HURRICANE DORIAN

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DATA REPORT

Members of FAST-1 (above), entire FAST-2 PA Team (below), US-based FAST-2 members (right)

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PREFACE

The National Science Foundation (NSF) awarded a 2-year EAGER grant (CMMI 1841667) to a consortium of universities to form the Structural Extreme Events Reconnaissance (StEER) Network (see https://www.steer.network for more details). *StEER builds societal resilience by generating new knowledge on the performance of the built environment through impactful post-disaster reconnaissance disseminated to affected communities.* StEER achieves this vision by: (1) deepening structural engineers' **capacity** for post-event reconnaissance by promoting community-driven standards, best practices, and training, as well as their understanding of the effect of natural hazards on society; (2) **coordination** leveraging its distributed network of members and partners for early, efficient and impactful responses to disasters; and (3) **collaboration** that broadly engages communities of research, practice and policy to accelerate learning from disasters. StEER works closely with other extreme event reconnaissance organizations and the Natural Hazards Engineering Research Infrastructure (NHERI) to foster greater potentials for truly impactful interdisciplinary reconnaissance after disasters.

Under the banner of NHERI's CONVERGE node, StEER works closely with the wider Extreme Events Reconnaissance consortium including the Geotechnical Extreme Events Reconnaissance (GEER) Association and the networks for Nearshore Extreme Event Reconnaissance (NEER), Interdisciplinary Science and Engineering Extreme Events Research (ISEEER) and Social Science Extreme Events Research (SSEER), as well as the NHERI RAPID equipment facility and NHERI DesignSafe CI, long-term home to all StEER data and reports. While the StEER network currently consists of the three primary nodes located at the University of Notre Dame (Coordinating Node), University of Florida (Atlantic/Gulf Regional Node), and University of California, Berkeley (Pacific Regional Node), StEER aspires to build a network of regional nodes worldwide to enable swift and high quality responses to major disasters globally.

StEER's founding organizational structure includes a governance layer comprised of core leadership with Associate Directors for each of the primary hazards as well as cross-cutting areas of Assessment Technologies and Data Standards, led by the following individuals:

- **Tracy Kijewski-Correa (PI),** University of Notre Dame, serves as StEER Director responsible for overseeing the design and operationalization of the network and representing StEER in the NHERI Converge Leadership Corps.
- **Khalid Mosalam (co-PI),** University of California, Berkeley, serves as StEER Associate Director for Seismic Hazards, leading StEER's Pacific Regional node and serving as primary liaison to the Earthquake Engineering community.
- **David O. Prevatt (co-PI),** University of Florida, serves as StEER Associate Director for Wind Hazards, leading StEER's Atlantic/Gulf Regional node and serving as primary liaison to the Wind Engineering community.
- **Ian Robertson (co-PI),** University of Hawai'i at Manoa, serves as StEER Associate Director for Assessment Technologies, guiding StEER's development of a robust approach to damage assessment across the hazards.
- **David Roueche (co-PI),** Auburn University, serves as StEER Associate Director for Data Standards, ensuring StEER processes deliver reliable and standardized reconnaissance data suitable for re-use by the community.

ACKNOWLEDGMENTS

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Data was collected in part using equipment provided by the National Science Foundation as part of the RAPID Facility, a component of the Natural Hazards Engineering Research Infrastructure, under Award No. CMMI: 1611820. StEER is grateful for the partnership with the NHERI RAPID Equipment Facility at the University of Washington and the efforts of Jeff Berman and Joe Wartman, as well as the support of Catlin Bourassa and Jacqueline Peltier in making this challenging and swiftly mobilizing mission possible.

Special thanks also go to Steve Pece and his associates for their active participation and outstanding logistical support in the FAST-1 deployment, including securing transportation, lodging, and other resources. His services and resources were invaluable to the success of this mission and the safety of our team. We are especially thankful for his proactive outreach to StEER, which made this mission possible. Special thanks also to Spatial Networks and Fulcrum Community, for providing an efficient platform to both capture and share high quality reconnaissance datasets. We also thank StEER FAST-2 member Andrew Kennedy for his efforts to secure high-resolution satellite imagery in support of FAST-1's mission, as well as Notre Dame undergraduate Andrew Copp for his processing of this debris from this imagery.

The sharing of videos, damage reports and briefings via Slack by the entire NHERI community was tremendously helpful and much appreciated. StEER further recognizes the efforts of the DesignSafe CI team who continuously supported and responded to StEER's emerging needs.

For a full listing of all StEER products (briefings, reports and datasets) please visit the StEER website: https://www.steer.network/products

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Note: See Appendix C for the standard StEER glossary which defines many of the mission-specific terminology used in this report. See Appendix D for a standard list of StEER Acronyms (not all are used in this report).

1.0 Event Summary and Team Configuration

Hurricane Dorian struck the northwest Bahamas with remarkable and long-lasting ferocity, attaining estimated maximum gust wind speeds exceeding 200 mph and storm surge estimated upwards of 20 ft above mean sea level. StEER's previously published reports for additional information on Hurricane Dorian:

Preliminary Virtual Reconnaissance Report (PVRR)	PRJ-2549	https://doi.org/10.17603/ds2-saf8-4d32
Early Access Reconnaissance Report (EARR)	PRJ-2555	https://doi.org/10.17603/ds2-4616-1e25

In response, two Field Assessment Structural Teams (FASTs) were activated, drawing from StEER members with requisite expertise and availability. The surveyed regions are summarized in Figure 1.1 and were assessed by the following teams:

- FAST-1 was a single scout team deployed between 24-26 September 2019, utilizing Door-to-Door assessments and Applied StreetView imaging from the NHERI RAPID Facility to document structural performance of buildings and other structures across Marsh Harbour and Treasure Cay on Great Abaco Island.
- FAST-2 featured a blend of practitioners and researchers, including Bahamian Engineers, and was organized under three subteams: (i) a Coastal Survey Team to map coastal storm surges, (ii) a Rapid Imaging Team to rapidly image significant wind and storm surge damage using 360-imaging and Applied StreetView technologies from the NHERI RAPID Facility, and (iii) a Performance Assessment (PA) Team to conduct in-depth forensic assessments using StEER's mobile applications and lidar scanning. FAST-2 focused on targets on Great Abaco Island, Man-o-War Cay, and Grand Bahama Island between October 5-8, 2019.

Members of FAST-1 and FAST-2 are summarized in Table 1.1. Following the reconnaissance effort, a team of student Data Librarians were trained to execute StEER's Data Enrichment and Quality Control (DEQC) process described in Section 4.1. These Data Librarians are listed in Table 1.2.

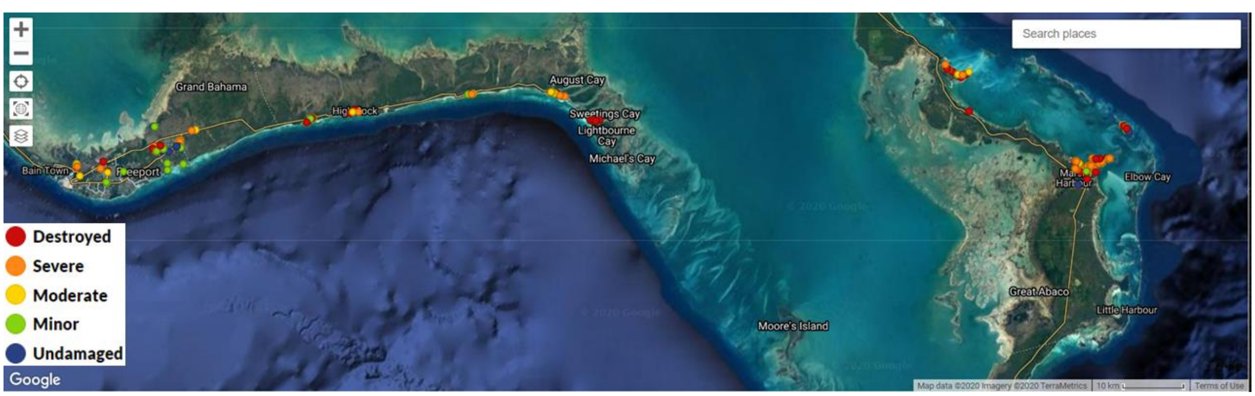


Figure 1.1. Map of assessed regions extracted from Fulcrum App. Performance Assessments are color coded by overall damage rating.

Table 1.1. Team Members and Dates of Field Work		
FAST-1: 24-26 September 2019		
Team Member	**Affiliation**	**Team Assignment**
Andrew Lyda	University of Washington NHERI RAPID facility	Imaging
Justin Marshall	Auburn University	Lead, PA
Steve Pece	Pece of Mind Environmental, Inc.	Logistics, access
Daniel Smith	James Cook University/University of Florida	PA
FAST-2: October 5-8, 2019		
Team Member	**Affiliation**	**Team Assignment**
Doug Allen	Simpson Strong-Tie	PA (Lead)
Terran Brice	Caribbean Coastal Services (Bahamas)	PA
Kevin Brown	Caribbean Coastal Services (Bahamas)	PA
Davon Edgecombe	Caribbean Coastal Services (Bahamas)	PA
Andrew Kennedy	University of Notre Dame	Coastal Survey Team (Lead)
James Kaihatu	Texas A&M University	Coastal Survey Team
Richard L. Wood	University of Nebraska-Lincoln	Imaging Team (Lead)
Henry Lester	University of South Alabama	Imaging Team (Trainee)
Mike Vorce	Site Tour 360	Imaging Team

Table 1.2. Data Librarians		
Name	**Affiliation**	**QC ID**
Kevin Ambrose	Auburn University	KMA
Madeline Rihner	Auburn University	Madeline Rihner
Hadiah Rawajfih	Auburn University	HZR
Christian Brown	Auburn University	CVB
Joseph Palmer	Auburn University	JP
Mohammadtaghi Moravej	Walker Consultants	MM

2. Data Collection Methodology

Teams were assembled to document damage to structures, delineating the effects of wind, storm surge and wave action using the following survey classes and in accordance with the *StEER Field Assessment Structural Team (FAST) Handbook* (Version 1.2, 2019). The StEER response strategy centered on pre-identifying clusters of structures based on typology, year of construction, post-Dorian performance (as indicated by satellite imagery), and hazard exposure/intensity. Post-Dorian satellite imagery obtained by StEER was also used pre-deployment to identify a number of apparent "successes" worthy of documentation as case studies. In-depth forensic assessments were supplemented by mobile imaging techniques to document performance over larger areas/transects. Hazard intensity (storm surge characteristics) was documented through coastal surveys, including the processing of debris fields from satellite imagery.

2.1 Performance Assessments

IMPLEMENTATION: FAST-1, FAST-2

For the clusters of structures that were identified and assessed, PA were conducted at regular intervals (e.g., every third structure) to provide detailed evaluation of building performance without biasing toward damaged structures. Beyond sampled clusters, individual case study buildings of notable successes were also documented using the Fulcrum mobile app. Assessments documented primary structural typologies and component types, construction materials, and damage levels. These were established using direct observation and contact/non-contact measurements accompanied by geotagged photos, videos, and statements from eyewitnesses to establish failure sequences. All data was collected using the library of Fulcrum mobile applications developed by StEER. PA, including adopted damage ratings, follow the *StEER Field Assessment Structural Team (FAST) Handbook* (Version 1.2, 2019). Appendix A lists the fields acquired by the Fulcrum Application. Note that damage assessments may also be accompanied by additional observations (from measurements and interviews) that may be entered in the notes field of the Fulcrum Application or recorded via audio recordings.

2.2 Surface-Level Panoramas

Surface-Level Panoramas were used by both FAST-1 and FAST-2 and were captured by two different systems (1) an Applied StreetView system from the University of Washington NHERI RAPID facility, and (2) an NCTech iStar Pulsar system from Site Tour 360. These systems and data captured by them are described below.

APPLIED STREETVIEW

IMPLEMENTATION: FAST-1, FAST-2

PUBLIC ACCESS POINT:

- Marsh Harbour and Treasure Cay ASV Scans (September 24-25, 2019): Mapillary
- Grand Bahama ASV Scans (October 5-8, 2019):
  Mapillary | https://goo.gl/maps/vaqeunYGFSG1QdFy5

The Applied StreetView (ASV) system from the University of Washington NHERI RAPID Facility was deployed by both FAST-1 and FAST-2. Its purpose was to capture temporally significant 360-degree surface-level panoramas (SLP), of a location via a mobile platform, thereby documenting damage that researchers can review later. The system consists of six cameras mounted together to gather a 360 x 160 degree field of view. Each camera has a resolution of 5 MP, sensor size of 2560 x 1920 pixels, and uses fisheye lenses with fixed focus and focal length of 2.8. GNSS-tracking allows for ~2 m image location accuracy. Images and locations are post-processed to SLP image collections using the Applied Streetview Creator 3 software. Maximum resolution for panoramas is 8192 x 4096 pixels. Camera module and GNSS receiver were mounted on a car roof and the system was controlled by users inside the vehicle. Under this configuration, FAST-1 captured near-continuous coverage of exterior building performance while driving along routes in Marsh Harbour and Treasure Cay. Photographs were acquired at 5 m intervals. FAST-2 captured similar coverage of building performance along routes at 1m intervals on Grand Bahama Island (see Figure 2.1). FAST-2 images were then limited to 4 m intervals for processing capabilities afterwards. Images of SLP routes can be seen below and SLP image collections can be found at the links above.

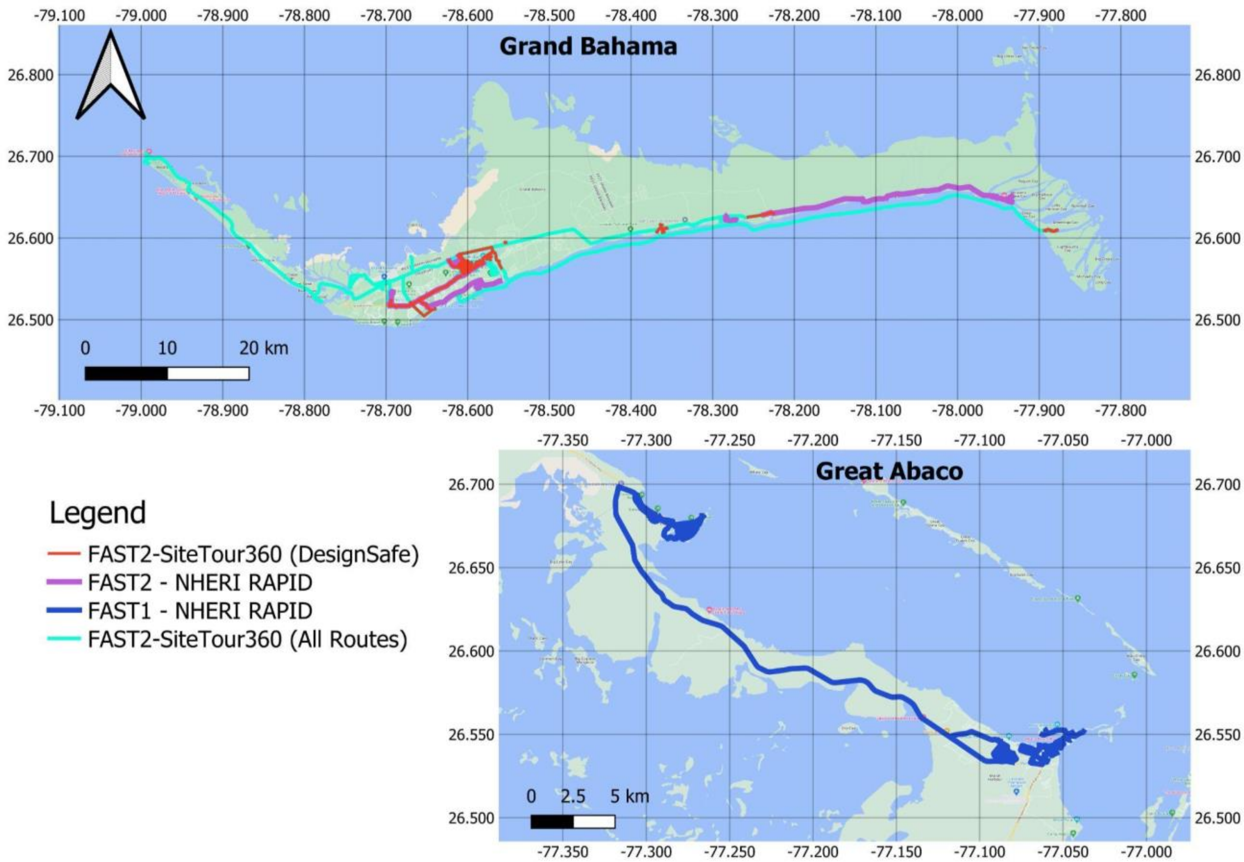


Figure 2.1. SLP routes from both NHERI RAPID and Site Tour 360 systems for FAST-1 (Top) and FAST-2 (Bottom).

SITE TOUR 360 NCTECH PULSAR
IMPLEMENTATION: FAST-2
PUBLIC ACCESS POINT: Grand Bahama Island data hosted on Google:

- Sweeting's Cay
- Golden Grove Road - washed away
- Golden Grove Rd - ocean front
- Neighborhood near Golden Grove

- Grand Bahama University
- Jack Hayward Bridge

SiteTour360 President and CEO Mike Vorce was contracted to deploy with FAST-2 to capture additional 360 degree panoramas in Grand Bahama. SiteTour360 used the NCTech iStar Pulsar+ system, which consists of four cameras mounted together to gather a 360 x 145 degree field of view. Each camera has a resolution of 12.3 MP, sensor size of 3042x4062, and uses fisheye lenses with fixed focus and focal length of 2.6. GNSS-tracking via a U-BLOX Neo M8N receiver geotagged each image location with ~2.5 m accuracy. The iStar Pulsar camera was mounted on a variety of platforms to capture imagery, including a vehicle, backpack, and boat. Under this configuration, FAST-2 captured near-continuous coverage of exterior building performance throughout Grand Bahama and extending out to McLean's Town Cay and Sweetings Cay. Data was mostly collected via a backpack-mounted unit, whose leveling capability is inferior to car-mounted systems. Data collection was intermittently disrupted by rainfall. Approximately 180 GB of imagery were captured. A map of the Site Tour360 SLP routes are provided in Figure 2.1 and SLP image collections can be found at the links above.

2.3 Coastal Surveys

IMPLEMENTATION: FAST-2

A documentation of coastal hazard intensity was achieved through both processing of satellite imagery and field surveys by FAST-2. Field Surveys were conducted in Great Abaco Island, Man-O-War Cay, and Grand Cayman Island to establish high water marks and inundation extent. Runup and maximum still water elevations were determined from debris fields, watermarks, and eyewitness accounts. Elevations were measured from local still water level using one of two methods: (1) rod and level and (2) laser rangefinder with angular measurement from horizontal. Most measurements were taken down to the still water level.

Satellite reconnaissance employed pre-and-post-storm imagery on Great Abaco Island near Marsh Harbour taken from various sources including images purchased from commercial satellite providers, and freely-available imagery on Google Earth. Two aspects were considered: movement of shipping containers during the storm, and debris fields generated by the storm. Both could only consider features clearly visible on approximately 0.5m resolution imagery, which was sufficient for large objects. Where possible, but not always, confirmation was obtained from other sources that, for example, a presumed shipping container was not actually a mobile home. In cases where identification was suspect, these objects were noted as uncertain. When possible, shipping containers were divided into standard 40 foot, 20 foot, 9 foot, and 7 foot lengths. Ground observations confirmed some of the shipping containers, but it was not possible to visit all of the sites. Debris fields were evaluated by eye, with additional ground-level confirmation and guidance where possible. Only debris with linear dimensions of at least 5m was considered.

2.4 Ground-Based Lidar Scanning

IMPLEMENTATION: FAST-2

A Faro Focus S-350 lidar scanner was used to document select structures on Grand Bahama Island by the FAST-2 Imaging Team in terms of geospatial point clouds. Point clouds were collected for the following four sites: (i) Communication Tower and (ii) a Boat Repair Facility (single scan) at Mclean's Town in East Grand Bahama Island (ii) the Sir Jack Hayward Bridge, and (iv) the University of the Bahamas at Freeport of West Grand Bahama Island. The Faro S-350 data were acquired through a three step process of scan planning, data acquisition, and data processing. The planning phase considers the scanning positions with the purpose to determine an optimum number of scans and their positions such that the scans can be accurately registered to maximize coverage with minimal occlusions. At a site of interest, the number of scans conducted was a function of the available site access (relative to both permission and safety), geometry of the structure (due to its line of sight technology), and permissible time. In the data acquisition phase, terrestrial scanners often record the 3D information of the targeted objects, and a built-in function will automatically register all the points from a single scan to the local coordinate system of the scanner.

The Faro scans were collected using parameters of 1:4 density with 4x oversampling to minimize noise in the dataset while minimizing acquisition time. Each Faro scan position was approximately 15 minutes and included color imaging capture. The resultant from each scan is a point cloud in its relative coordinate system. For sites with multiple scans, the distance between scans was less than 7 meters. Post-processing of the lidar point clouds was performed in Faro Scene. This included scan registration, scan processing (colorizing), and exporting to an open-source format (*.las) for curation.

2.5 Other Documentation

IMPLEMENTATION: FAST-1, FAST-2

While conducting reconnaissance, teams acquired additional photos/videos on their personal mobile devices or GPS cameras. Additional observations/notes similarly recorded outside of the Fulcrum mobile application are included in the Daily Summaries prepared each day by the FAST using the standard StEER template.

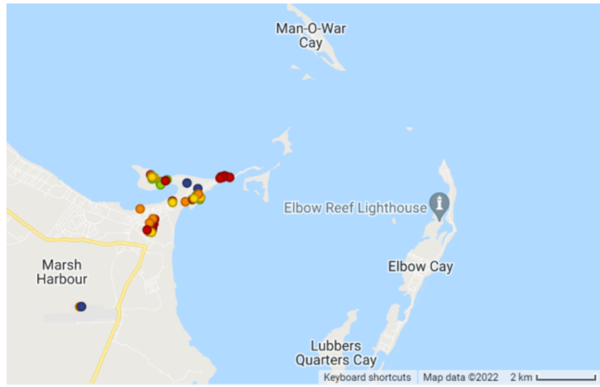
FAST-1 also acquired surface imagery using an Insta360 One camera from the NHERI RAPID Facility. The Insta360 is a small, pocket sized camera that can be paired with a phone or fit with a micro-SD card to instantly take stabilized, 360 degree images. The camera has a F2.2 aperture and is rated at 24 MP, producing 360 degree images at 6912×3456 pixels. Images are output in proprietary format but can be viewed and exported to JPEG via free app or software. The camera was used during FAST-1 sparingly to assist with damage assessments and provide further imagery as needed. Because the camera does not have GPS capabilities the images were not recorded in the Fulcrum mobile application.

3.0 Chronology and Geospatial Distribution of Data Collection

FAST-1

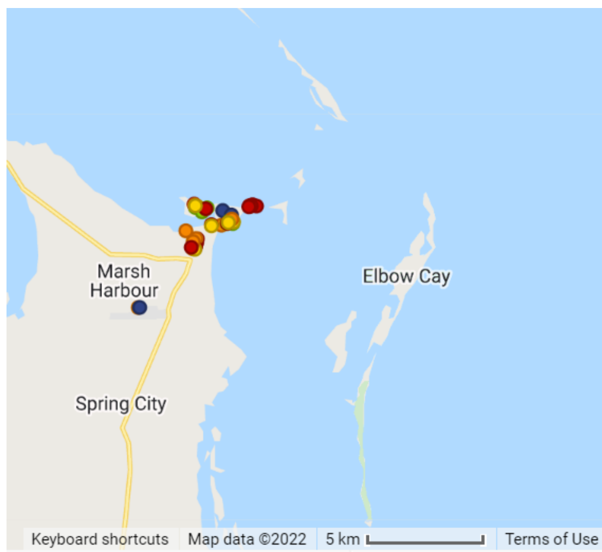
24 September 2019
Marsh Harbour, Great Abaco Island

1. Leonard Thompson International Airport – PA
2. Industrial/Commercial Region around Ace Hardware (26.537,-77.062) – Performance Assessments and initiation of SLP
3. Pelican Shores – PA, 2 UAV Flights, SLP
4. Marsh Harbour Marina – PA, SLP
5. Abaco Beach Resort – PA, SLP
6. Eastern Shores – PA, SLP
7. Marsh Harbour Port – PA



25 September 2019
Marsh Harbor and Treasure Cay, Great Abaco Island

1. Maxwell's Grocery Store – PA
2. NGO and Emergency Support Functions at Bahamian Government Building
3. Central Pines Residential – PA, SLP
4. Treasure Cay – PA, SLP
5. Shelter Meeting at Bahamian Government Building
6. Industrial Commercial Region (Ace Hardware)
7. Pelican Shores

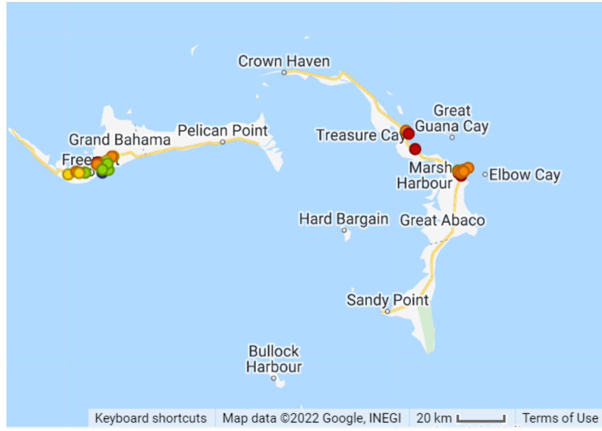


FAST-2

5 October 2019

Coastal and PA Teams: Great Abaco Island

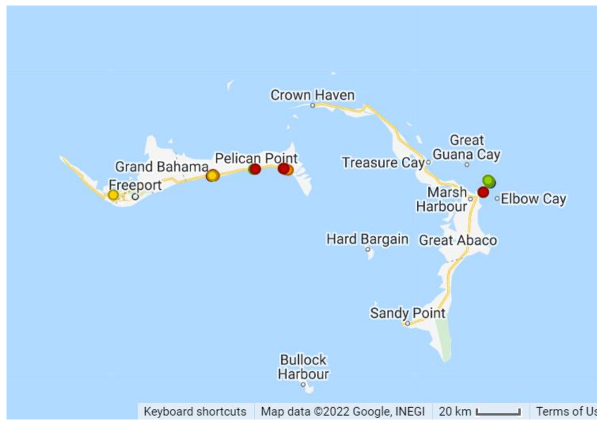
Rapid Imaging Team: West Grand Bahama



6 October 2019

Coastal and PA Teams: Man-o-War Cay

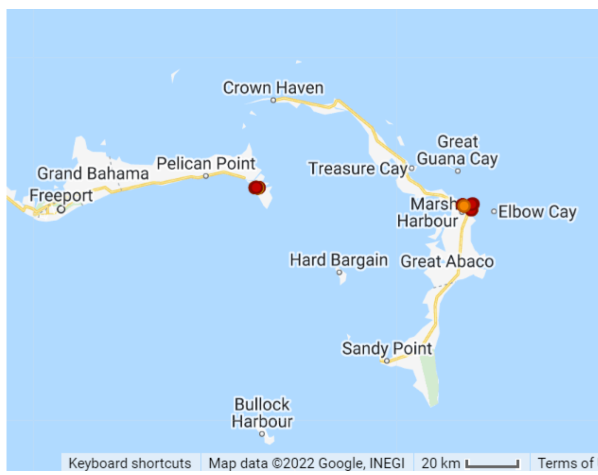
Rapid Imaging Team: East Grand Bahama Gradient Survey



7 October 2019

Coastal and PA Teams: Marsh Harbour/Transit to Grand Bahama Island

Rapid Imaging Team: Grand Bahama West End Survey



8 October 2019 Eastern Cayes Boat Excursion	

4.0 DATA PROCESSING

4.1 Performance Assessments

Each record in the Fulcrum database underwent StEER's Data Enrichment/Quality Control (DE/QC) process outlined in *Virtual Assessment Structural Team (VAST) Handbook: Data Enrichment and Quality Control (DE/QC) for US Windstorms* (Version 2.0, 2019). Records were updated by the librarians in Table 1.2 in real-time, immediately available within the Fulcrum Community portal at each stage of the DE/QC Process. As each record completed one of these stages, a code is updated within the record. A QC notes field is also provided for the Data Librarian to include any relevant information regarding changes made to the record in the process. The StEER DE/QC process was executed at a minimum to Stage 2 for all records, meaning basic attributes such as location, building type, damage ratings, structural wall and roof system, number of stories, and component-level damage ratings were assessed with reasonable confidence. Due to the unique nature of the construction encountered in the Bahamas, a new attribute was defined that classified residential buildings as Class 1, Class 2, or Class 3 using the guidelines set forth in the companion paper by Kijewski-Correa et al. (2021).

Where insufficient information was available to have a reasonable degree of confidence in the Stage 2 fields, a Stage 2e code is used to warn potential users of the data that the information therein may be more incomplete or uncertain than typical records. Where high quality data was available for a given record, typically through overlapping data sources (e.g., multiple of audio recordings, on-site photographs, satellite imagery, and/or surface-level panoramas), Stage 3 was executed which includes finer details of the building attributes and structural load path. Table 4.1 summarizes the number of records for which each Stage was executed. Once each record was advanced to its respective Stage in the DE/QC process, the final database was downloaded from Fulcrum and subjected to some final formatting edits before uploading to DesignSafe in XLSX and GeoJSON formats.

For the majority of assessments, at least two data librarians participated in the DE/QC process of each record separately to help catch errors and reduce uncertainties. In addition, the entire dataset underwent a number of macro-level QC checks to identify potential errors, such as filtering the dataset for blank entries in the number of stories, searching for invalid field entries (e.g., 72 was entered for first floor elevation (ft) due to unit error), and more. Every effort was made here to find and fix major errors or inconsistencies. Despite the best efforts of the data librarians, there is likely to be a small number of errors in a few records, and there is also uncertainty present due to incomplete data and/or use of engineering judgment. Despite these, additional QC should not be necessary for most research applications, but may be warranted for any analysis particularly sensitive to errors and uncertainties. Consumers of the data are encouraged to conduct additional stages in the DE/QC process in accordance with StEER's *Virtual Assessment Structural Team (VAST) Handbook: Data Enrichment and Quality Control (DE/QC) for US Windstorms* (Version 2.0, 2019).

Table 4.1: Breakdown of records by DE/QC stage executed

Stage	Brief Description	Number of Records
2	The minimum information required for a completed assessment has been verified or added. For example, the correct building type is assigned, overall damage ratings are confirmed to be in agreement with the quantitative guidelines, and basic building attributes, e.g., number of stories, are identified.	**108**

2e	There is insufficient information to meet the minimum data standards for a complete assessment, or there is considerable uncertainty in assignment of one or more critical fields. If a record is at 2e, it may not be possible or worthwhile to advance into additional stages and caution should be used in conducting analysis that includes this data.	**48**
3	The majority of fields up through Stage 3, as described in the DE/QC handbook, have been completed and validated with reasonable confidence in accuracy and precision.	**140**
3e	Some Stage 3 fields have been completed, but lack of data (e.g., only 2 sides of the structure are visible) prevents the assessment from being completed without undue uncertainty.	**62**

4.2 Surface-Level Panoramas

NHERI RAPID Applied StreetView

Individual images from the ASV capture system were processed into panoramas and panorama tiles using the ASV Creator 3 software. Images were filtered using a duplicate remover so that no panorama was within 5 meters of another horizontally or vertically. Images were also leveled and some minor manual cleaning applied. Panoramas are created and uploaded to Google through the G-Publisher option of ASV. The final resolution of the processed panoramas is 8192x4096 pixels and can be found at the links in Section 2.2. The ASV Creator 3 software also generates a set of tiled imagery and a web player that allows any user to setup a virtual server for SLP imagery. Images are processed under the web player option and lower resolution SLP tiles are created for the web player instead of panoramas. The web player requires a server (WAMP/MAMP/LAMP) and is run through a SQL database. Tiles are organized and displayed using the server and software output by Creator 3. Further information and directions for setting this option up can be obtained from NHERI RAPID or ASV. All outputs also have the option of incorporating logos and web links for attribution purposes.

Site Tour 360 NCTech Pulsar

Individual images were post-processed to panoramas using the NCTech Immersive Studio software at ~3 m spacing (actual spacing varied between 1 and 3 m), and then uploaded to Google Street View, Mapillary, and to DesignSafe. The final resolution for the processed panoramas is 11000x5500 pixels (11k). The backpack collections of 360 imagery hosted by Google are listed in Appendix B, which also includes a series of before-after comparisons and case studies, all generated by Mike Vorce (FAST-2). Due to licensing limitations that were in place on the Site Tour 360 imagery, all of the captured imagery was uploaded to the Google Street View platform, but only a portion (~85 GB of the 180 GB dataset) was able to be exported as raw .JPG panoramas and were included in this DesignSafe project.

4.3 Coastal Surveys
4.3.1 High Water Marks

The details of the coastal survey can be found in the companion journal paper (Kijewski-Correa et al., 2022). A list of processed HWM (standardized where possible to mean sea level (MSL) are provided in the Appendix of Kijewski-Correa et al. (2022). For publication on DesignSafe, this list of HWM were enhanced with additional notes and metadata from the Fulcrum Hazard Indicator app, and each site was assigned a numeric site ID using the following format:

HD-MMDDYY-SXXXX

where HD=Hurricane Dorian, MMDDYY is the date of the survey as month, day, year (e.g., 090817), S=site, XXXX = 4-digit site number, sequentially increasing and resetting daily (e.g., 0020).]

4.3.2 Shipping Container Transport
Storm-surge-transported shipping containers were mapped as a further indication of hazard intensity. These containers have very distinctive shapes in satellite imagery and tend to originate from shipping yards near the coast, for which pre-disaster satellite imagery is generally available to confirm debris sources. In this analysis, a combination of satellite imagery from September 4-5, 2019 was used. The analysis focused on Great Abaco Island, with Post-Dorian imagery that was acquired on the 5th and 14th of September 2019 with resolution of 50.0 cm by the Pleiades 1B satellite platform. Shipping containers were manually classified into one of three standard sizes (small = 7-9 ft long, medium = 20 ft long, large = 40 ft long) using measuring tools in standard GIS software and color-coded. Sizes were estimated to the nearest foot and classifications permitted a 2-ft margin of error.

The analysis of the above post-Dorian satellite imagery also extended to debris pile classification. Debris piles (sequentially numbered DP ##) are areas roughly larger than 5x5 meters. Debris piles were largely comprised of building remnants, boats, cars and sediment/soil. Image quality and the interpretation of previously heavily forested areas obscuring the pre-Dorian soil condition made debris classification at times challenging and reliant on analyst judgment. Buildings that appeared mostly undamaged were excluded from debris piles; buildings that experienced more than significant damage often had damaged components included within the debris pile. There were also some instances of what appeared as new construction since the pre-event satellite imagery; debris within these new construction zones was mostly assumed negligible. There are three aerial delineations where the debris pile damage assessment is not yet complete: North Finger, North End, and Isthmus. In all of the other aerial delineations, an estimated 95% confidence in debris classification was achieved. For each identified debris pile, the perimeter and area were estimated using standard GIS tools.

4.4 Ground-Based Lidar Scans
After field data collection, all of the raw or unprocessed lidar scans have to go through several post-processing steps such as filtering to reduce noise, colorization, and scan registration. Note scan registration is performed for sites where multiple scans were acquired, which were the Communication Tower, Sir Jack Hayward Bridge, and the University of the Bahamas. Only a single scan was collected at the Boat Repair Facility. Processing of all scans were performed within the Faro Scene environment.

Registration is required for sites with multiple scan setups to register all of the lidar points to a common global or universal coordinate system (UCS). To achieve a UCS, the scans were first manually placed aligning natural and anthropological features such as planes and edges (e.g., walls, columns, ground surfaces, etc.) and then optimized using a cloud-to-cloud technique. While filtering is commonly used to reduce noise, no filtering or cleaning techniques were performed on the lidar scans, as this can vary by application for further data processing and may introduce bias into the assessment. Moreover, colorization of the scans was performed within the Faro Scene environment using the onboard and integrated camera. The resultant mean scan alignment values are 11.2, 2.0, and 4.9 mm for the Communication Tower, Sir Jack Hayward Bridge, and the University of the Bahamas, respectively. Alignment values do vary as a function of non-static damage in the scene (e.g., corrugated metal moving and swaying in the wind), particularly for the communication tower facility at Mclean's Town.

4.5 Other Documentation

Media acquired outside of Fulcrum was reviewed to remove poor quality, redundant, ambiguous or irrelevant photos/videos. Time, date and coordinates can be extracted from the metadata of each geotagged photo, or are also available in photo logs included with each folder of photographs. This also includes images acquired with the Insta360 camera.

5. ARCHIVED DATA PRODUCTS

This section details the directory structure created in DesignSafe-CI and the contents therein.

🖿 Directory D1. Performance Assessments

FORMATS = XLSX, GeoJSON, JPG, MP4a

The folder **Performance Assessment Data — Processed** contains the final enriched and quality controlled performance assessment dataset (as XLSX and GeoJSON) with all the response fields in Appendix A. Not all response fields have values, for reasons described in Section 4.1. Each media file (e.g., photograph, audio file) is linked to a specific record by a unique alpha-numeric string. This unique string is both the filename of the media file, and also listed in the corresponding data field (e.g., photos, audio) for the record it is associated with in the XLSX or GeoJSON database.

🖿 Directory D2. Surface-Level Panoramas

↳🖿 Directory D2.1. Applied Streetview

FORMAT = JPG, CSV, ANPP, SQL, PHP, XML, GEOJSON

This directory contains two primary subdirectories, one (Raw_Data) containing approximately 60 GB of raw images captured by the Applied Streetview camera, and the other (Processed_Data) containing the processed panoramas. The root directory also contains two GEOJSON files that provide the geospatial coverage of the ASV camera in FAST-1 and FAST-2.

The Raw_Data sub-folder contains images organized by camera and tour (equivalent to new projects started in the field). Tour naming structure follows “camera-yyyymmdd-hhmmss” or camera/year/month/day/hour/minute/second. Time was kept in Pacific Day Time (PDT), so add three hours for Bahamas time (EDT). Each camera folder contains seven sub-folders under it. Folders 1-6 contain the JPG images of the six cameras on the ASV system, one folder for each camera. Folder 7 contains the panorama capture locations, collection tracks, and the log for the photo collection. The panorama locations and tracks are in *.csv files and the log file is in the ASV specific *.anpp format. Sub-folders are present within the Raw_Data directory for both FAST-1 and FAST-2.

The Processed_Data sub-folder contains approximately 100 GB of image products processed through the ASV Creator 3 software. All of the image products are meant for 360 degree SLP applications and there are two derivatives in this folder. The panorama tiles folder contains small tiled photos used to create large panoramic experiences on a self-contained web server. The folder contains more than 16 thousand subfolders, each representing a photo location. Within the subfolders are 133 JPG images used to create a 360 degree photo player. Directions and metadata for building the players are contained in the player folder. The folder contains SQL, PHP, and XML files used to build a web player. The web player requires a server (WAMP/MAMP/LAMP) and runs through a SQL database using the provided file types. Further information and directions to set up a web player can be provided by ASV or NHERI RAPID. If unable to host SLPs or web servers, the panoramas folder contains more than 16 thousand single panoramic images as an alternative. The images are 360 degree panoramas and are meant to be hosted on other SLP services such Google Street View. The naming structure for these matches with the raw data, following "camera-tour-capture number". The capture number counts up with the photos in the original tour folder, minus duplicates or corrupted images.

1. *panorama-tiles* contain small tiled images to build 360 degree SLP.
2. *panoramas* contains single 360 degree panoramic images from each capture location.
3. *player* contains files for hosting a SLP web player given a server and database.

Sub-folders are present within the Processed_Data directory for both FAST-1 and FAST-2.

↳📁 Directory D2.2. NC Tech Pulsar (FAST-2)

FORMAT = JPG, GEOJSON, TXT

Due to licensing restrictions, the raw movie files captured by the Site Tour 360 NCTech Pulsar camera for FAST-2 could not be exported and uploaded to DesignSafe. In the restricted workflow, the raw movie files were uploaded to the NCTech VR.World platform for processing and publishing to Google Street View. A portion of the processed panoramas were later able to be downloaded, and these were uploaded to DesignSafe and placed in this directory under the Processed sub-folder. Each folder in the Processed sub-folder contains the panoramas for a given route, along with two metadata files - *cameraNNN-routeNNN*_framepos.txt and *cameraNNN-routeNNN*-outputFormatIMU.txt - with formats as given below, where *cameraNNN* = the unique camera ID, and *routeNNN* is a unique numeric identifier assigned to each route.

Table 5.1. Data structure of the *cameraNNN-routeNNN*_framepos.txt files.

systemTime_sec	frame_index	lat	lon	altitude	distance	heading	pitch	roll	jpeg_filename
Epoch time (seconds since 1970)	Sequential index starting at 0	GPS Latitude	GPS Longitude	Altitude in meters	Cumulative distance (m) of each photo from starting position	Heading in degrees from north	Pitch in degrees	Roll in degrees	Original filename of panorama

Table 5.2. Data structure of the *cameraNNN-routeNNN*_outputFormatIMU.txt files.

systemTime_sec	sensortime_reg	accel_x	accel_y	accel_z	gyro_x	gyro_y	gyro_z	field_x	field_y	field_z
Camera System Timestamp, UTC (seconds since epoch))	Camera System Timestamp, UTC (microseconds)	Acceleration along X-axis (m/s2)	Acceleration along Y-axis (m/s2)	Acceleration along Z-axis (m/s2)	Gyroscope X-coordinate (rad/s)	Gyroscope Y-coordinate (rad/s)	Gyroscope Z-coordinate (rad/s)	Magnetometer X-axis (𝝁T)	Magnetometer Y-axis (𝝁T)	Magnetometer Z-axis (𝝁T)

🖿 Directory D3. Coastal Survey

↳🖿 Directory D3.1. High Water Levels

FORMAT = CSV

The excel file named 'HD-Coastal Survey' contains a listing of high water levels identified from field surveys. The contents of each column are itemized below:

Column		Header	Description
A	1	Site ID	Format: HD-YYYYMMDD-S####
B	2	fulcrumID	Unique identifier linking back to original record in the StEER Hazard Indicator Fulcrum app.
C	3	Project	Name of project
D	4	Investigator	Lead investigator for the survey
E	5	Date	Date data was acquired
F	6	Time_local	Local time at which data was acquired
G	7	Latitude	Coordinates for location of measurement
H	8	Longitude	
G	9	DepthAboveGround_m	Depth (m) of water level above ground level
I	10	UncorrectedElevation_m	Depth (m) of water level above sea level without correcting for tide level
J	11	TideLevel_m	Tide level (m) relative to mean sea level at time of measurement
K	10	ElevationFromMSL_m	High Water Mark (m) with respect to mean sea level
L	11	Notes	Field notes or other descriptions of measurement/photos

↳🖿 Directory D3.2 Field Photos

FORMAT = JPG

Photos associated with each of the High Water Level surveys are included in .jpg format with the following naming convention:

HD-YYYYMMDD-S####-photo#.JPG

where HD = Hurricane Dorian, YYYY is the year (e.g., 2019), MM is the month (e.g., 09), DD is the day (e.g., 08), S=site, #### is the site number (linked to High Water Levels spreadsheet), and photo# = sequential photo number associated with each site.

↳■ Directory D3.3 Shipping Containers

FORMAT = KML, XLSX

The analysis of displaced shipping containers in post-Dorian satellite imagery resulted in the following curated GIS data:

- **Dorian Shipping Containers Small.kml:** Identified small shipping containers (7-9 ft long x 8 ft wide) in post-Dorian imagery (Symbol: yellow squares)
- **Dorian Shipping Containers Medium.kml:** Identified medium shipping containers (20 ft long x 8 ft wide) in post-Dorian imagery (Symbol: green squares)
- **Dorian Shipping Containers Large.kml:** Identified large shipping containers (40 ft long x 8 ft wide) in post-Dorian imagery (Symbol: red squares)
- **Shipping_Container_Sources.kml:** identified sources of shipping containers pre-Dorian
- **Areal Delineations.kml:** polygons of what the analyst believes are helpful areal separations, simply to divide the large area into more reasonable segments for analysis. These polygons are also not completely developed.

Identified containers were also cataloged. **SC_Coordinates.xls** contains the coordinates and classification of shipping containers, numbered sequentially as SC #. Entries marked as “uncertain” could not be verified by the analyst. Entries that are not classified as one of the standard sized shipping containers are the result of uncertainty in the length measurement (or inconclusive boundaries on the object) or a measured length that was not within ± 2 ft of a standard container length. Columns in this spreadsheet are organized as follows:

A	B	C	D	E	F
Shipping container name	Latitude	Longitude	Certainty	Length Estimate	Nearest Standard Size

↳■ Directory D3.4 Debris Piles

The analysis of debris piles in post-Dorian satellite imagery resulted in two files:

- **Dorian debris Piles. Kml:** Debris piles identified in Dorian imagery, denoted by red polygons

- **Debris Dimensions.xls:** Measured perimeter and area of identified debris fields. Columns in this spreadsheet are organized as follows:

A	B	Area
Name	Perimeter (m)	(sq. m)

🖿 Directory D4. Ground-Based Lidar

↳🖿 Directory D4.1. Raw_Data

FORMAT = 7z

This directory contains compressed archive files for the scans conducted at the University of the Bahamas, McClean's Town (both the communication tower and the boat repair facility), and the Sir Jack Hayward Bridge. When these files are unzipped, a replicate of the SD card is provided as well as the raw *.fls files that can be opened within the select point cloud software platforms. Example software platforms include Faro Scene (proprietary) and CloudCompare (opensource).

↳🖿 Directory D4.2. Processed_Data

FORMAT = LAS, 7x

This directory contains two subfolders: 1) LAS Registered Files and 2) Potree Zipped File. Within the first folder, four LAS files exist for each site where lidar data were collected. These data correspond to the aligned point clouds and can be used in various geospatial and visualization software platforms, including open source platforms of CloudCompare and Potree. The second folder contains a single compressed archive file that was assembled with the PotreeConverter, which enables efficient and detailed visualization of the four sites via Potree, an opensource WebGL point cloud renderer that works within an internet browser. To view each of the, open one of the corresponding html files after extracting the 7z file: 1) UniBahamas.html , 2) Comm_Tower.html, 3) Boat_Repair.html, and 4) Sir_Jack_Hawyard_Bridge.html. At the publication time of this document, Microsoft Edge performed best for viewing of the downloaded html files and their dependent files/folders in the windows operating system.

🖿 Directory D5. Other Documentation

↳🖿 Directory D5.1 Photos

FORMAT = JPG, PNG, XLSX

This directory contains additional photos captured by investigators outside of Fulcrum. Subdirectories are organized by investigator last name and include attributed photos and a photo log (named HD-PHOTO-LOG-FAST-LastName) with a chronological listing of the following attributes for each photo:

A	B	C	D	E	F
1	2	3	4	5	6
File Name	Date Taken	Time Taken	Latitude	Longitude	Camera

↳■ Directory D5.2. 360 Camera
FORMAT = .jpg

The folder contains 360 degree images collected during FAST-1. A total of 51 images were taken with an Insta360 One camera and converted to .jpg. The naming convention follows 'IMG/year-month-date/hour-min-sec/unique identifier'. Further information is provided in Section 2.5.

↳■ Directory D5.3. Daily Summaries
FORMAT = PDF

StEER daily summaries are organized into subfolders by FAST-1 and FAST-2. Within FAST-2, they are further organized by sub-teams with the naming convention: FAST#-[Mission]-Daily-Summary-MMDDYY.PDF where FAST# specifies the FAST team (e.g., FAST-1 or FAST-2), [Mission] is an optional field identifying the type of mission (e.g., Coastal, Imaging, PA), MM is the month (=10), DD is the day (e.g., 06), YY is the year (=20).

6.0 Contacts

For inquiries on specific sets of data, please contact the following individuals:

Coastal Survey	Damage Assessments
Andrew Kennedy Andrew.B.Kennedy.117@nd.edu	David Roueche dbr0011@auburn.edu
360 Imagery	**Ground-Based Lidar**
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Applied StreetView Imagery	**General Inquiries**
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7.0 References

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Roueche, D., Kijewski-Correa, T., Mosalam, K., Prevatt, D., and Robertson, I. (2019). StEER: Virtual Assessment Structural Team (VAST) Handbook: Data Enrichment and Quality Control (DEQC) for US Windstorms, Version 1.0, StEER. https://www.steer.network/resources.

APPENDIX A. PERFORMANCE ASSESSMENT FIELDS

Column		Column Header	Field	Format	% Filled [1]
A	1	fulcrum_id	Record ID	Text	100%
B	2	project	Project	Text	100%
C	3	latitude	Latitude	Decimal	100%
D	4	longitude	Longitude	Decimal	100%
E	5	name_of_investigator	Name of Investigator	Text	100%
F	6	date	Date	MM/DD/YYYY	100%
G	7	general_notes	General Notes	Text	16%
H	8	assessment_type	Assessment Type	Single Choice	100%
I	9	all_photos	All Photos	Comma separated values	100%
J	10	audio	Audio	Comma separated values	30%
K	11	overall_damage_notes	Overall Damage Notes	Text	14%
L	12	hazards_present	Hazards Present	Multiple Choice (Comma separated text)	100%
M	13	wind_damage_rating	Wind Damage Rating	Single Choice	100%
N	14	surge_damage_rating	Surge Damage Rating	Single Choice	89%
O	15	rainwater_ingress_damage_rating	Rainwater Ingress Damage Rating	Single Choice	24%

P	16	attribute_notes	Attribute Notes	Text	61%
Q	17	address_sub_thoroughfare	House Number	Text	2%
R	18	address_thoroughfare	Street Name	Text	71%
S	19	address_suite	Suite Number	Text	0%
T	20	address_locality	City/Town	Text	34%
U	21	address_sub_admin_area	County	Text	0%
V	22	address_admin_area	State	Text	73%
W	23	address_postal_code	Zip Code	Text	0%
X	24	address_country	Country	Text	100%
Y	25	building_type	Building Type	Single Choice	100%
Z	26	residential_building_class	Residential Building Class	Single Choice	60%
AA	27	number_of_stories	Number of Stories	Integer	96%
AB	28	understory_pct_of_building_footprint	Understory Area(% of Building Footprint)	Single Choice	54%
AC	29	first_floor_elevation_feet	First Floor Elevation in Feet	Decimal	99%
AD	30	year_built	Year Built	Integer	4%
AE	31	roof_shape	Roof Shape	Multiple Choice (Comma separated text)	83%
AF	32	roof_slope	Roof Slope	Integer	37%

AG	33	front_elevation_orientation	Front Elevation Orientation	Integer	71%
AH	34	structural_notes	Structural Notes	Text	8%
AI	35	mwfrs	Main Wind Force Resisting System	Multiple Choice (Comma separated text)	90%
AJ	36	foundation_type	Foundation Type	Multiple Choice (Comma separated text)	90%
AK	37	wall_anchorage_type	Wall Anchorage Type	Multiple Choice (Comma separated text)	7%
AL	38	wall_structure	Wall Structure	Multiple Choice (Comma separated text)	94%
AM	39	wall_substrate	Wall Substrate	Multiple Choice (Comma separated text)	18%
AN	40	wall_cladding	Wall Cladding	Multiple Choice (Comma separated text)	90%
AO	41	soffit_type	Soffit Type	Multiple Choice (Comma separated text)	66%
AP	42	front_wall_fenestration_ratio	Front Wall Fenestration Ratio	Single Choice	44%
AQ	43	front_wall_fenestration_protection	Front Wall Fenestration Protection	Multiple Choice (Comma separated text)	41%
AR	44	left_wall_fenestration_ratio	Left Wall Fenestration Ratio	Single Choice	37%
AS	45	left_wall_fenestration_protection	Left Wall Fenestration Protection	Multiple Choice (Comma separated text)	35%
AT	46	back_wall_fenestration_ratio	Back Wall Fenestration Ratio	Single Choice	37%

AU	47	back_wall_fenestration_protection	Back Wall Fenestration Protection	Multiple Choice (Comma separated text)	37%
AV	48	right_wall_fenestration_ratio	Right Wall Fenestration Ratio	Single Choice	37%
AW	49	right_wall_fenestration_protection	Right Wall Fenestration Protection	Multiple Choice (Comma separated text)	36%
AX	50	large_door_present	Large Door Present	Multiple Choice (Comma separated text)	74%
AY	51	large_door_opening_type_front	Large Door Opening Type Front	Multiple Choice (Comma separated text)	56%
BZ	52	large_door_opening_type_left	Large Door Opening Type Left	Multiple Choice (Comma separated text)	56%
BA	53	large_door_opening_type_back	Large Door Opening Type Back	Multiple Choice (Comma separated text)	55%
BB	54	large_door_opening_type_right	Large Door Opening Type Right	Multiple Choice (Comma separated text)	55%
BC	55	roof_system	Roof System	Multiple Choice (Comma separated text)	84%
BD	56	r2wall_attachment	Roof to Wall Attachment	Multiple Choice (Comma separated text)	11%
BE	57	r2w_attachment_type	Roof to Wall Attachment Type	Text	1%
BF	58	roof_substrate_type	Roof Substrate Type	Multiple Choice (Comma separated text)	50%
BG	59	roof_cover	Roof Cover	Multiple Choice (Comma separated text)	75%

BH	60	secondary_water_barrier	Secondary Water Barrier	Multiple Choice (Comma separated text)	28%
BI	61	overhang_length	Overhang Length	Integer	71%
BJ	62	parapet_height_inches	Parapet Height in inches	Integer	50%
BK	63	wind_damage_details	Wind Damage Details	Text	7%
BL	64	roof_structure_damage_	Roof Structure Damage	Single Choice	97%
BM	65	roof_substrate_damage	Roof Substrate Damage	Single Choice	90%
BN	66	roof_cover_damage_	Roof Cover Damage	Single Choice	98%
BO	67	wall_structure_damage_	Wall Structure Damage	Single Choice	99%
BP	68	wall_substrate_damage_	Wall Substrate Damage	Single Choice	77%
BQ	69	building_envelope_damage_	Building Envelope Damage	Single Choice	99%
BR	70	front_wall_fenestration_damage	Front Wall Fenestration Damage	Single Choice	80%
BS	71	left_wall_fenestration_damage	Left Wall Fenestration Damage	Single Choice	73%
BT	72	back_wall_fenestration_damage	Back Wall Fenestration Damage	Single Choice	75%
BU	73	right_wall_fenestration_damage	Right Wall Fenestration Damage	Single Choice	73%
BV	74	large_door_failure	Large Door Failure	Multiple Choice (Comma separated text)	65%
BW	75	soffit_damage	Soffit Damage	Single Choice	42%
BX	76	fascia_damage_	Fascia Damage	Single Choice	61%

BY	77	stories_with_damage	Stories with Damage	Integer	65%
CZ	78	water_induced_damage_notes	Water Induced Damage Notes	Text	5%
CA	79	percent_of_building_footprint_eroded	Percent of Building Footprint Eroded	Single Choice	20%
CB	80	_damage_to_understory	Damage to Understory	Single Choice	25%
CC	81	maximum_scour_depth_inches	Maximum Scour Depth in inches	Integer	17%
CD	82	_piles_missing_or_collapsed	Piles Missing or Collapsed	Single Choice	24%
CE	83	_piles_leaning_or_broken	Piles Leaning or Broken	Single Choice	24%
CF	84	cause_of_foundation_damage	Cause of Foundation Damage	Multiple Choice (Comma separated text)	17%
CG	85	reroof_year	Reroof Year	Integer	0%
CH	86	retrofit_type_1	Retrofit Type 1	Text	0%
CI	87	retrofit_1_year	Retrofit 1 Year	Integer	0%
CJ	88	data_librarians	Data Librarian	Text	100%
CK	89	qc_progress_code	QC Progress Code	Single Choice	69%
CL	90	qc_notes	QC Notes	Text	10%
CM	91	qc_notes	QC Notes	Text	10%
CN	92	qc_progress_code	QC Progress Code	Single Choice	69%
CO	93	qc_notes	QC Notes	Text	10%

[1] Percent filled column ignores any entries that are blank, or defined as “Unknown”, “Unk”, “Not

Applicable", or "NaN".

APPENDIX B. 360 IMAGERY CASE STUDIES

Backpack Collections

- Sweeting's Cay
- Golden Grove - oceanfront houses
- University of Bahama
- Hugh Campbell Primary School - republishing using another method
- Jack Hayward Bridge - severe erosion
- Queens Cove Home - where occupants road out storm & shot interior video
- Video taken from inside home during one of two high tide & storm surge confluences

Before/After Comparisons

Bishop's Bonefish Lodge - High Rock - Grand Bahama			
Main Building		Beach bar	
Before	After	Before	After
University of Bahama			
Secondary Building		Main Building	
Aug 2018	After	Aug 2018	After
Sir Jack Hayward Bridge		**Casuarina Bridge**	
Aug 2018	After	Aug 2018	After
Sweeting's Cay - Sea Gull Restaurant		**Freeport Traffic Circle**	
Apr 2019	After*	Aug 2018	After
*view from opposite direction (see power pole for common reference point)			

Case Study: Eyewitness Video in Queen's Cove

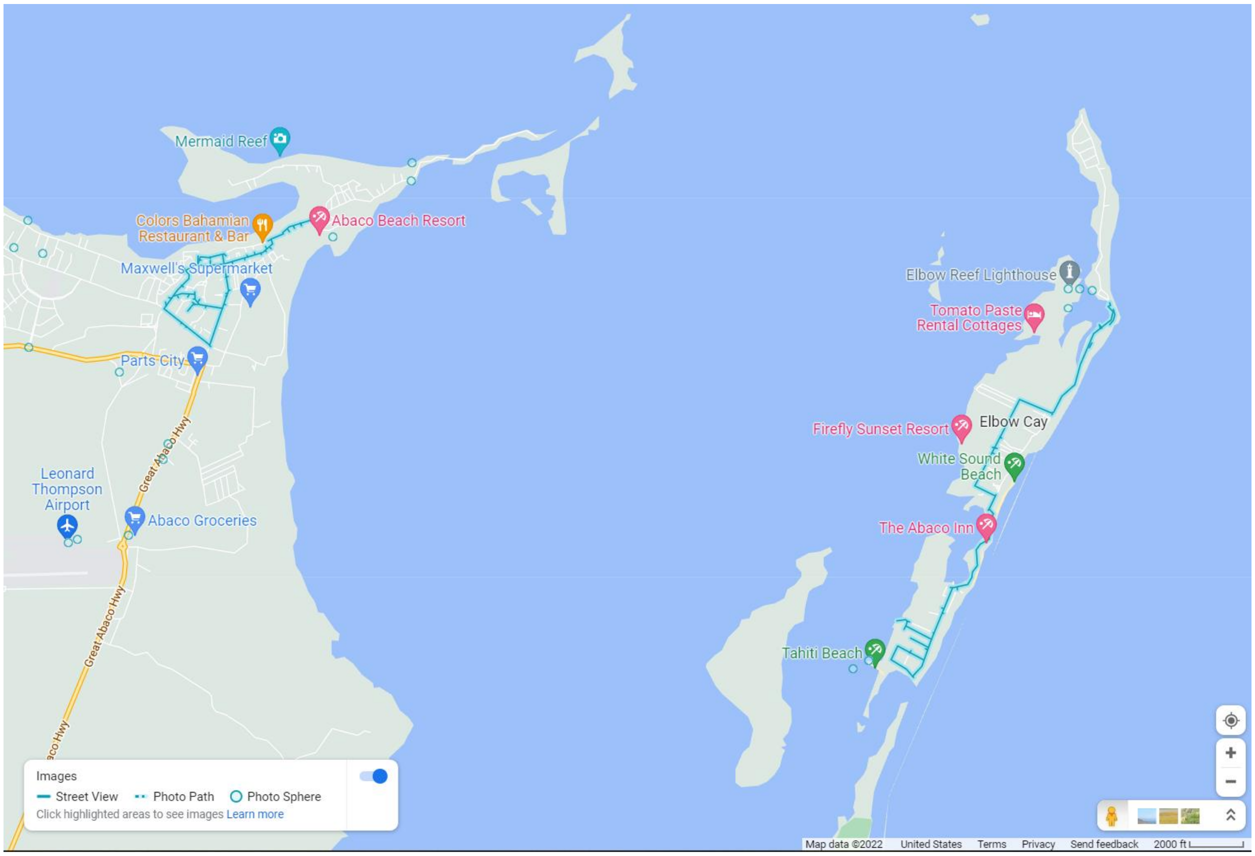
- Home exterior
- Video taken from inside home during one of two high tide & storm surge confluences

Storm Surge Documentation

- Debris line
- Trees with bark damage**:** Along Queens Hwy - bark loss at high water mark observed for several miles and at multiple locations across Grand Bahama Island
- Pine Bay: significantly impacted by storm surge, note elevation changes distinguishing areas subject to storm surge
    - Pine Bay - Storm surge
    - Pine Bay **-** Storm surge2
    - Pine Bay - Debris line and tree scarring at elevation change

Additional 360 Imagery
SiteTour360 President Mike Vorce collected additional imagery in the Bahamas, including the Abaco Islands and Grand Bahama, in a deployment in January 2020, funded by the National Disaster Preparedness Training Center out of the University of Hawaii (N D P T C :: National Disaster Preparedness Training Center/ Home (hawaii.edu)). These images can be viewed through the following public access points:
Abaco Islands & Grand Bahama - Site Tour 360

Google Street View Platform


Mermaid Reef
Colors Bahamian Restaurant & Bar
Abaco Beach Resort
Maxwell's Supermarket
Parts City
Great Abaco Hwy
Leonard Thompson Airport
Abaco Groceries
Elbow Reef Lighthouse
Tomato Paste Rental Cottages
Firefly Sunset Resort
Elbow Cay
White Sound Beach
The Abaco Inn
Tahiti Beach
Images
Street View
Photo Path
Photo Sphere
Click highlighted areas to see images Learn more
Map data ©2022
United States
Terms
Privacy
Send feedback
2000 ft

Appendix C. Standard StEER Glossary

Version Number	1.1	Updated	22-Aug. 2022
Term	**Acronym**	**Class**	**Description**
Response Levels			
Level 1 Response	L1	Response Level	virtual mission gathering and synthesizing publicly available online data, including high resolution satellite imagery; used in major hazard events that have potential to generate new knowledge relevant to StEER's mandate
Level 2 Response	L2	Response Level	field scout; wide-canvassing smaller FAST operating out of regional node for a rapid survey of the entire affected area to collect highly perishable data; used in major hazard events with ability to generate new knowledge relevant to StEER's mandate
Level 3 Response	L3	Response Level	full field investigation with systematic target selection using interdisciplinary teams with the objective of developing detailed case studies through Forensic Load Path Evaluation (FLPE) or Direct Quantification of Component Performance (DQCP) conducted on a robust statistical sampling of the inventory; used in major hazard events where knowledge can be gained through in-depth evaluation of select structures
Mission Document Classes		Sub-division	Standard StEER sub-division of data, focused on written products
Planning Documents		Document Class	Standard StEER document class, encompasses assets produced to guide a Level 2 or Level 3 response
Pre-Deployment Briefing	--	Internal Document	Standard StEER document, defines mission scope, target areas and structures to visit, technologies, and team configuration
Daily Summaries	--	Document Class	Standard StEER document, submitted daily to document mission coverage and observed performance
Data Classes		Sub-division	Standard StEER sub-division of data, focused on observations and measurements
Performance Assessment	PA	Data Class	Standard StEER data class, direct evaluation of structural performance using StEER's standard assessment frameworks (often using StEER mobile apps)
PA: Coastal Buildings	PA-CB	Data Subclass	Standard StEER data subclass, direct evaluation of structural performance of buildings under coastal hazards
PA: Coastal Non-Buildings	PA-CNB	Data Subclass	Standard StEER data subclass, direct evaluation of structural performance of non-buildings under coastal hazards
PA: Earthquake Buildings	PA-EB	Data Subclass	Standard StEER data subclass, direct evaluation of structural performance of buildings under seismic hazards
PA: Earthquake Non Buildings	PA-ENB	Data Subclass	Standard StEER data subclass, direct evaluation of structural performance of non-buildings under seismic hazards
PA: Windstorms Buildings	PA-WB	Data Subclass	Standard StEER data subclass, direct evaluation of structural performance of buildings under wind hazards

PA: Windstorms Non-Buildings	PA-WNB	Data Subclass	Standard StEER data subclass, direct evaluation of structural performance of non-buildings under wind hazards
Surface-Level Panoramas	SLP	Data Class	Standard StEER data class, rapid imaging technique collecting 360 photographic evidence
SLP: car-mounted systems	SLP-C	Data Subclass	Standard StEER data subclass, rapid imaging technique collecting 360 photographic evidence using cars
SLP: boat-mounted systems	SLP-B	Data Subclass	Standard StEER data subclass, rapid imaging technique collecting 360 photographic evidence using boat
SLP: backpack-mounted systems	SLP-BP	Data Subclass	Standard StEER data subclass, rapid imaging technique collecting 360 photographic evidence using backpack mounts
SLP: handheld systems	SLP-HH	Data Subclass	Standard StEER data subclass, rapid imaging technique collecting 360 photographic evidence using handheld
Unmanned Aerial Systems	UAS	Data Class	Standard StEER data class, common mode of aerial data collection in the field
Free-Flight	UAS-FF	Data Subclass	Standard StEER data subclass, unmanned aerial system in free flight
Panoramas	UAS-P	Data Subclass	Standard StEER data subclass, unmanned aerial system generating panoramas
3D Models	UAS-3D	Data Subclass	Standard StEER data subclass, unmanned aerial system generating 3D models
LiDAR-Based Imaging	LBI	Data Class	Standard StEER data class, Light Detection and Ranging measurements collected by various platforms
LBI: Fixed	F-LBI	Data Subclass	LBI subclass; fixed/stationary mode for ground-based data collection
LBI: Mobile	M-LBI	Data Subclass	LBI subclass; mobile mode for ground-based data collection
LBI: Aerial	A-LBI	Data Subclass	LBI subclass; aerial mode for data collection
Site Hazard Assessment	SHA	Data Class	Standard StEER data class, forensic evidence of hazard intensity
SHA: Coastal Surveys	SHA-C	Data Subclass	SHA subclass, documenting coastal impacts after hurricanes/tsunamis
SHA: Windfield Indicators	SHA-W	Data Subclass	SHA data subclass, documenting evidence of wind speed such as tree fall patterns
SHA: Earth Movement/Rupture	SHA-E	Data Subclass	SHA data subclass, documenting evidence of earthquake intensity and ground shaking in ground surface
Other Ground-Based Observations	GBO	Data Class	Standard StEER data class, general category of observations using other data collection platforms beyond those in other standard data collection platforms such as photographs and videos captured outside of StEER mobile apps
Digital single-lens reflex camera	DSLR	Data Subclass	GBO subclass, documented using DSLR cameras
Other camera	--	Data Subclass	GBO subclass, documented using other types of cameras
Geospatial Positioning Data	GPD	Data Class	Standard StEER data class, coordinates or tracks that define locations of data collection
GPD: GPS Locations	GPD-L	Data Subclass	Standard StEER data subclass, coordinates of point data collection
GPD: GPS Routes	GPD-R	Data Subclass	Standard StEER data subclass, coordinates of data collection routes
Sampling Strategies			

Statistical Sample		Sampling Strategy	Sampling every Nth building in a cluster or along a route for performance assessment
Critical Case Sampling		Sampling Strategy	Sampling buildings that meet specific criteria, e.g., instrumented, or performance characteristics
Cluster-Based Sampling		Sampling Strategy	Sampling buildings within a defined radius of a point, e.g., ground motion station
Transect-Based Sampling		Sampling Strategy	Sampling buildings along a path that moves across the hazard intensity gradient
Quota-Based Sampling		Sampling Strategy	Sampling buildings to achieve a representative sample based on characteristics of underlying building inventory
Opportunistic Sampling		Sampling Strategy	Assessment of structure not included in initial sampling strategy, based upon unique features or performance observed in the field
Activities			
Rapid Assessment	RA	Activity	Lowest fidelity performance assessment, includes high-level global damage assessment for identifying damage gradient in affected communities following a hazard event
Load Path Assessment	LPA	Activity	Moderate fidelity performance assessment, includes in-depth performance assessment of Critical Load Path Elements (CLPE) including identification of (a) geolocation of damaged elements, (b) damage measures/modes, (c) component damage ratings
Detailed Component Assessment	DCA	Activity	Highest fidelity performance assessment, involves collecting detailed information on components, including dimensional data and/or material properties, as well as hazard intensity measures
Reconnaissance Engagement and Communication Hub	REACH	Activity	Communication and dissemination of findings to audiences in academia, policy and practice
Data Enrichment Quality Control	DEQC		Review and supplementing of assessment data to improve its quality and richness
Dissemination Products			Outputs of StEER Missions
Standard StEER Products			
Data Report	--	Product	Standard StEER Product; accompanies curated data in DesignSafe to detail the scope and structure of data
Event Briefing	EB	Product	Standard StEER Product, released in Level 1 response to synthesize the findings from VAST efforts
Early Access Reconnaissance Report	EARR	Product	Standard StEER Product, released after FAST-1 in a Level 2 or Level 3 response, summarizes the data collection process and major observations
Preliminary Virtual Reconnaissance Report	PVRR	Product	Standard StEER Product, released in Level 1 response to synthesize the findings from VAST efforts
Other Academic Products			
Conference Paper		Product	StEER document subclass, external communications of findings at conference venues
Journal Papers		Product	StEER document subclass, external communications of findings in journals

Other Products		Product	StEER document subclass, external communications of findings in other venues/audiences
Personnel Models			
Field Assessment Structural Team	FAST	Personnel Model	Standard StEER personnel model, comprised of StEER members charged with field data collection in a Level 2 and Level 3 response; may be multiple sequential or parallel teams numbered FAST-1, FAST-2, etc.
Virtual Assessment Structural Team	VAST	Personnel Model	Standard StEER personnel model, comprised of StEER members charged with virtual data collection and synthesis
Data Librarians		Personnel Model	Undergraduate students responsible for data enrichment and quality control tasks
Research Associates		Personnel Model	Postdoctoral scholars who support overall operations and research/development activities
Student Administrator		Personnel Model	Undergraduate student who manages member records, correspondence
Board of Directors		Personnel Model	Highest unit of governance, includes director, associate directors for each hazard, associate director for data standards (PIs on NSF Award)
StEERing Committee		Personnel Model	10-person governing body, which includes a representative from each Working Group (2) and Hazard Advisory Board (3), two elected at-large StEER members and three elected regional node representatives will be responsible for making activation decisions under the tiered regional response model and will lead the science planning activities
Hazard Advisory Boards		Personnel Model	5-member elected boards dedicated to wind, coastal and earthquake hazards, led by the respective Associate Directors, to guide StEER activities/protocols from each hazard perspective
Working Groups		Personnel Model	Collaboratives focused on specific tasks/capabilities, open to StEER members at all ranks, with an appointed chair

Appendix D. Standard StEER List of Acronyms

General Terms		
American Society of Civil Engineers	ASCE	Professional Organization
Building Officials and Code Administrators	BOCA	Code Body
Creative Commons Attribution License	CC-BY	Code/Standard
Critical Load Path Elements	CLPE	StEER Term
Concrete Masonry Unit	CMU	Building Material
Cyberinfrastructure	CI	Research Asset
DesignSafe	--	Data Repository
DesignSafe-CI	--	Academic Organization within NHERI
Digital Object Identifier	DOI	Common Term
Enhanced Fujita	EF	Intensity Measure
Equipment Facility	EF	Academic Organization within NHERI
Federal Aviation Administration	FAA	Federal Agency
Federal Emergency Management Agency	FEMA	Federal Agency
Frequently Asked Questions	FAQ	Common Term
Government Services Administration	GSA	Federal Agency
Geotechnical Extreme Events Reconnaissance	GEER	Academic Organization within NHERI
International Building Code	IBC	Code/Standard
International Code Council	ICC	Code Body
International Residential Code	IRC	Code/Standard
Interdisciplinary Science and Engineering Extreme Events Research	ISEEER	Academic Organization within NHERI
National Building Code	NBC	Code/Standard
Nearshore Extreme Event Reconnaissance	NEER	Academic Organization within NHERI
Natural Hazards Engineering Research Infrastructure	NHERI	Academic Organization within NHERI
National Oceanic and Atmospheric Administration	NOAA	Federal Agency
National Science Foundation	NSF	Federal Agency
National Weather Service	NWS	Federal Agency
Operations and Systems Engineering Extreme Events Research	OSEEER	Academic Organization within NHERI
RAPID Grant	RAPID	Funding Mechanism
RAPID Experimental Facility	RAPID-EF	Academic Organization within NHERI
Social Science Extreme Events Research	SSEER	Academic Organization within NHERI
Storm Prediction Center	SPC	Federal Agency
Structural Extreme Events Reconnaissance network	StEER	Academic Organization within NHERI
SUstainable Material Management Extreme Events Reconnaissance	SUMMEER	Academic Organization within NHERI
United States Geological Survey	USGS	Federal Agency