation Concept

NCST Investigation of the Champlain Towers South Collapse

3D Visualization of Evidence

Presenters: David G. Goodwin, Jr.
Georgette Hlepas