FSBPA Annual Conference 2017

Technology & Coastal Management

Coastal Systems International, Inc • Inteli4 3D Scanning

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Drones, UAV's: What are these?

1. Remotely-Piloted Air Frame
2. Generally powered by batteries
3. Equipped with flight computer, GPS, storage and one or more sensors
4. Most use propellers
5. Some are launched horizontally, others vertically and some are hybrids

Drones, UAV's: The Core Technology and Benefits

CORE TECHNOLOGY

1. Light Airframe housing GPS, Propulsion System, Batteries, Flight Computer
2. Sensor(s): Visual, Video, 3-band, 5-band, LiDAR, Thermal, Hyper-spectral
3. Gimbal Mount
4. Remote Controller
5. Other payloads specific to application e.g. fertilizer pods, drop housing
6. [illegible] without Ground Control Points

BENEFITS

- Comparatively Low Entry Cost
- Easy to deploy
- Fast data acquisition
- Very High Resolution Data

How we use Drones: A Sampling of Applications

Beach Monitoring Surveys

Pre- and Post-Storm Assessments

Topographic Mapping

Producing High-resolution Ortho-Mosaics

Volumetric Surveys

Vegetation Mapping

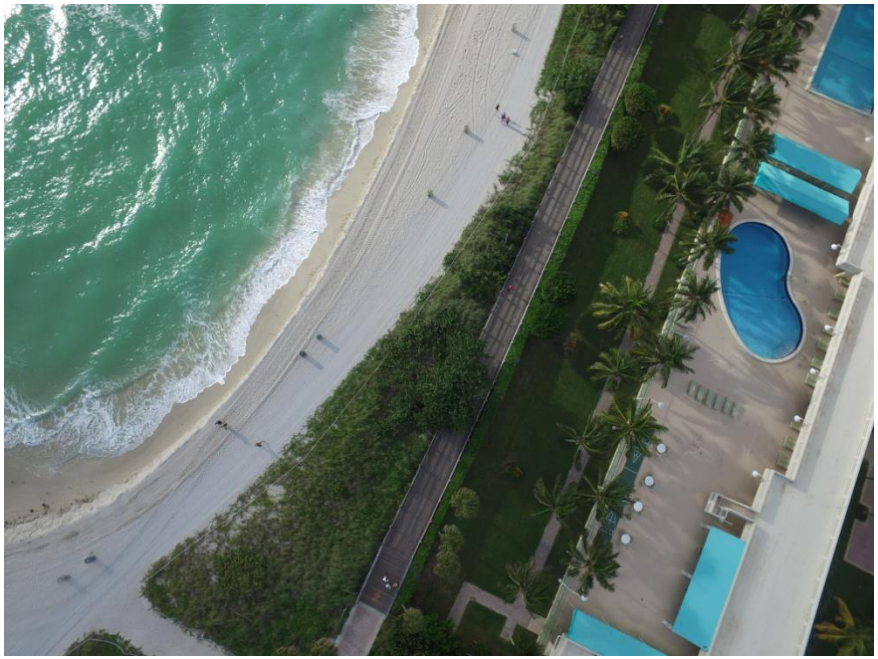
Vegetation Reflectance Mapping

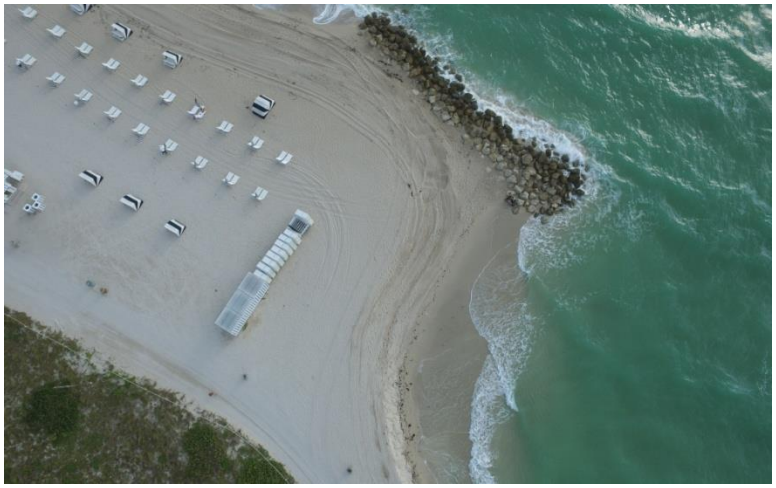
As-Built Maps

Volumetric Surveys and Construction Monitoring

As-Built Maps

Beach Surveys





Vegetation Mapping

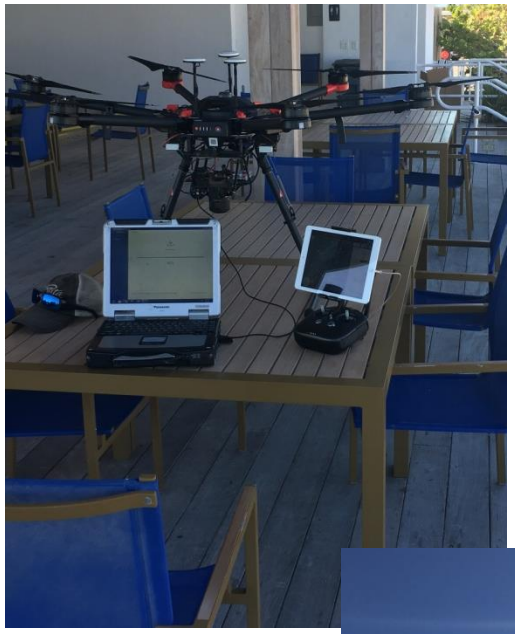
Large-Area Mapping

North Bay Village

- Altitude: 300 ft
- Survey Area: 400 Acres
- 1 pixel = 1.2 cm
- Number of GCP's = 25
- Hard Surfaces
- RTK GPS vs. Point Cloud
- Horizontal agreement: 0.5 in
- Vertical agreement: 1.15 in

UAV – Mapping Accuracy

- Based on Aerial Photography alone, equations default to inherent accuracy budget of low altitude Photogrammetry
- Horizontal Accuracies based on 2x the GSD while your Vertical Accuracy near 3x GSD.
- If you add LiDAR, achieved Vertical Accuracies approaching 1 – 1.5 cm (0.03 - 0.05 ft)
- Horizontal Accuracies either :
  - Relative : Measure of the accuracy of the data within itself
  - Absolute: Measure of the accuracy of the position of the data in the world
- To increase the Absolute Accuracy: Use Ground Control Points or RTK/PPK positioning.



Wetland Management

Simplified, this is divided into issues associated with:

1) natural wetland protection;
2) activities, involving natural wetlands, that are specifically exempted from regulatory requirements;
3) wetland creation and restoration; and
4) wetland construction for water quality improvement.

Wetland Management – Data Needs

Factors to Consider	Data Type
wetland type and landscape position	Ortho-photos, topography
surrounding land uses	ownership, zoning, geometry, location
cumulative impacts on the wetland	physical sampling, health assessment
vegetation quality	phenotyping, classification, health assessment, density
presence or absence of rare or endangered species	observations, cataloging, photography, classification, density assessments
surface water quality	physical sampling
wildlife habitat	topography, ground cover density, ground cover types, vegetation assessment
cultural values	population studies, classification, understanding cultural norms and expectations

*Red Text indicates demonstrated use of UAV Technology and Advanced Sensors

UAV Sensor Use in Plant Phenotyping

Application	Fluorescence Sensor	Multispectral Camera/ Color-Infrared Camera**	Hyperspectral Camera	Thermal Sensor/Camera	Spectrometer	3D Camera	Lidar Sensor
Canopy Density						X	
Chlorophyll	X						
Disease		X		X	X		
Nutrient Deficiency (Responses To)		X					
Photosynthesis	X						
Plant Height						X	X
Plant Stress			X				
Plant Volume							X
Produce Quality			X				
Stomatal Conductance				X			
Water Stress	X	X		X			

James Schett, Editor, http://www.photonics.com, Biophotonics, April 2016

Combining Aerial and Terrestrial Data Collection

Benefits

- Recreating the existing environment increases the clarity of the problems created by the event.
- Produces adequate accuracies at the mapping level and simultaneously at the structures level
- Significantly faster data collection
- Significantly faster deliverables
- Ease of repeatability of surveys
- Ability to survey once and analyze in more than one way for more than one discipline e.g. topography, hi-resolution imaging, vegetation mapping, inundation mapping, structures surveys, erosion and accretion, damage assessment etc.

Terrestrial Laser Scanner – What is it?

1. Ground-based high-tech laser equipment (TLS)

2. Real world analysis and data collection

3. Records target position (X,Y,Z), intensity, and color (RGB) generating Point Cloud data

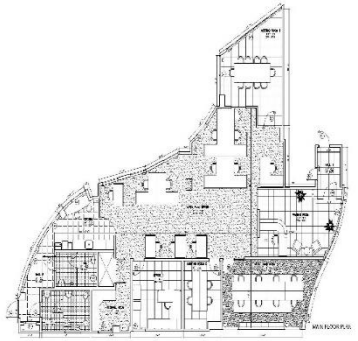
4. Precision at mm accuracy

Terrestrial Laser Scanner – What are the Benefits?

1. It brings the outdoor environment to an indoor workstation

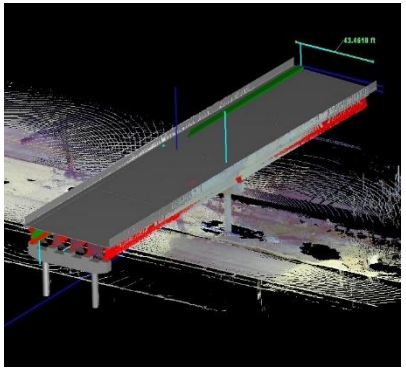
2. Fast and accurate measurements

3. Generation of 2D and 3D as-built drawings



4. Combination with GPS for time series measurements

5. Point Cloud and Post-process data files compatibility



Terrestrial Laser Scanner – Possible Uses

1. Creation of 2D and 3D as-built drawings of infrastructure for maintenance, expansion or rebuild

2. Aid in predicting risk of coastline infrastructure change caused by long-term events

3. Pro-active approach in performing rehabilitation of infrastructure affected by natural disasters

Terrestrial Laser Scanner – Possible Uses

Steps:

- Definition of a strategic risk map (classifying / prioritizing areas / facilities)
- Pre-event assessment / scan of all infrastructure (updated log)
- Post-event assessment / scan of all infrastructure damaged
- Technical analysis of the changes in order to make decisions aiming to better protect local population, infrastructure and coastline
- Rebuilt plans

Using TLS for monitoring changes before and after natural disasters is ***FASTER, MORE ACCURATE, MORE AFFORDABLE, AND USES LESS RESOURCES*** *in the field, compared to traditional surveying method.*

Terrestrial Laser Scanner – Hillsboro Inlet

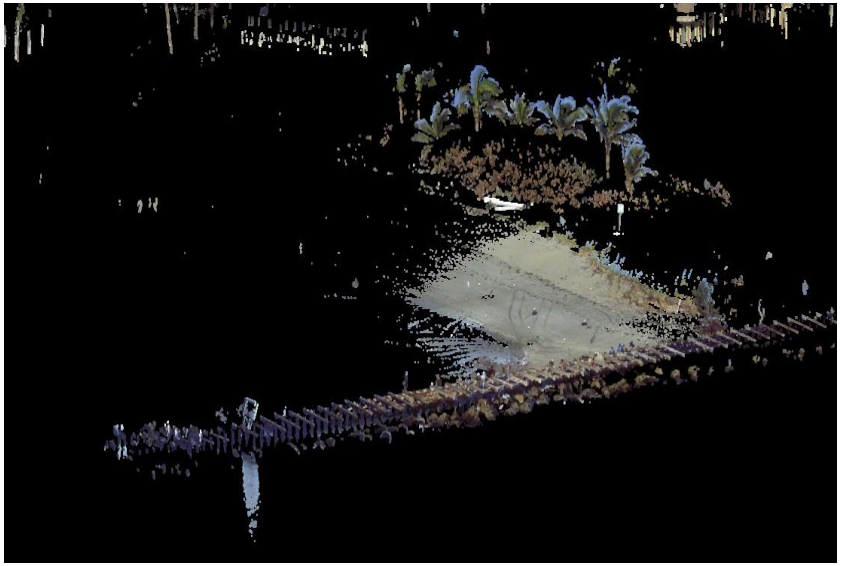
Sample Study: Hillsboro Inlet

Overall View of Study Area

Terrestrial Laser Scanner – Hillsboro Inlet

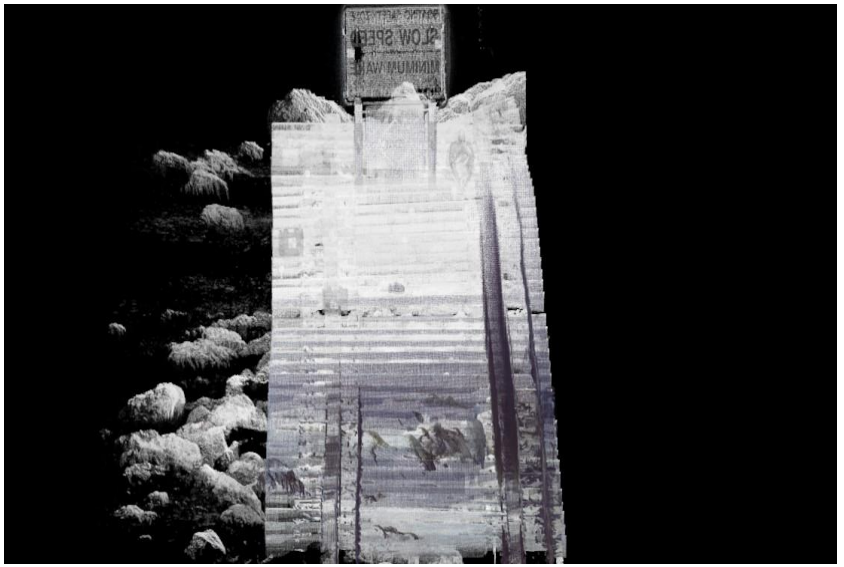
BEFORE HURRICANE IRMA

AFTER HURRICANE
IRMA-
SMALLER SURVEY AREA

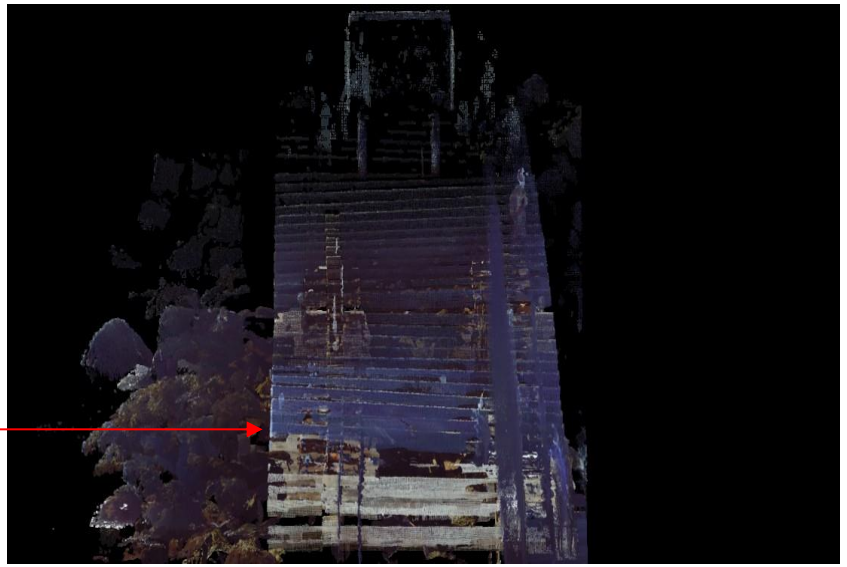


Terrestrial Laser Scanner – Hillsboro Inlet

BEFORE HURRICANE IRMA

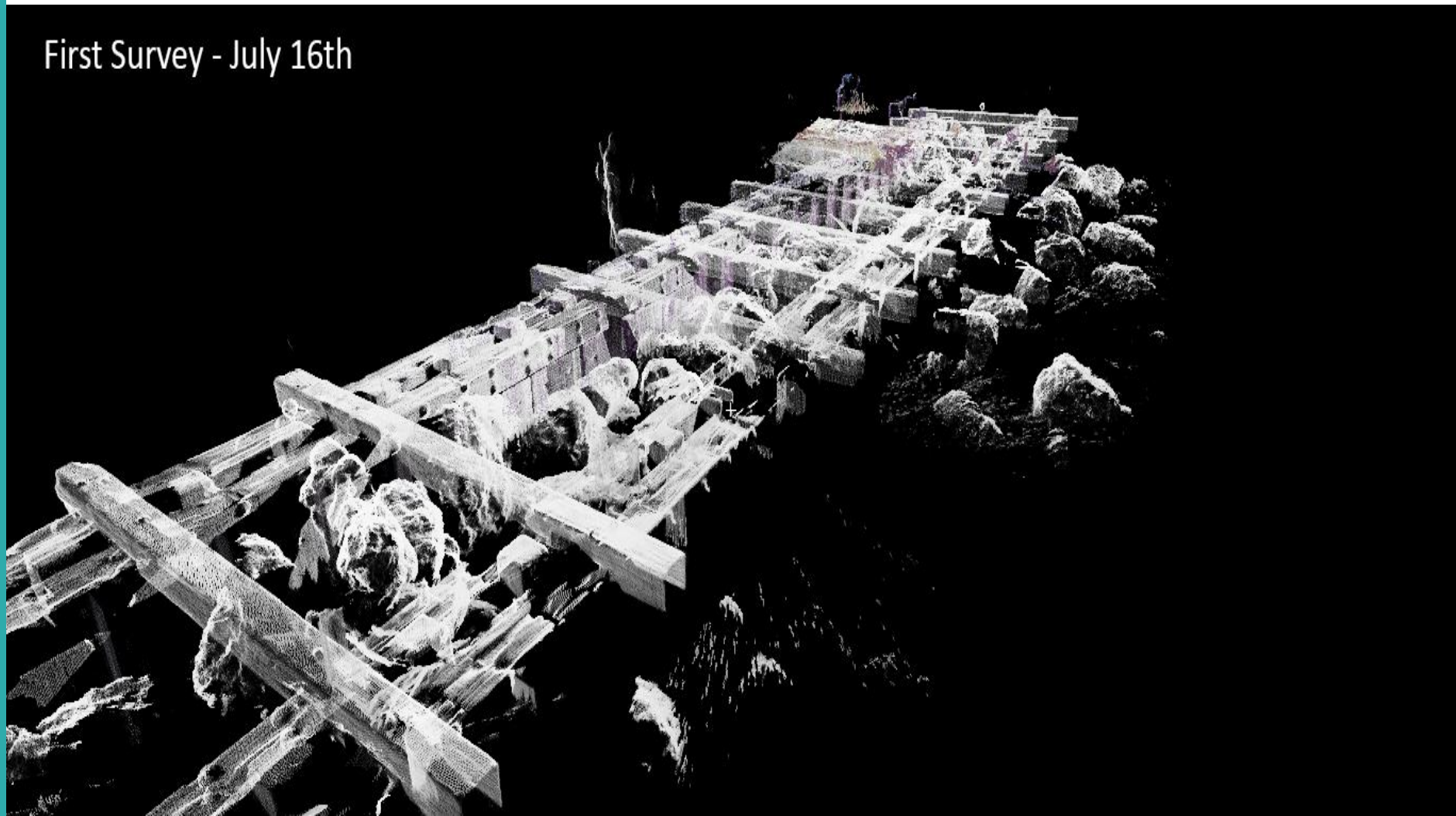


AFTER HURRICANE
IRMA-
DISTORTIONS FOUND Pier torsion



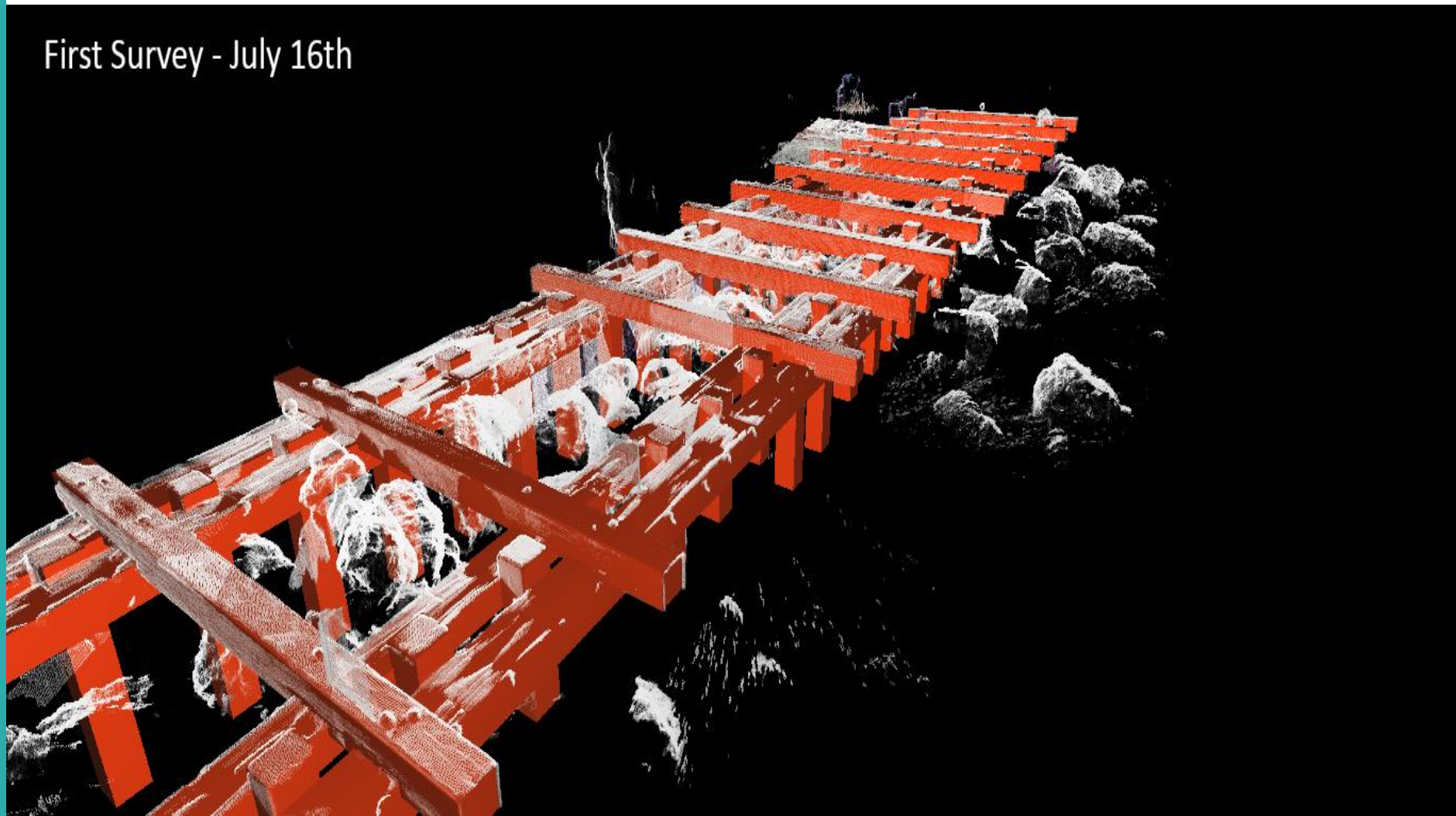
Terrestrial Laser Scanner – Hillsboro Inlet

Point Cloud Data before Hurricane Irma



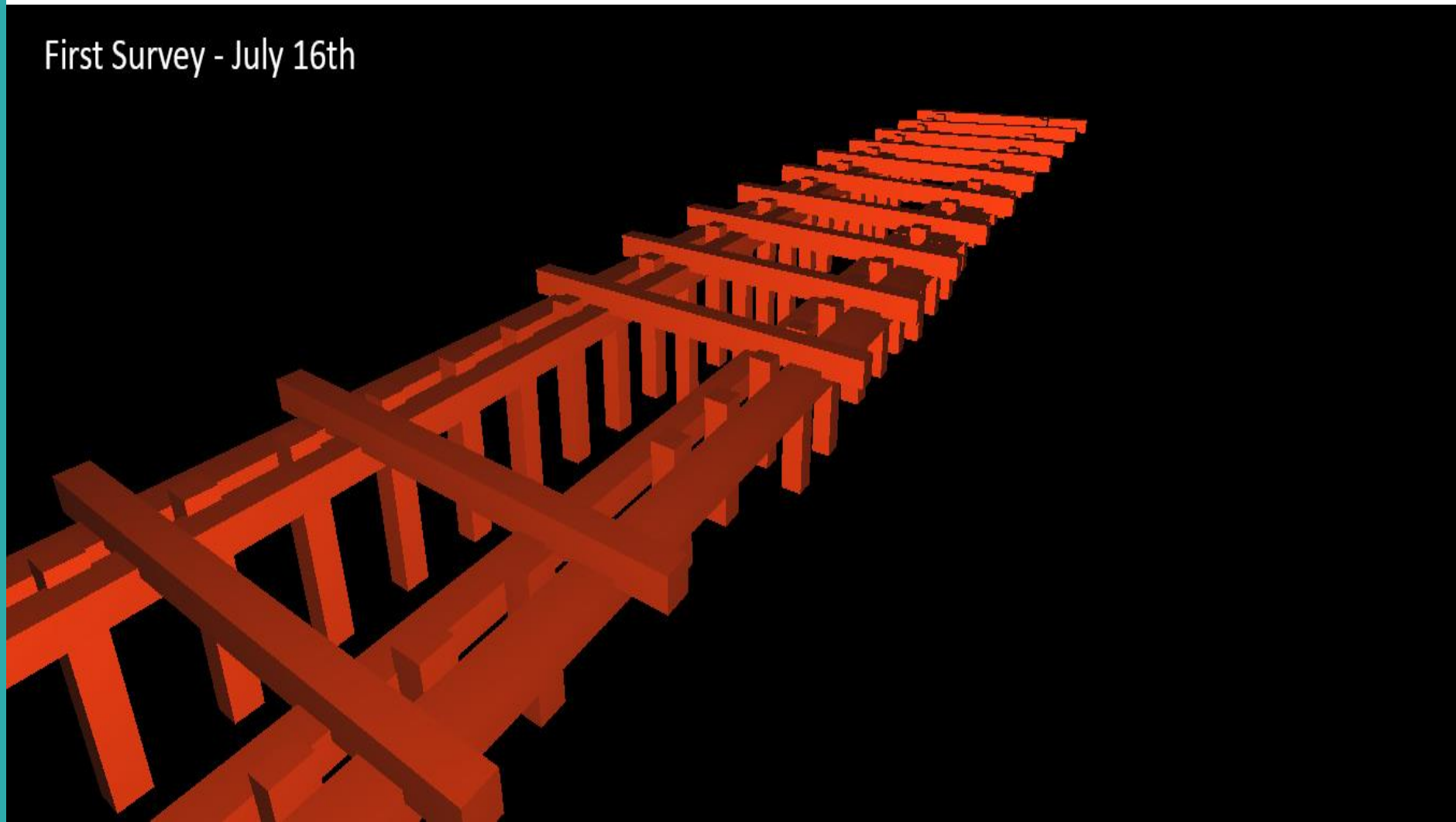
Terrestrial Laser Scanner – Hillsboro Inlet

Extracted Element Geometric information- Point Cloud post-processing



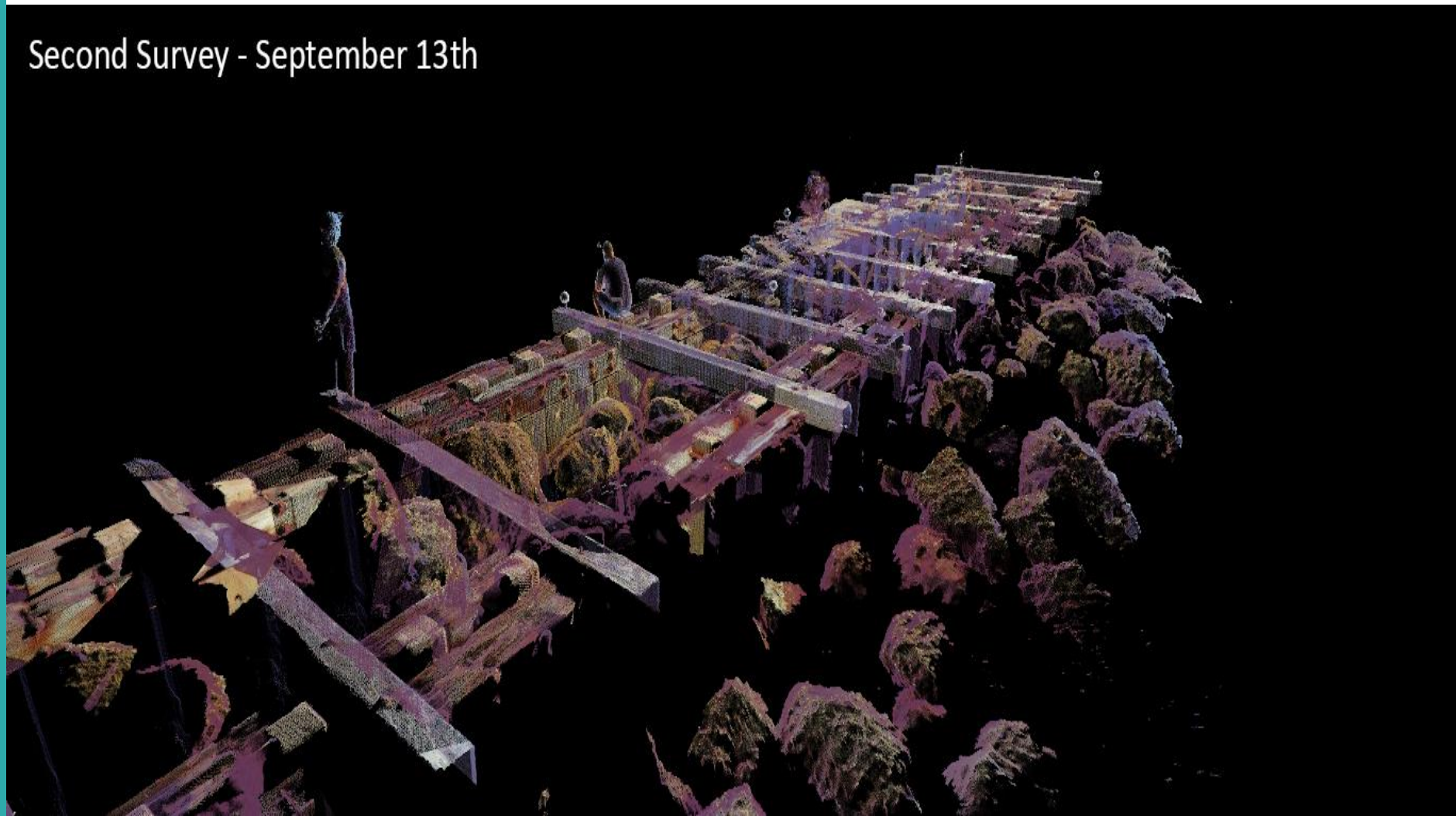
Terrestrial Laser Scanner – Hillsboro Inlet

3D model for analysis and easy understanding



Terrestrial Laser Scanner – Hillsboro Inlet

Point Cloud Data after Hurricane Irma



Terrestrial Laser Scanner – Hillsboro Inlet

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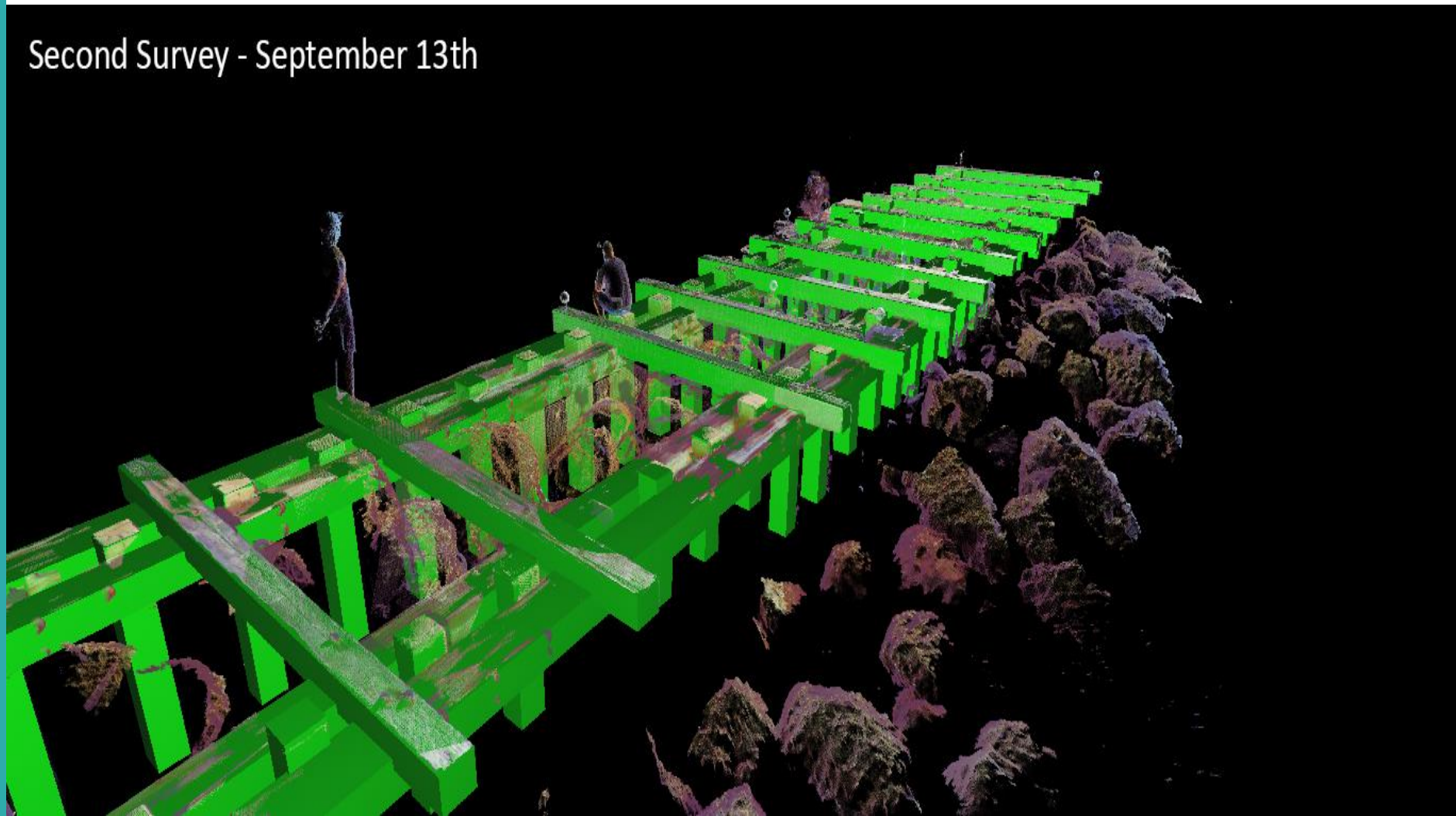
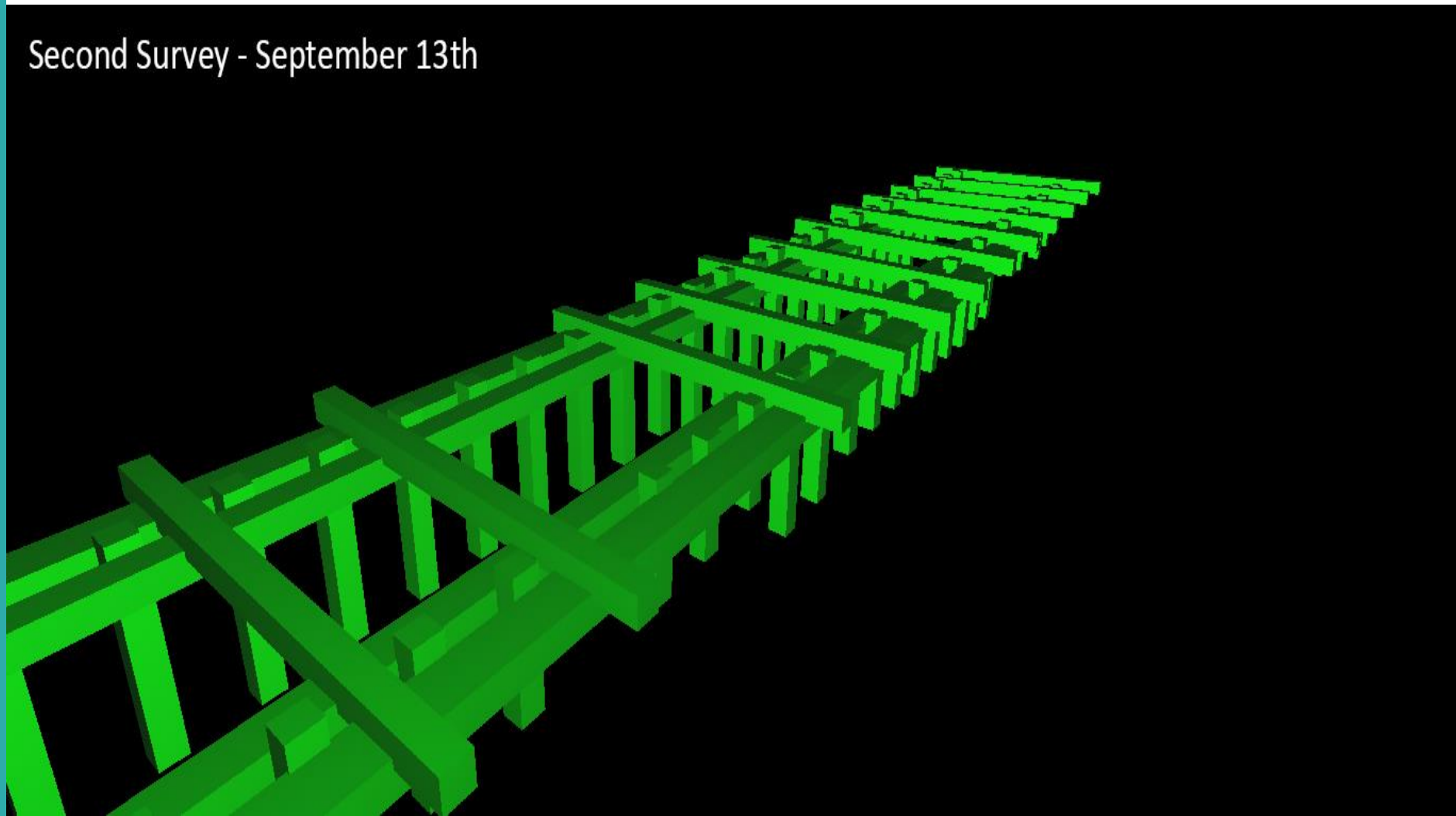


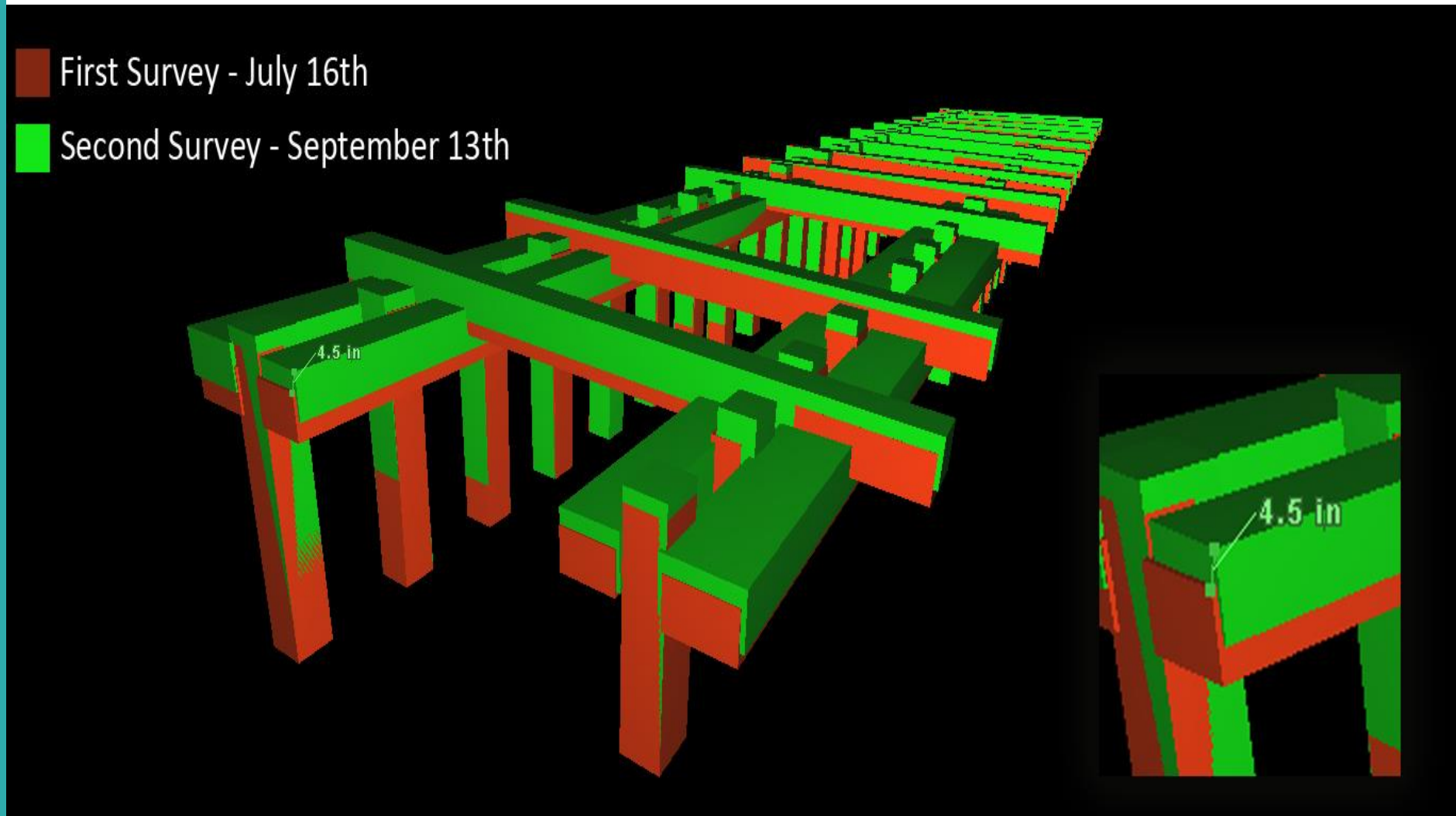
Terrestrial Laser Scanner – Hillsboro Inlet

3D model for analysis and easy understanding



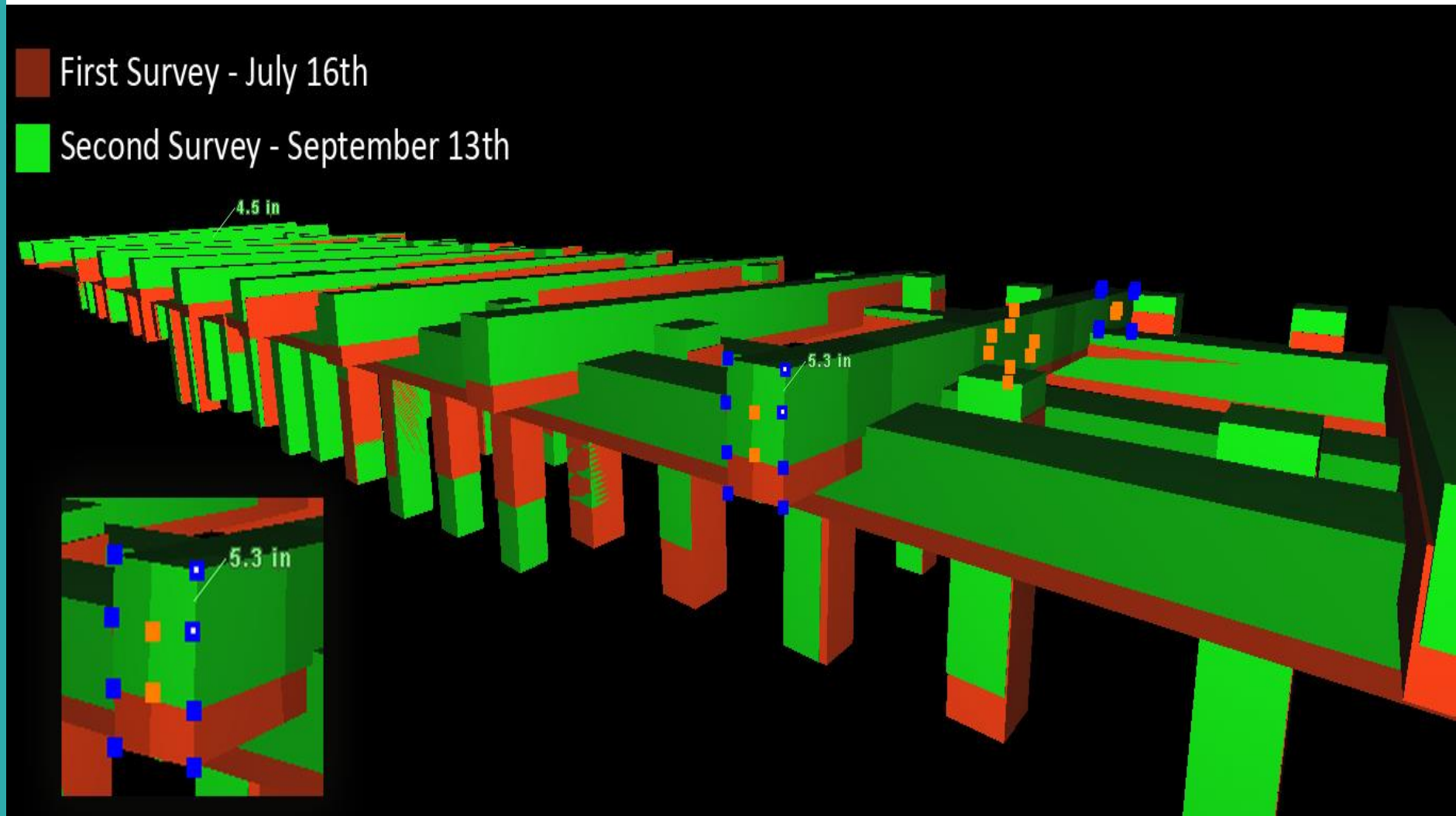
Terrestrial Laser Scanner – Hillsboro Inlet

Pre and Post 3D models overlapped – primary analysis



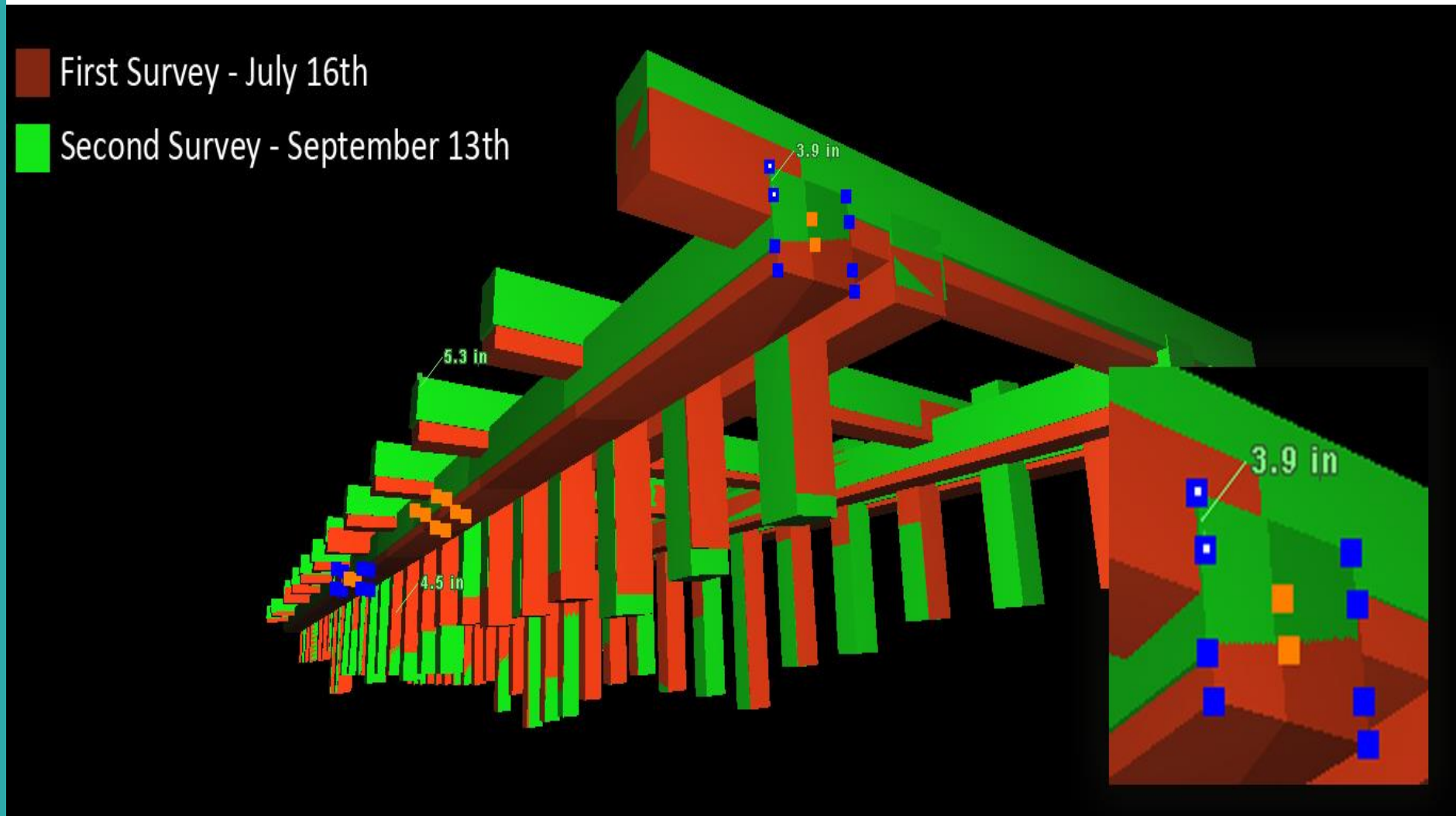
Terrestrial Laser Scanner – Hillsboro Inlet

Detailed 3D model overlapped – primary analysis



Terrestrial Laser Scanner – Hillsboro Inlet

Detailed 3D model overlapped – primary analysis



Conclusions

- Using Aerial Mapping techniques and LiDAR sensors, one can achieve near or equivalent GPS RTK Accuracies in open areas with the right combination of equipment specs and ground control.
- Combining Terrestrial Laser Scanner data enhances the product by delivering very high accuracies on hard structures.
- High accuracy 3D models of structures allows for more detailed deformation and damage analysis.
- A comprehensive plan for regular surveys and/or pre- and post- event surveys at specific or high-value locations can help promote realistic design expectations.

Technology & Coastal Management

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