NORTH CAROLINA
Department of Transportation









NCDOT - Division of Aviation
UAS Program Office

Darshan Divakaran, UAS Program Engineer

October 12th, 2017

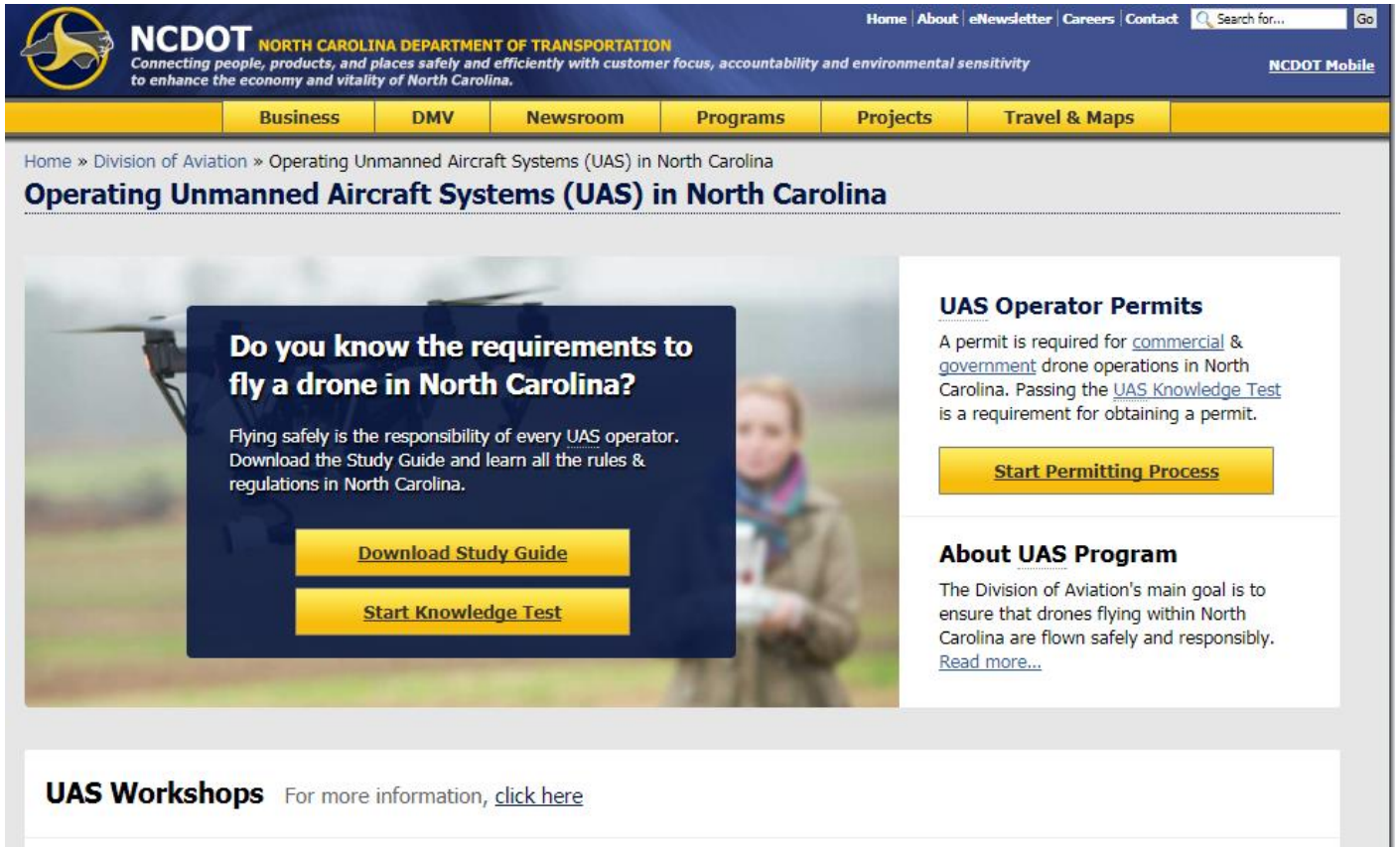
Thomasville Workshop

Location – Davidson County Community College

Address - Mary E. Rittling Conference Center
297 DCC Road, Thomasville, NC 27360

Visit - https://www.ncdot.gov/aviation/uas/

DOA Website



https://www.ncdot.gov/aviation/uas/

Social Media

Search – NCDivisionofAviation

Go ahead click a picture or post and use **#ncdroneworkshop** on social media

NC Drone Safe

#ncdronesafe

Presenters

- Division of Aviation
- FAA
- AUVSI
- Barnhill Contracting Company
- North Carolina Board of Examiners for Engineers and Surveyors
- Precision Hawk
- Duke Energy
- NCDOT Photogrammetry
- ANRA Technologies
- SURVAE
- NCSHP

Presenters


FEDERAL AVIATION ADMINISTRATION


STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION


NORTH CAROLINA
HIGHWAY PATROL
MAY 20, 1775
APRIL 12, 1776


NORTH CAROLINA BOARD OF EXAMINERS FOR ENGINEERS AND SURVEYORS
MAY 20, 1775
APRIL 12, 1776
1921


AUVSI
ALL THINGS UNMANNED


PRECISIONHAWK


ANRA
TECHNOLOGIES


BENCHMARK
TOOL & SUPPLY, INC.


BARNHILL
CONTRACTING
COMPANY


DUKE
ENERGY®


GSC
SURVEYING


GO
UNMANNED
EXPERT UAV SYSTEMS


SURVAE


MONTGOMERY
COMMUNITY COLLEGE


DIVISION OF AVIATION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION


DCCC
THE COLLEGE OF
DAVIDSON AND DAVIE COUNTIES

Main Sponsors

Flight Demo & Data Discussion

Welcome!

Bobby Walston

Director

DIVISION OF AVIATION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

NC Community College

On September 15, 2017 the NC State Board of Community Colleges approved a new UAS course to be offered by any of the 58 community colleges across the state. The course provides 24 hours of instruction to prepare students for FAA Part 107 and the NCDOT UAS Operators Permit. Topics in the course focus on safe flight theory, flight operations, and flight training.

NC State Highway Patrol

On September 29th, 2017 NCSHP had a press release with NCDOT to unveil the newly implemented UAS usage for collision reconstruction and investigation. The UAS will also provide the NCSHP Aviation Unit more time to focus on life saving missions such as search and rescue of missing persons across the state. The NCSHP currently has 2 UAS in deployment and seven members that have their FAA Part 107

Wings of Freedom Tour

DOA invites you to the Collings Foundation's 'Wings of Freedom Tour' from Oct. 19th to Oct. 22nd at RDU airport for a one-of-a-kind chance to see living aviation history. The tour features four living WWII aircraft – a B-17 Flying Fortress, a Consolidated B-24 Liberator, a B-25 Mitchell bomber and a P-51 Mustang. Visitors may also experience the once-in-a-lifetime opportunity to take a 30-minute flight aboard these rare aircraft.

Address –

1050 Meridian Drive,

Morrisville, NC, 27560

Website – http://www.collingsfoundation.org/

NORTH CAROLINA
Department of Transportation

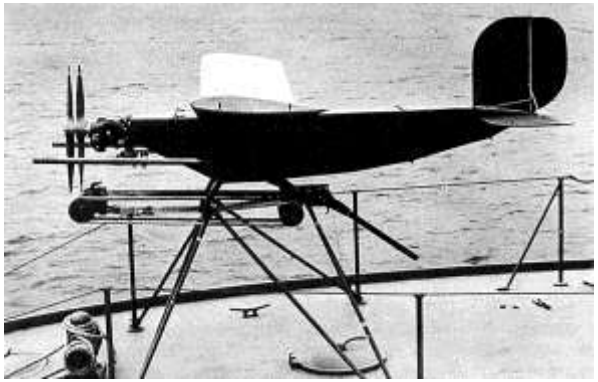
UAS Regulatory Landscape

Basil Yap, UAS Program Manager

October 12, 2017

Quick Drone History Fact

- Radioplane OQ-2 was the first mass-produced drone in the US
- Used to train Army and Navy anti-aircraft gunners during WW2
- The first instance of “Drone” being associated with remotely piloted vehicle



Division of Aviation Mission

Promote the economic well being of North Carolina through air transportation system development and improved aviation safety and education.

Division of Aviation Core Functions

Provide:

- Aviation Safety and Education Programs
- State and Federal Airport Grant Programs
- Air transportation, operations, and support for state agencies
- Management of the state's Unmanned Aircraft System Program

Aviation in North Carolina

Annually:

- 29.1 million total passenger enplanements
- 3.2 million total aircraft operations
- Over 1.4 billion pounds of air cargo

Pilots and Aircraft:

- 17,760 Pilots
- 7,139 Manned Aircraft
- **> 20,253 UAVs***

*as of Feb. 2, 2017 per FAA FOIA Library

Drone Regulations

- Critical to UAS Program Development
  - Constantly Evolving
- Federal Regulations
  - Airspace Safety for Manned and Unmanned Aircraft
- State and Local Regulations
  - Privacy, Safety, Launch and Recovery

UAS Operator Permits

Federal

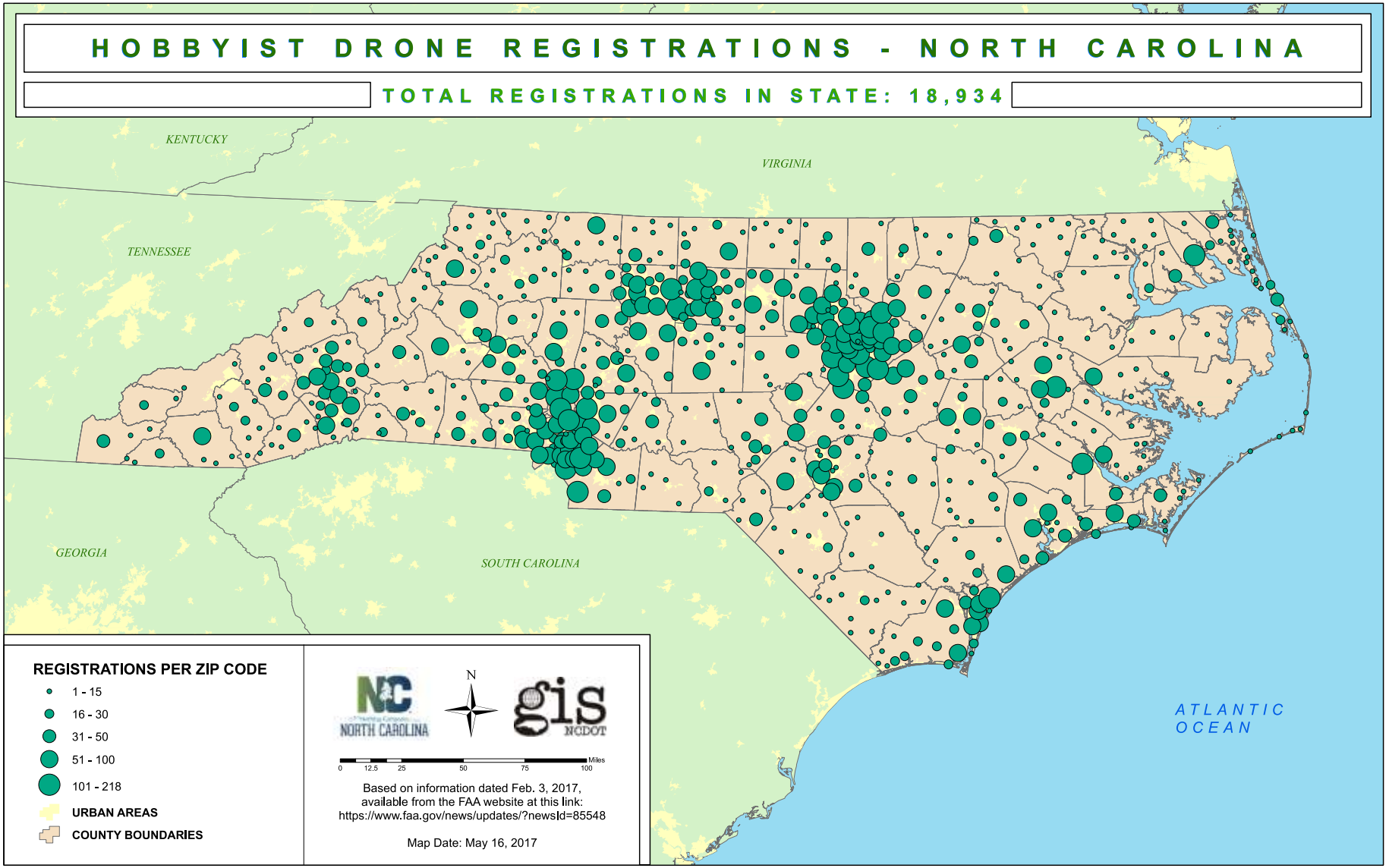
- Pass a UAS knowledge test at FAA testing center and TSA background check
- Apply for Remote Pilot Certificate

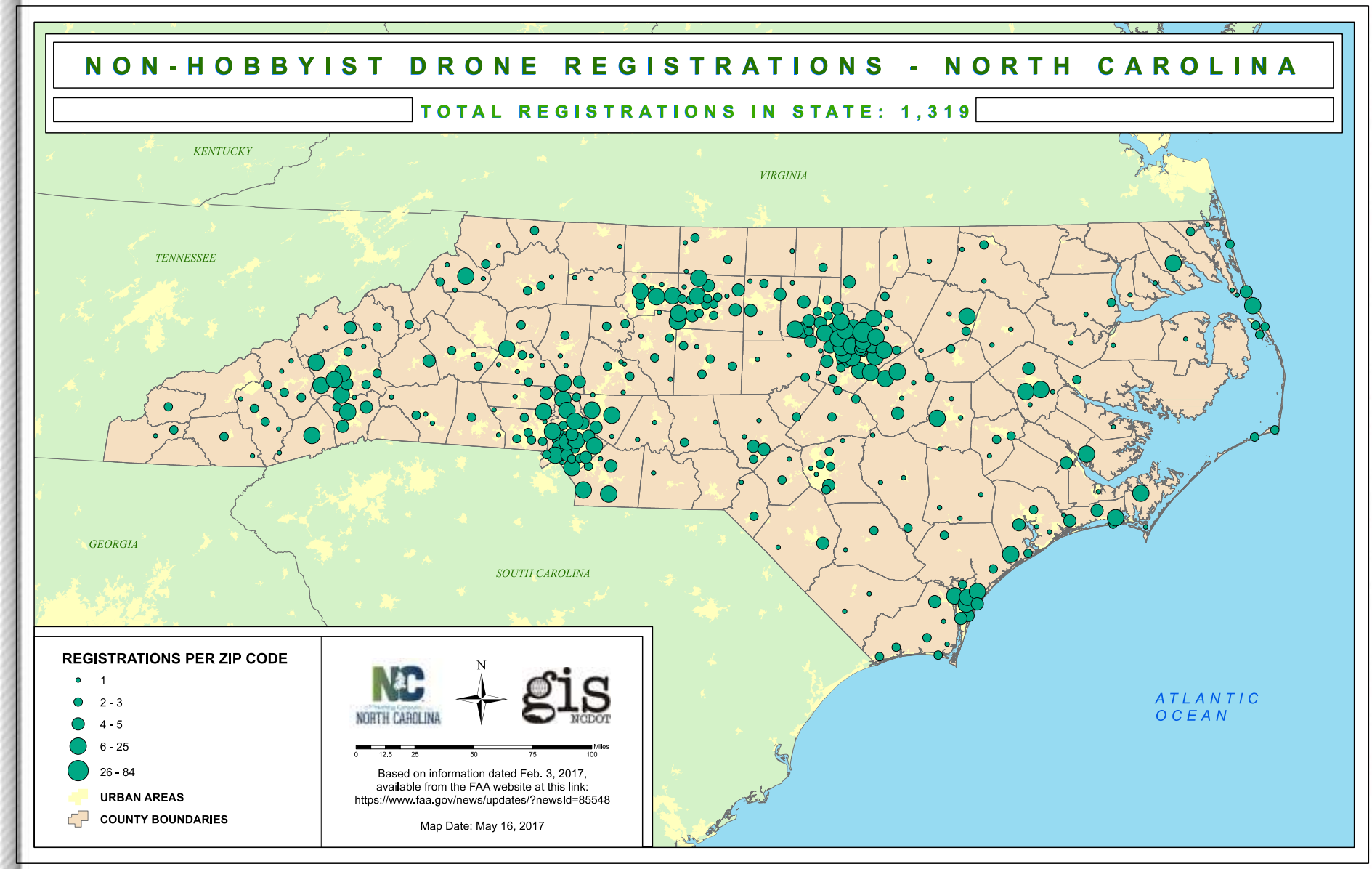
North Carolina

- Pass NC UAS Knowledge test online
- Apply for commercial or government NC Operator Permit online
- www.ncdot.gov/aviation/uas

HOBBYIST DRONE REGISTRATIONS - NORTH CAROLINA

TOTAL REGISTRATIONS IN STATE: 18,934



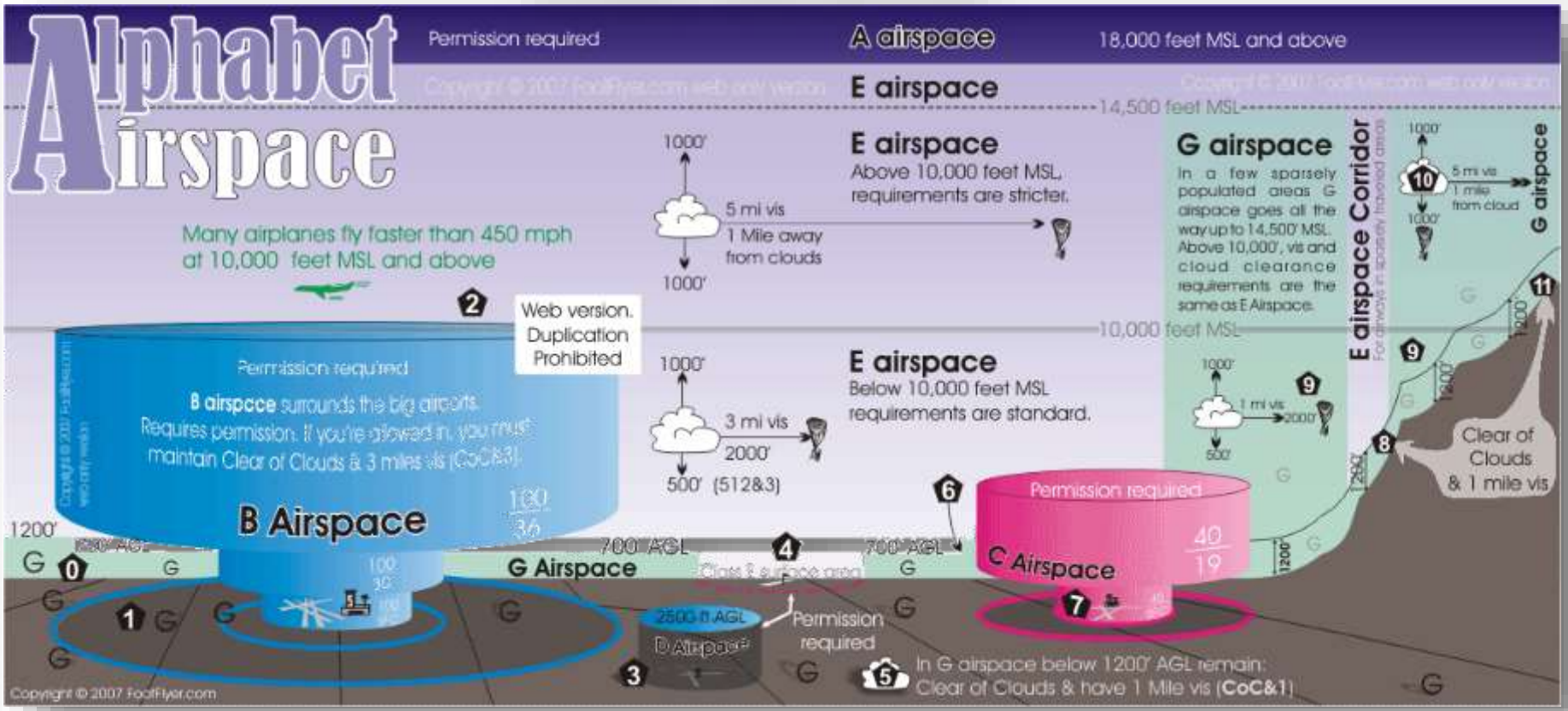

NON-HOBBYIST DRONE REGISTRATIONS - NORTH CAROLINA
TOTAL REGISTRATIONS IN STATE: 1,319
KENTUCKY
VIRGINIA
TENNESSEE
GEORGIA
SOUTH CAROLINA
ATLANTIC OCEAN
REGISTRATIONS PER ZIP CODE
1
2 - 3
4 - 5
6 - 25
26 - 84
URBAN AREAS
COUNTY BOUNDARIES
N
NORTH CAROLINA
gis NCDOT
0 12.5 25 50 75 100 Miles
Based on information dated Feb. 3, 2017, available from the FAA website at this link: https://www.faa.gov/news/updates/?newsId=85548
Map Date: May 16, 2017

North Carolina's Airport System

72 Publicly Owned Airports in North Carolina

Federal UAS Regulations

Airspace Management



Federal UAS Regulations

Hobbyist or Recreational

- 14 CFR Part 101 (E) – Special Rule for Model Aircraft
- Must fly within line of sight
- Must notify an airport of operations within 5 statute miles
- Must not interfere with manned aircraft
- Must follow community based standards
- Must fly solely for hobby or recreation

- 14 CFR Part 107 – Small Unmanned Aircraft Systems
- Obtain Remote Pilot Certificate from FAA (2 years)
- 16 years or older
- Fly during day and civil twilight
- Max altitude of 400 ft. AGL
- Max speed of 100 mph
- Must fly within line of sight
- Cannot fly over people not involved with the operation
- Class G airspace

Federal UAS Regulations

Commercial and Government

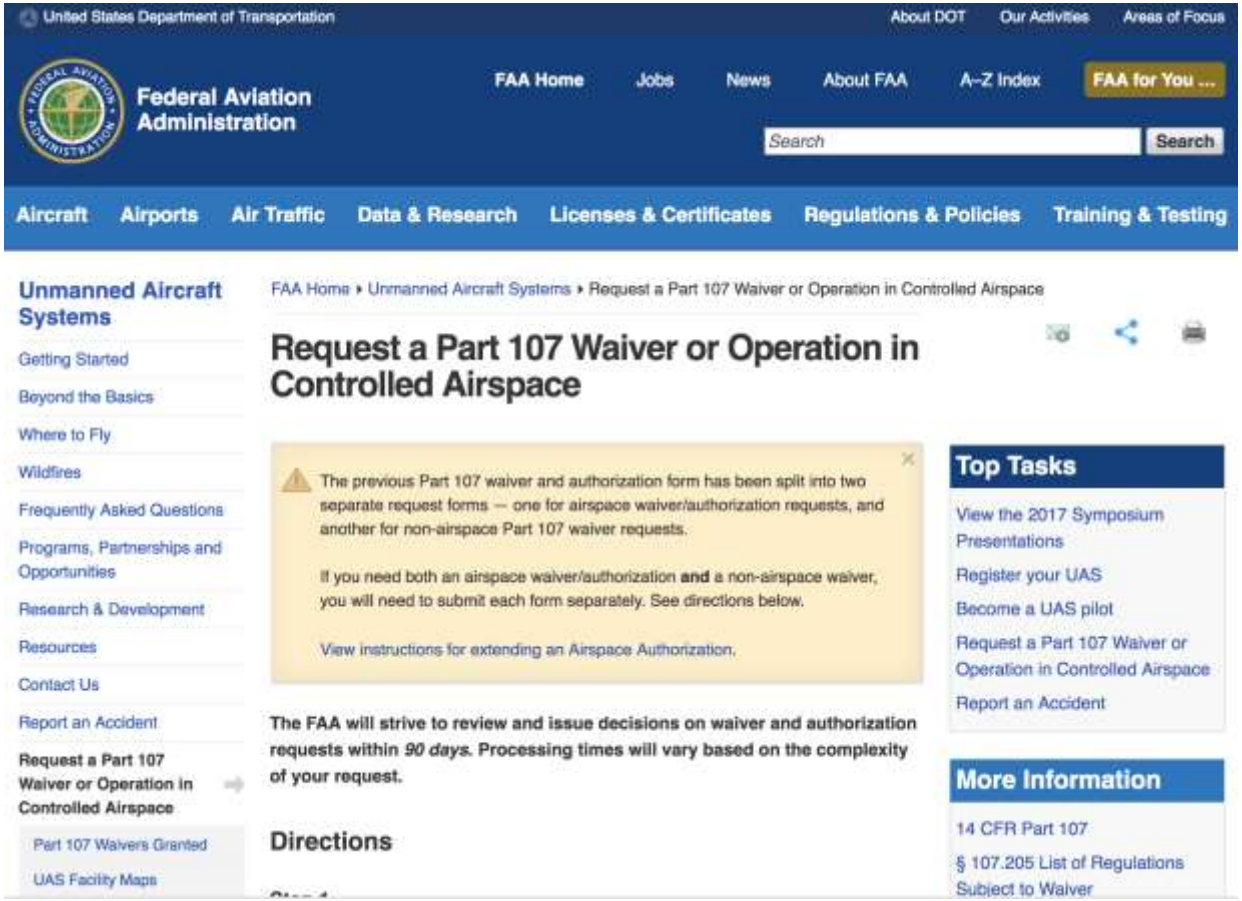
- 14 CFR Part 107 – Small Unmanned Aircraft Systems
- Obtain Remote Pilot Certificate from FAA (2 years)
- 16 years or older
- Aircraft weighs less than 55 lbs.
- Fly during day and civil twilight*
- Max altitude of 400 ft. AGL*
- Max speed of 100 mph
- Must fly within line of sight*
- Cannot fly over people not involved with the operation*
- Class G airspace*

Other options

- 333 Exemptions
- Certificate of Authorization (COA)

*Waivers for certain small UAS operating rules

Federal UAS Regulations



https://www.faa.gov/uas/request_waiver/

Future of Airspace Authorizations

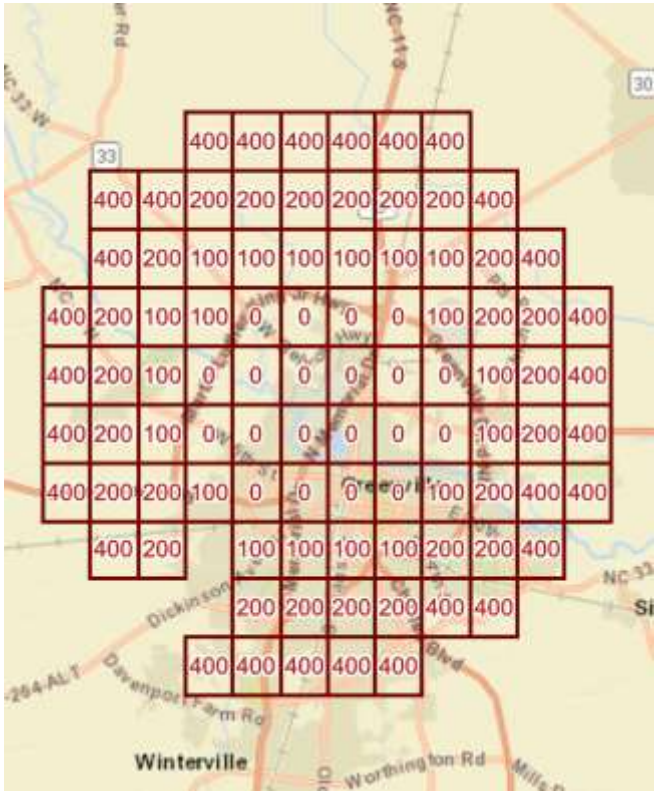
Waiver/Airspace

Currently

- Online Portal
- 90 days or less

Future

- LAANC should help with Airspace Authorizations
- Test run this fall



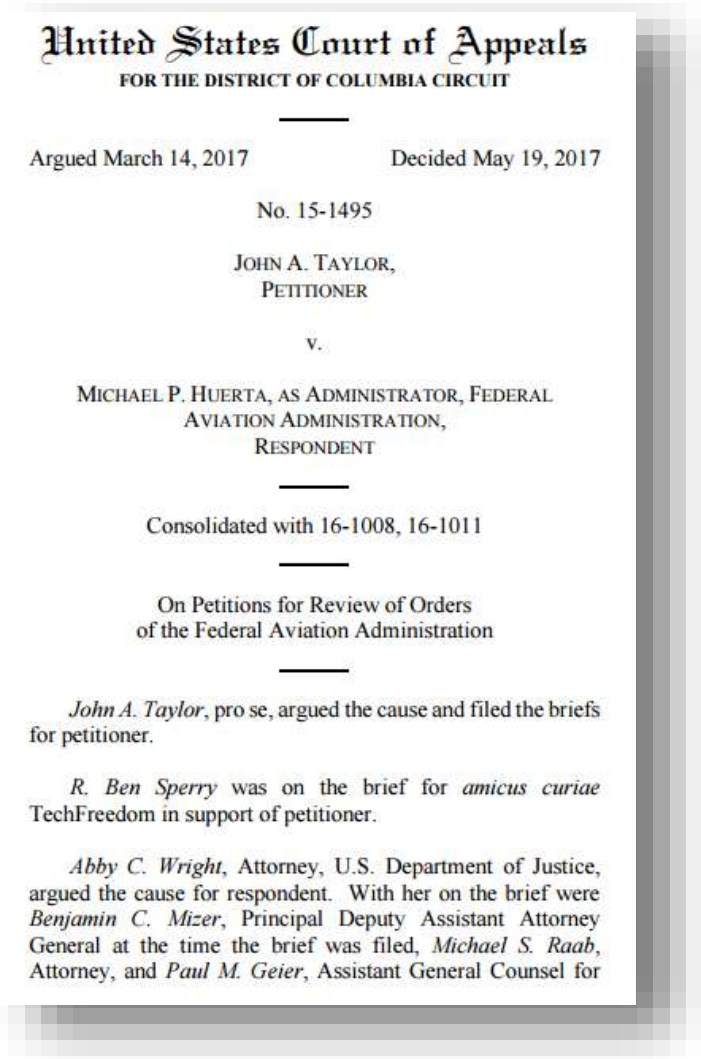
Federal UAS Regulations

- UAS over .55 lbs. must be registered with the FAA*
- https://registermyuas.faa.gov
- $5 registration fee
- UAS must be labeled
- Hobbyist – One number for all aircraft
- Non-Hobbyist – Each aircraft has unique number

*As of May 19,2017, hobbyist operating under the Special Rule for Model Aircraft no longer are required to register their drone

Model Aircraft Ruling

- John A. Taylor vs. FAA
- Ruling May 19, 2017
- Requiring operators under the Special Rule for Model Aircraft to register drones is unlawful
- “In short, Section 336 of the FAA Modernization and Reform Act prohibits the FAA from promulgating “any rule or regulation regarding a model aircraft.” The Registration Rule is a rule regarding model aircraft. Therefore, the Registration Rule is unlawful to the extent that it applies to model aircraft. “



United States Court of Appeals
FOR THE DISTRICT OF COLUMBIA CIRCUIT

Argued March 14, 2017 Decided May 19, 2017

No. 15-1495

JOHN A. TAYLOR,
PETITIONER

v.

MICHAEL P. HUERTA, AS ADMINISTRATOR, FEDERAL AVIATION ADMINISTRATION,
RESPONDENT

Consolidated with 16-1008, 16-1011

On Petitions for Review of Orders
of the Federal Aviation Administration

John A. Taylor, pro se, argued the cause and filed the briefs for petitioner.

R. Ben Sperry was on the brief for *amicus curiae* TechFreedom in support of petitioner.

Abby C. Wright, Attorney, U.S. Department of Justice, argued the cause for respondent. With her on the brief were *Benjamin C. Mizer*, Principal Deputy Assistant Attorney General at the time the brief was filed, *Michael S. Raab*, Attorney, and *Paul M. Geier*, Assistant General Counsel for

Military Airspace

- National Security UAS Flight Restrictions
- FAA and DoD have restricted UAS operations over 132 military facilities.
- The restrictions are up too 400’ AGL, 24 hours a day, 7 days a week.
- Facilities can be found here: http://uas-faa.opendata.arcgis.com/
- Other FAA restricted areas for civil operations apply to UAS operators

County	Base	FAA ID
Onslow	Marine Corps Air Station New River	20170410-DOD-New River-MCAS New River 2
Carteret	MCALF Bogue, Marine Corps Air Station Cherry Point	20161222-DOD-MCALF Bogue-Auxiliary Landing Field (ALF) Bogue CDSA by NOTAM during scheduled operations only.
Jones	MCOLF Oak Grove, Marine Corps Air Station Cherry Point	20161222-DOD-Oak Grove-Outlying Landing Field (OLF) Oak Grove CDSA by NOTAM. Heavy use as an uncontrolled airport.
Richmond	Fort Bragg, NC	20161222-DOD-Fort Bragg-Mackall AAF
Cumberland	Fort Bragg, NC	20161222-DOD-Fort Bragg-Simmons AAF
Stanly	Stanly County, NC	20161222-DOD-Stanly County-Stanly County
Onslow	MCB Camp Lejeune	20170508-DOD-MCB Camp Lejeune

Congressional Action

- Drone Federalism Act
  - S.1272
- Drone Innovation Act
  - H.R. 2930
- Both bills shift the regulatory authority to local and state governments while preserving defined parts of federal preemption
- Bard College released a study stating 135 local governments in 31 states enacted drone legislation

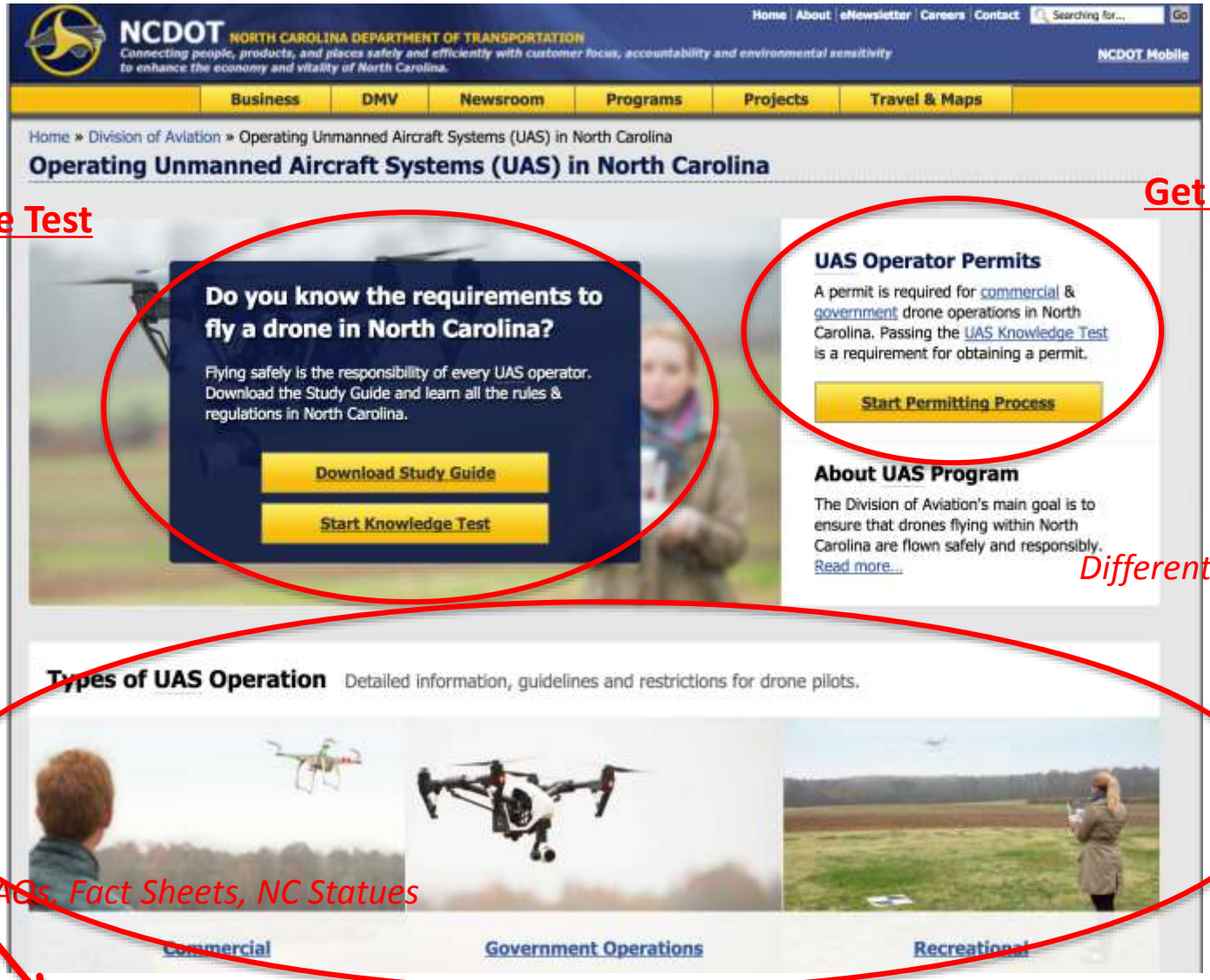
State UAS Regulations

- North Carolina General Assembly passed UAS bills into law in 2013, 2014, 2015, 2016, 2017
- Chapter 14 – Criminal Law
  - § 14-7.45 Crimes committed by use of UAS
  - § 14.280.3 Interference with manned aircraft by UAS
  - § 14.401.24 Unlawful possession and use of UAS (Weapon attached)
  - § 14.401.25 Unlawful distribution of images
- Chapter 15A – Criminal Procedure
  - § 15A-300.1 Restrictions on use of UAS
  - § 15A-300.2 Regulation of launch and recovery sites
  - " § 15A-300.3. Use of an unmanned aircraft system near a confinement or correctional facility prohibited.
- Chapter 63 – Aeronautics
  - § 63-95 Training required for operations of UAS (Knowledge Testing)
  - § 63-96 Permit required for commercial operation of UAS
- Chapter 113 – Conservation and Development
  - § 113-295 Unlawful harassment of persons taking wildlife resources

State UAS Regulations

- § 63-95 Training required for operations of UAS (Knowledge Testing)
  - The Division of Aviation will develop and administer a UAS Knowledge Test
  - Applicable to both government and commercial operators who operate in North Carolina
  - The test can be completed online and is the first part of the permitting process
- § 63-96 Permit required for commercial operation of UAS
  - Must be 16 years of age
  - Must provide a drivers license number
  - Must meet the federal requirements for access to the airspace (Remote pilot certificate)
  - Applies to commercial operators only
  - Application for permit is completed online

NCDOT Aviation UAS Website – One Stop



Take the Test

Get Permit

Learn

Different types of UAS operations

Help

Access FAQs, Fact Sheets, NC Statues

UAS Operator Permits

Federal

- Pass a UAS knowledge test at FAA testing center and TSA background check
- Apply for Remote Pilot Certificate

North Carolina

- Pass NC UAS Knowledge test online
- Apply for commercial or government NC Operator Permit online
- www.ncdot.gov/aviation/uas

State UAS Regulations

HB337

- Clarifies model aircraft applicability
- Remove restrictions around special imaging
- Adds emergency management exception
- Brings the NC UAS Permit in line with Federal requirements (age and Identification)
- Signed into law July 21, 2017
- Effective December 1, 2017

HB128

- Establishes § 15A-300.3. Use of an unmanned aircraft system near a confinement or correctional facility prohibited.
- Exceptions for commercial operators
- Signed into law July 25, 2017
- Effective December 1, 2017

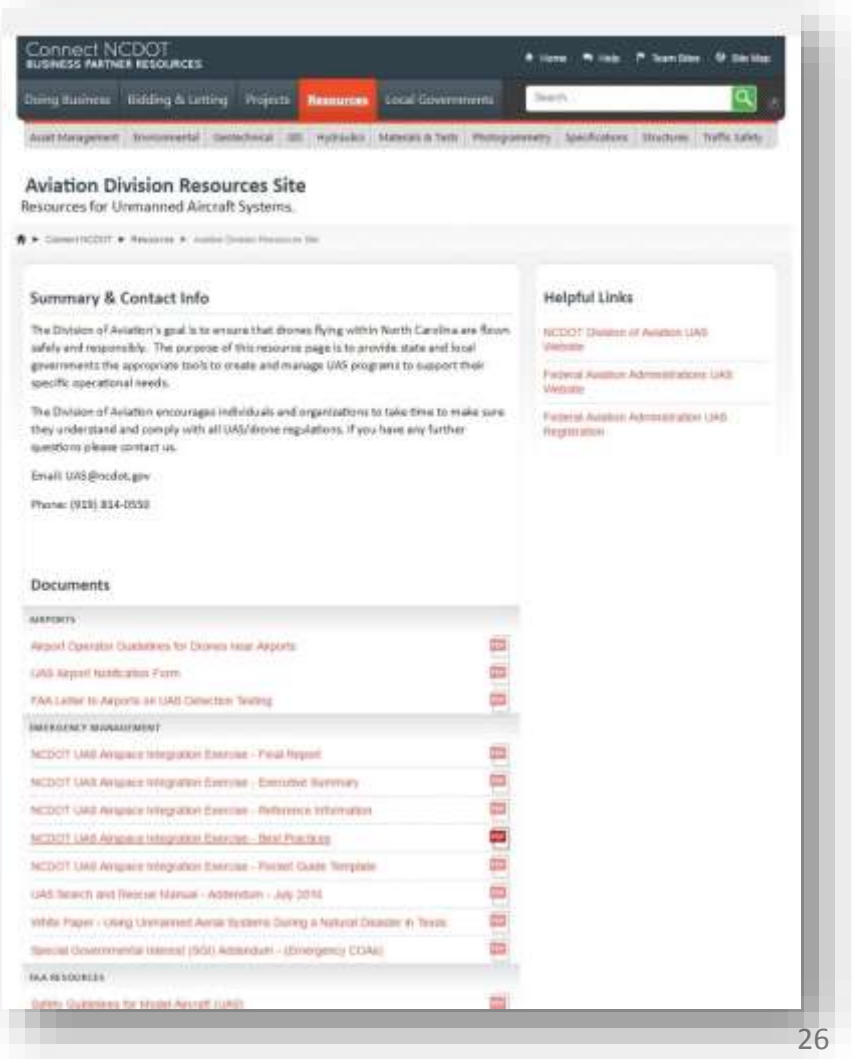
NC UAS Operator Checklist

- ✓ FAA Authorization – Must obtain:
  - Remote Pilot Certificate (under Part 107)
  - Or hold a 333 exemption
- ✓ FAA UAS Registration
  - All UAS/Drones above .55lbs
- ✓ NC Knowledge Test
  - Take and pass the test on the NCDOT Division of Aviation website
- ✓ NC Government Operator Permit or NC Commercial Operators Permit
  - Once you have passed your NC UAS Knowledge Test, you may obtain a permit
  - Need to have an airman certificate to complete the process
  - No fee charged at this time
- ✓ Insurance (best practice)

NCDOT UAS Resource Page

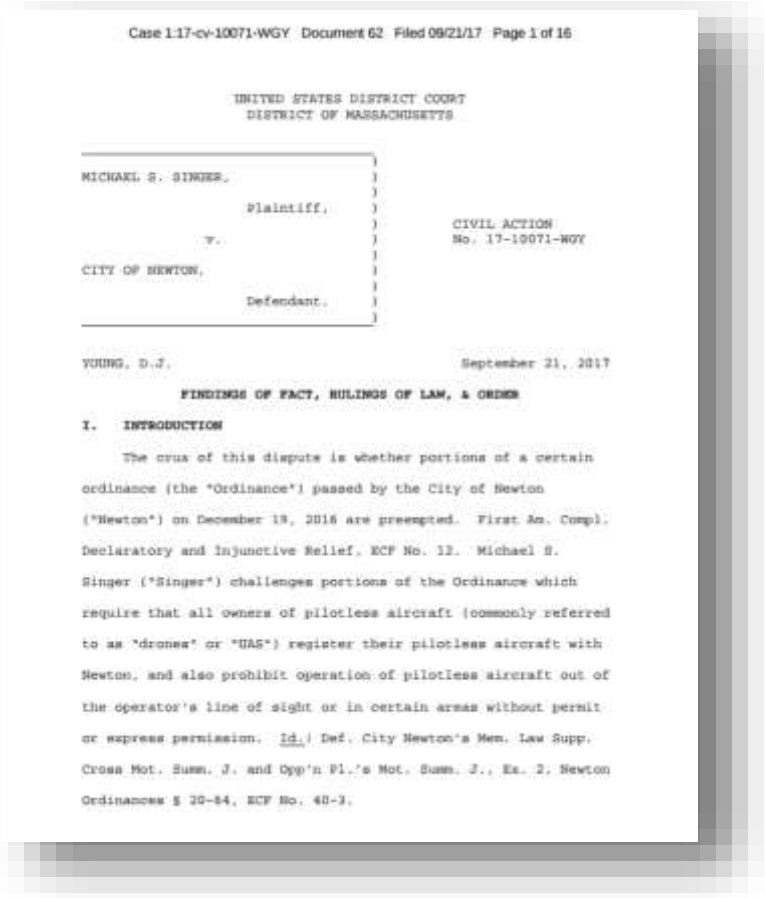
Publicly available online:

- List of NC General Statutes
- Best Practices
- UAS Research Reports
- UAS Related Links
- FAA Resources
- Law Enforcement Resources
- Emergency Management Resources
- Airport Operator Resources
- https://connect.ncdot.gov/resources/Pages/Aviation-Division-Resources.aspx



Local Ordinance Ruling

- Singer vs Newton
- Ruling September 21, 2017
- Four ordinances were conflict preempted
- Registration of UAS
- Altitude restrictions over private property without permission
- Altitude restrictions over public property
- Restriction on beyond visual line of sight operations



Case 1:17-cv-10071-WGY Document 62 Filed 09/21/17 Page 1 of 16

UNITED STATES DISTRICT COURT
DISTRICT OF MASSACHUSETTS

MICHAEL S. SINGER,
Plaintiff,
v.
CITY OF NEWTON,
Defendant.

CIVIL ACTION
No. 17-10071-WGY

YOUNG, D.J. September 21, 2017

FINDINGS OF FACT, RULINGS OF LAW, & ORDER

I. INTRODUCTION

The crux of this dispute is whether portions of a certain ordinance (the "Ordinance") passed by the City of Newton ("Newton") on December 19, 2016 are preempted. First Am. Compl. Declaratory and Injunctive Relief, ECF No. 12. Michael S. Singer ("Singer") challenges portions of the Ordinance which require that all owners of pilotless aircraft (commonly referred to as "drones" or "UAS") register their pilotless aircraft with Newton, and also prohibit operation of pilotless aircraft out of the operator's line of sight or in certain areas without permit or express permission. Id.; Def. City Newton's Mem. Law Supp. Cross Mot. Summ. J. and Opp'n Pl.'s Mot. Summ. J., Ex. 2, Newton Ordinances § 20-64, ECF No. 40-3.

Questions

www.ncdot.gov/aviation/uas

www.faa.gov/uas

Basil Yap
UAS Program Manager
(919) 814-0572
bkyap@ncdot.gov

Tim Camelin
Aviation Safety Technician
Greensboro FSDO, EA39
(336) 369-3932

DIVISION OF AVIATION
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION


BARNHILL
CONTRACTING
COMPANY
RESERVED
PARKING
MAXIMUM
PENALTY
$250

Cody Whitelock

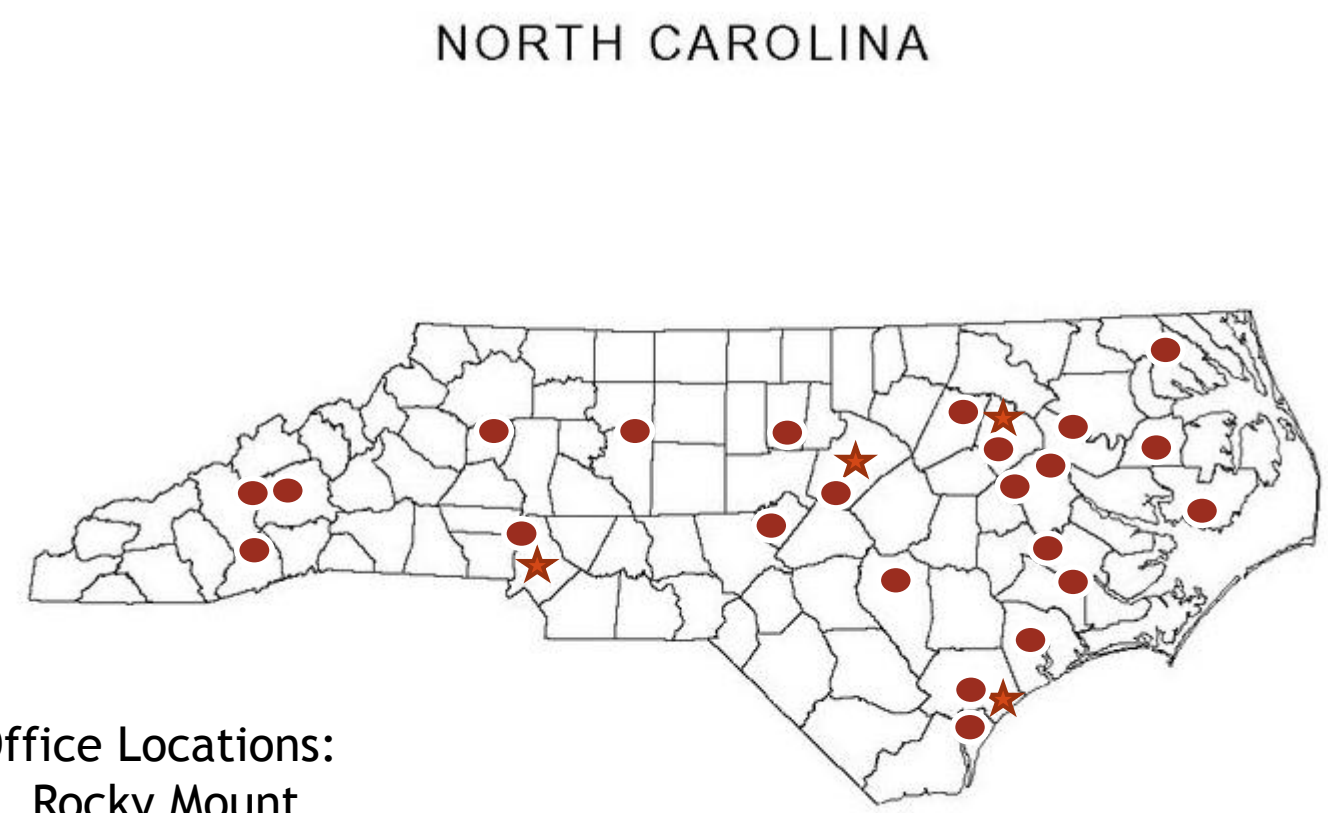
CLEMSON UNIVERSITY

- Bachelors of Science in Civil Engineering 2015
- Virtual Design & Construction Engineer Manager
- 6 years Experience with BIM
  (Building Information Modeling)
- 3 years Flying Drones (100+ Hours)
- RC/Fixed Wing/Quad Experience

BARNHILL


E. Barnhill, Sr. and
g form Barnhill
Construction
urplus equipment
sed from the US
ment after WWII.
1950's
1952
Robert buys RW's interest in Barnhill & Long and renames the company Barnhill Contracting Company. Later that year, Barnhill is awarded its first major project, a farm-to-market road from Ahoskie to Murfreesboro.
1960's
ASPHALT
DM
PAVING
985
arnhill purchases
scar Miller Contractor,
hich includes an asphalt
ant in Raleigh.
OSCAR MILLER
FORD
1987
Bob Barnhill is named President of the company. Robert E. Barnhill, Sr. becomes Chief Executive Officer and Chairman of the Board.
1990's
2000's
BPC
2012
Barnhill purchases the assets of Barnes Paving, adding an asphalt plant in Lumberton.
BARNHILL
Lumberton Plant
#215
arnhill is named
ent of the company.

History



- Office Locations:
  - Rocky Mount (Headquarters)
  - Raleigh
  - Charlotte
  - Wilmington
- Project Locations

Rankings

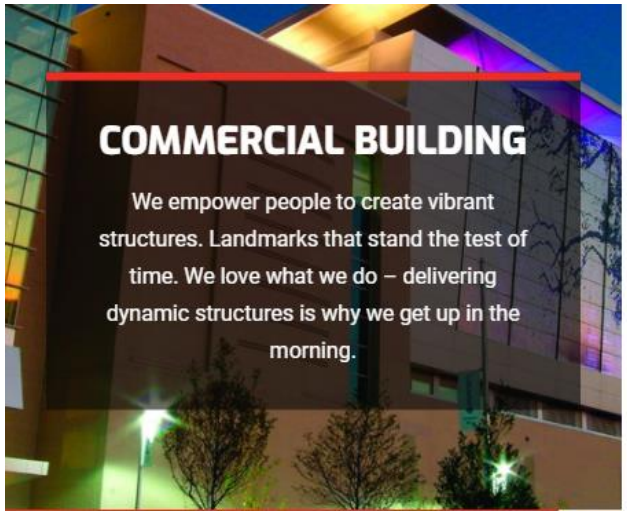
#135 ENR Top Contractors in US

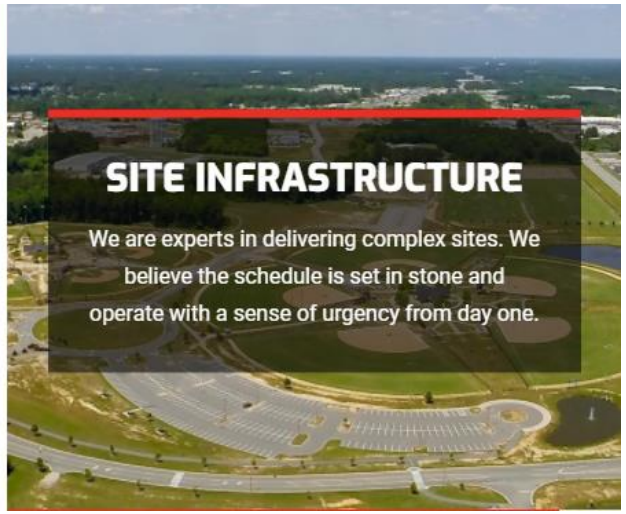
#16 ENR Southeast Top Contractors in Region

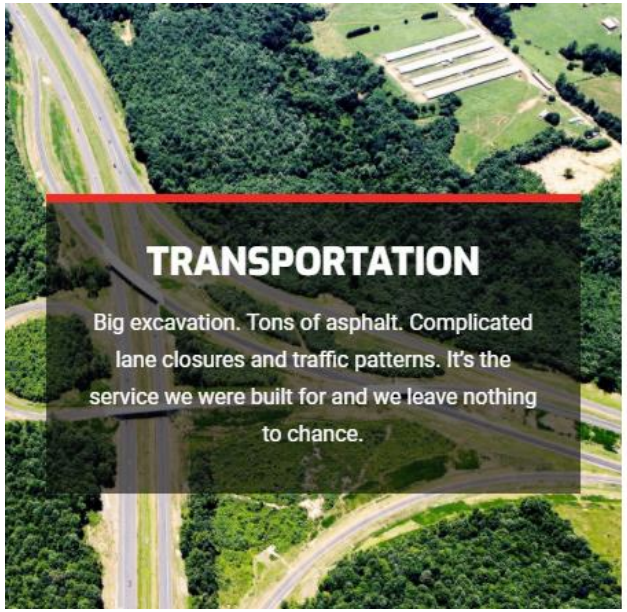
#1 Triangle Business Journal Largest Contractors in the Triangle

#2 Triangle Business Journal Largest Contractors in NC

#11 Business NC Top Privately Held Companies







WAKE COUNTY JUSTICE CENTER

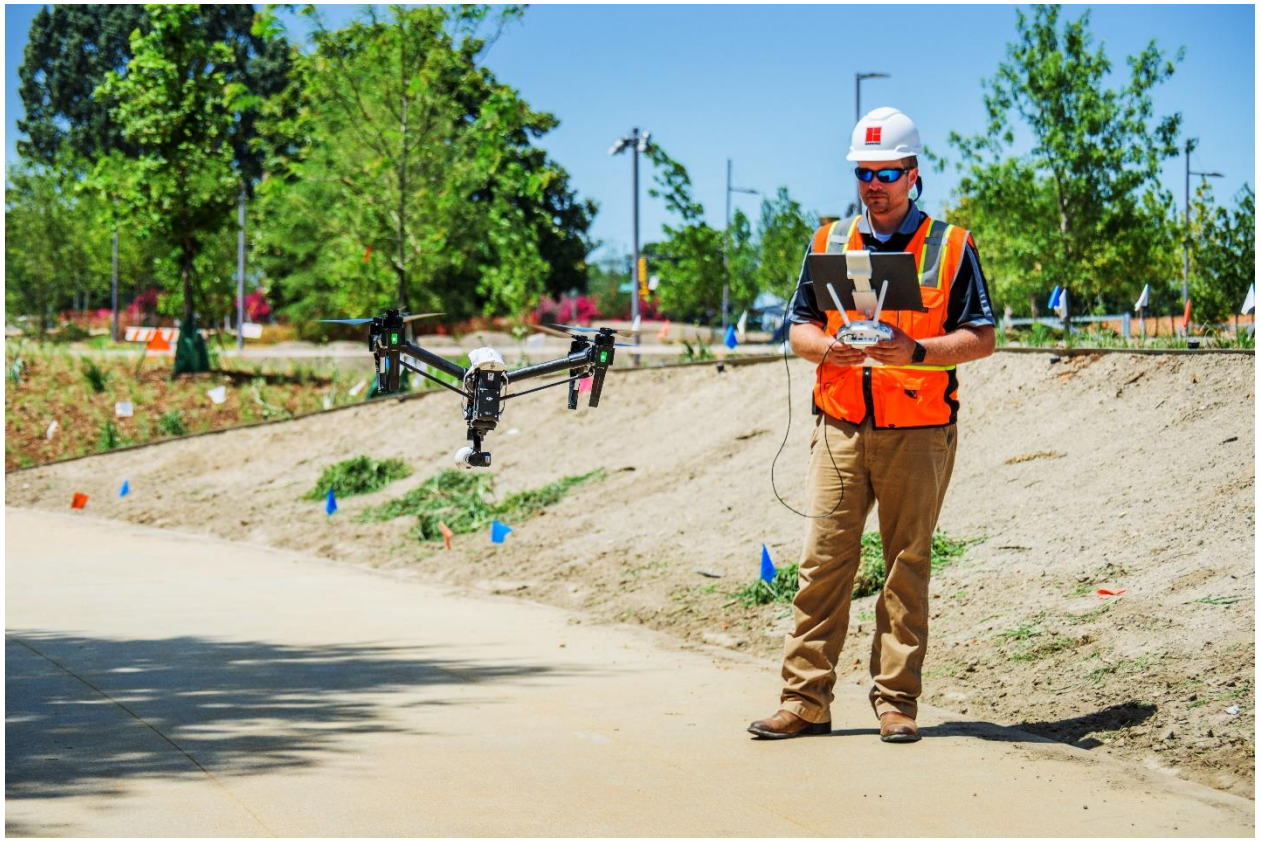
RALEIGH CONVENTION CENTER


NORTH CAROLINA MUSUEM OF ART

THE DILLON – DOWNTOWN RALEIGH

DURHAM INNOVATION DISTRICT

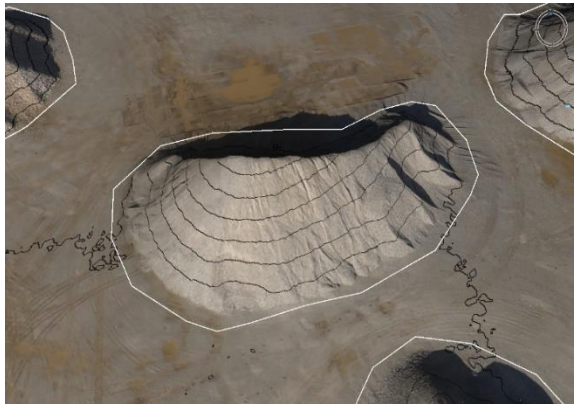
Barnhill Fleet

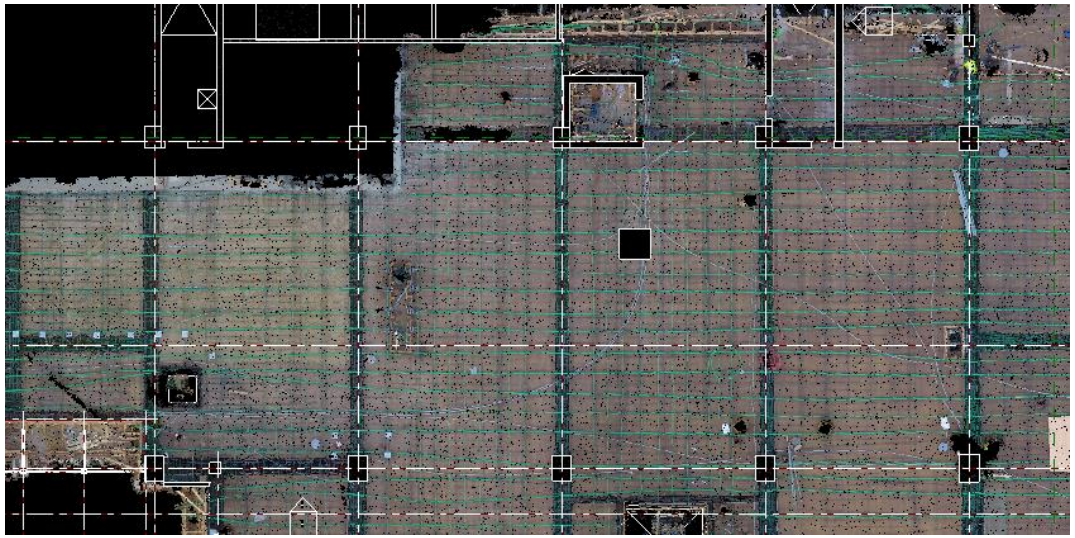


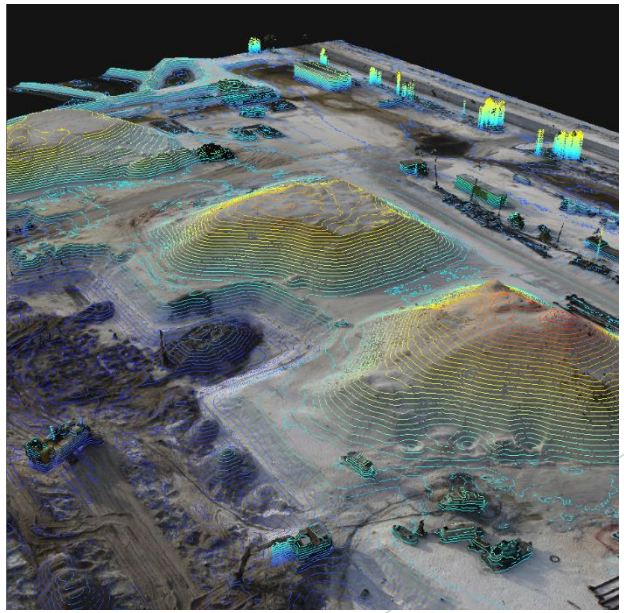
PHANTOM 4

Barnhill Drone Uses:

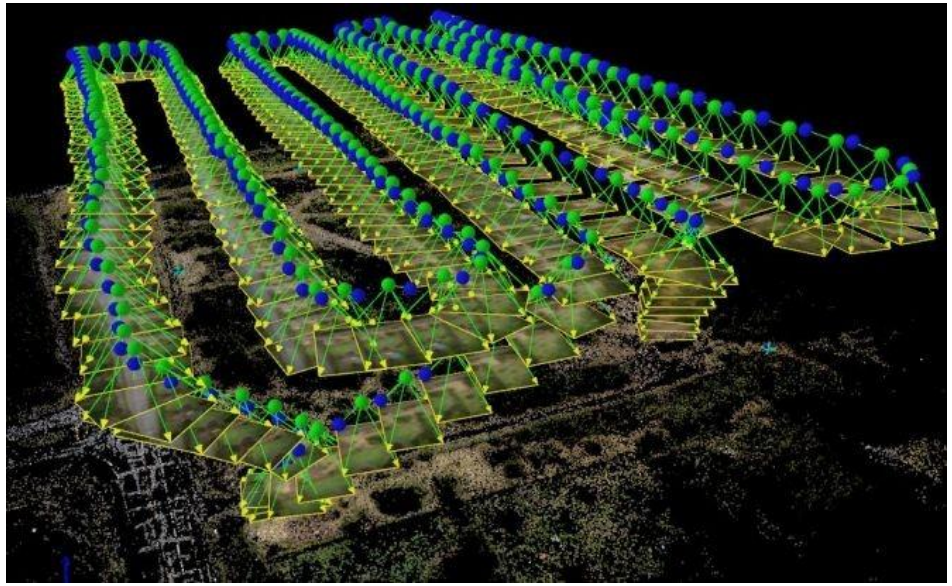
- Site Progress
- Marketing
- Post Tension Inspection
- Construction Inspection
- Contours
- Stock Pile Analysis
- Site Logistics Planning





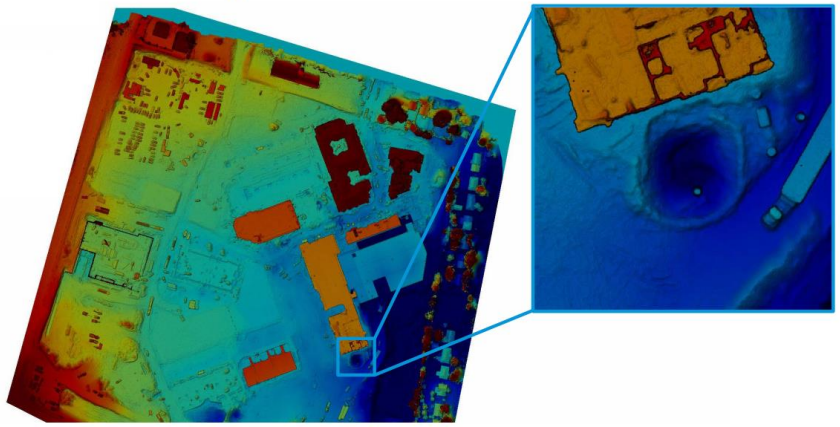


SITE – EXISTING CONDITIONS

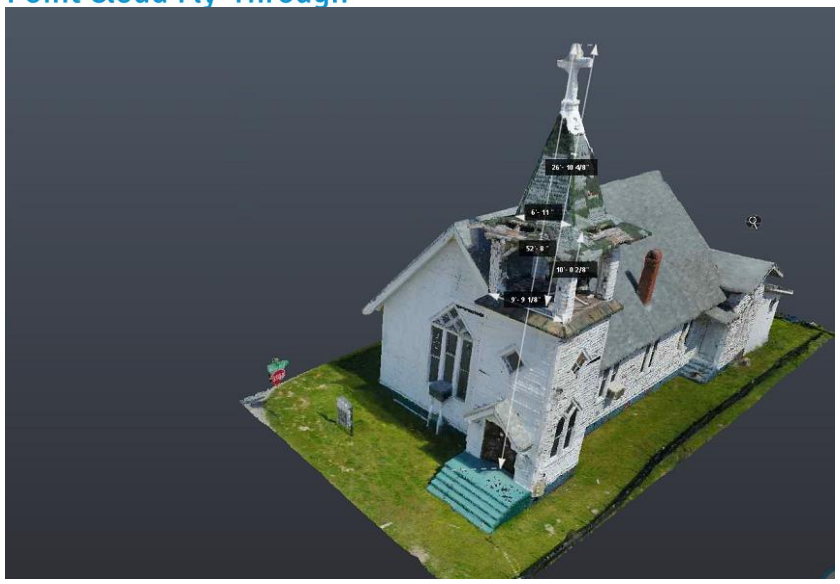


High-Res Orthomosaic Map

Elevation Digital Surface Model



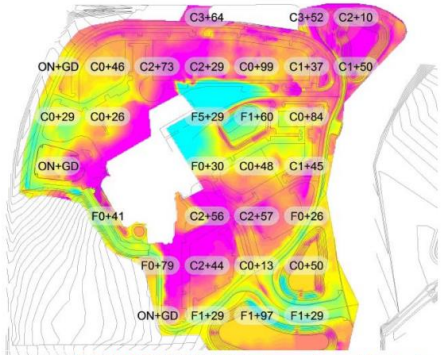
Point Cloud Fly-Through



Aerial Survey Outputs & Results

FLORIDA HOSPITAL | Contour Line Map

	Total	Cut	Fill	OnGrade	Cut	Fill	Cu
Region 1	1,252,510	882,893	304,004	65,613	54,867	17,518	1.0



FLORIDA HOSPITAL | Soils Import/Export Analysis

SITE LOGISTICS FOR BUILDINGS USING INFRAWORKS/DRONE

SITE LOGISTICS FOR INFRASTRUCTURE USING INFRAWORKS/DRONE

Challenges of Drone Laws in Construction

Part 107 Airspace Authorizations

107.41 Authorization vs Waiver

FAA UAS SYMPOSIUM

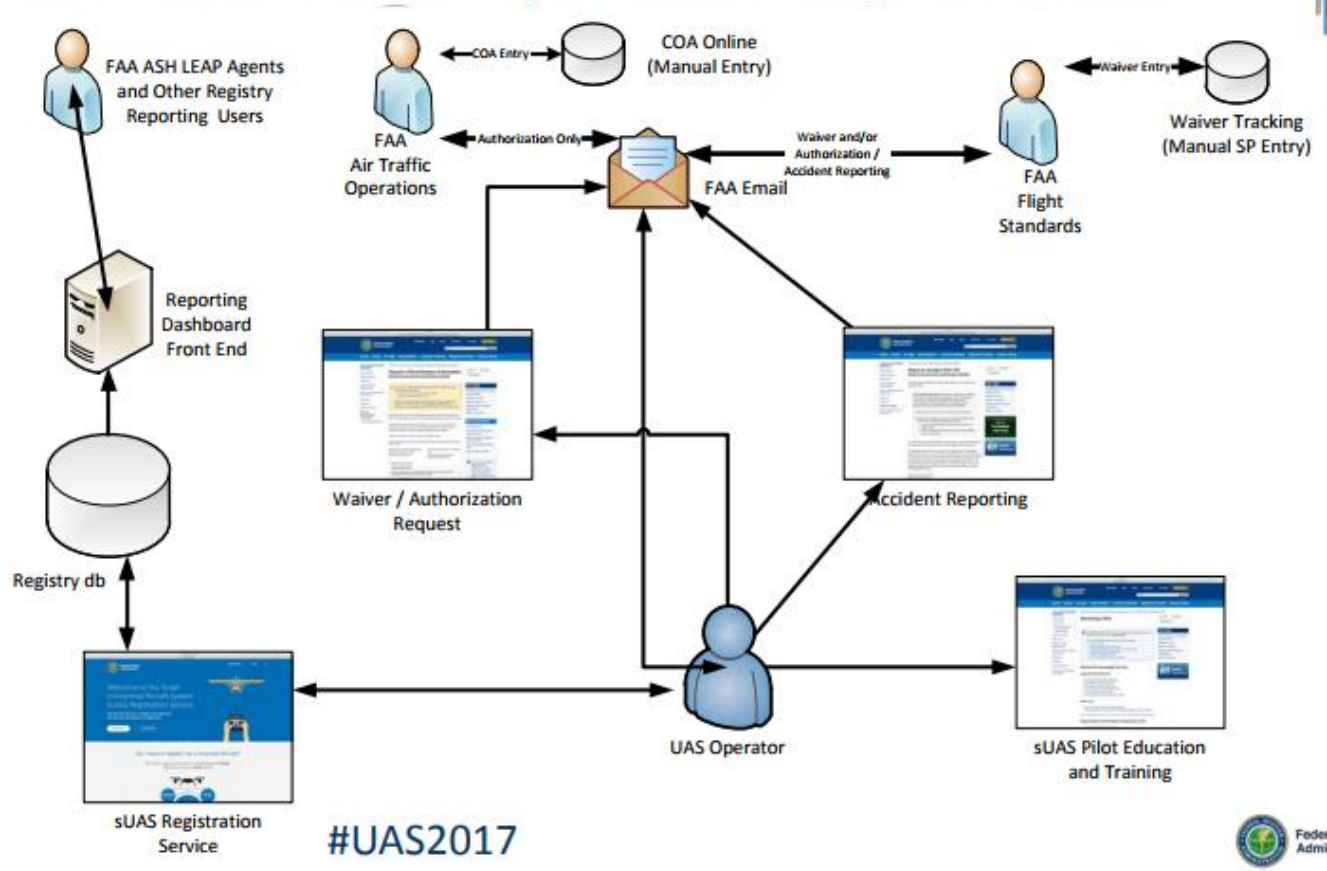
Authorization

- Limited duration (up to 6 months)
- Limited operational area
- Quicker to process

Waiver

- Up to 2 years
- Long term recurring operations
- Broad access to controlled airspace
- 90+ days to process

Current sUAS Operator Experience



#UAS2017

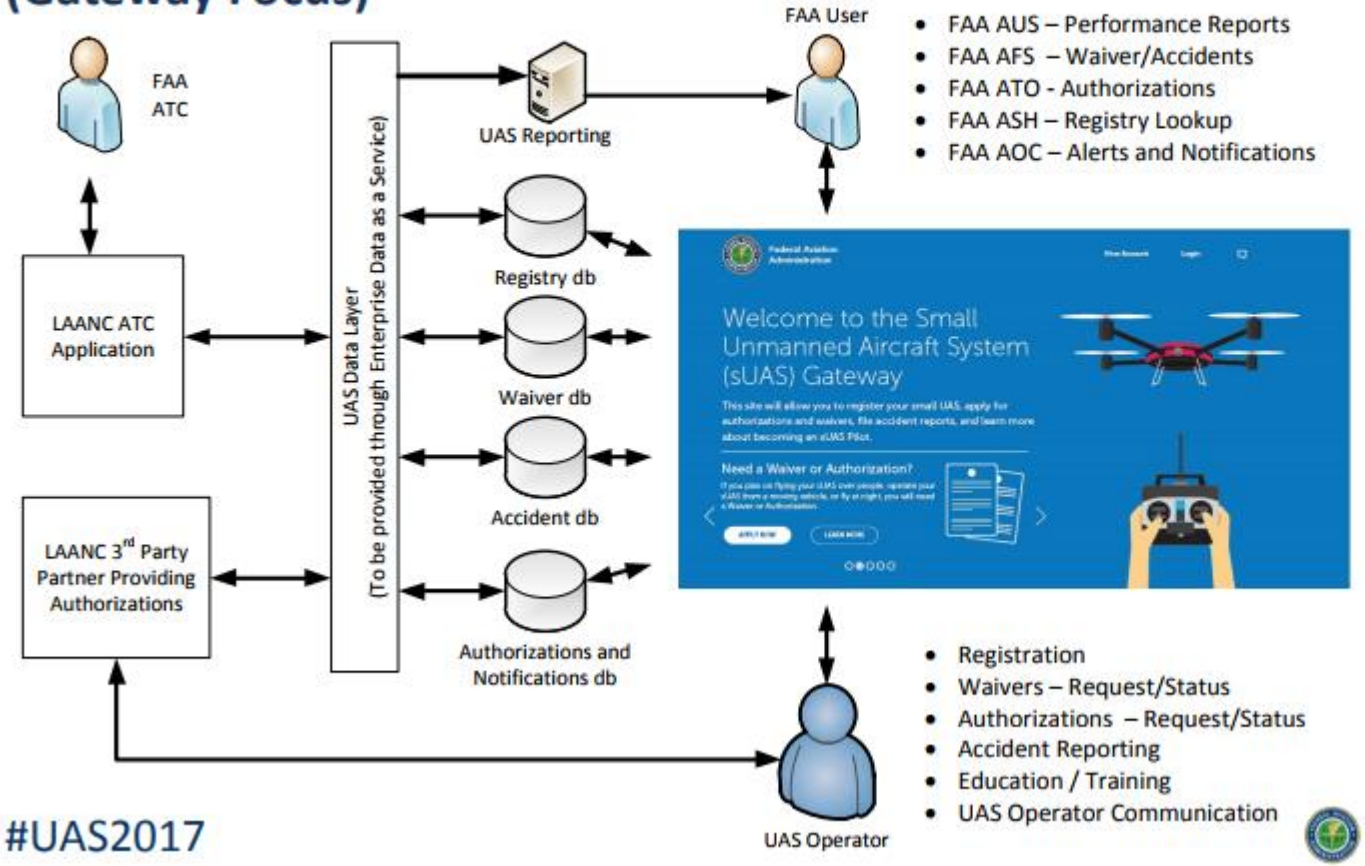
FAA UAS SYMPOSIUM

Federal Aviation Administration

AUVSI

Future sUAS Operator Experience

(Gateway Focus)



- FAA AUS – Performance Reports
- FAA AFS – Waiver/Accidents
- FAA ATO - Authorizations
- FAA ASH – Registry Lookup
- FAA AOC – Alerts and Notifications

- Registration
- Waivers – Request/Status
- Authorizations – Request/Status
- Accident Reporting
- Education / Training
- UAS Operator Communication

#UAS2017

Other Challenges

HOVER

#1 App for Drone Enthusiasts

PIX4D

imply powerful

AIRMAP

Verifly

SkyVector

Aeronautical Charts

AUTOPILOT

QUESTIONS?

NCDOT Division of Aviation

DRONE WORKSHOP
FOR COMMERCIAL AND
GOVERNMENT OPERATORS
PIEDMONT-TRIAD

Thomasville, NC
October 12, 2017

Unmanned Aircraft Systems and Surveying

NC Board of Examiners for Engineers and Surveyors

David Tuttle, Board Counsel
Mark Mazanek, Director of Firm Licensure

Where we're headed!

WHAT THE BOARD HAS SAID ABOUT UAS

- Article in Newsletter
- FAA and State Regulation of the Flying
- Board Regulation of the Work Product

BOARD POLICIES

- What are policies?
- Where can you find them?

SPECIFIC POLICIES

QUESTIONS

The Board of Examiners for Engineers and Surveyors

THE BOARD:
Four Professional Engineers
Three Professional Land Surveyors
Two Public Members

RESPONSIBILITY:
§ 89C-2. In order to safeguard life, health, and property, and to promote the public welfare, the practice of engineering and the practice of land surveying in this State are hereby declared to be subject to regulation in the public interest. It shall be unlawful for any person to practice or to offer to practice engineering or land surveying in this State, as defined in the provisions of this Chapter

Regulation of the Practice of Engineering and Land Surveying

www.ncbels.org Rules and Laws

- NCGS 89C – The Statute
- NCAC Title 21 Chapter 56 – The Rules in the NC Administrative Code

§ 89C-23. Unlawful to practice engineering or land surveying without licensure; unlawful use of title or terms; penalties; Attorney General to be legal adviser.

Any person who shall **practice, or offer to practice**, engineering or land surveying in this State without first being licensed in accordance with the provisions of this Chapter, or any person, firm, partnership, organization, association, corporation, or other entity using or employing the words "engineer" or "engineering" or "professional engineer" or "professional engineering" or "land surveyor" or "land surveying," or any modification or derivative of those words in its name or form of business or activity except as licensed under this Chapter or in pursuit of activities exempted by this Chapter, … in addition to **injunctive procedures** set out hereinbefore, shall be **guilty of a Class 2 misdemeanor**.

Photogrammetry

Photogrammetry is within the practice of land surveying as defined in GS 89C-3(7):

5. Determining the configuration or contour of the earth's surface or the position of fixed objects on the earth's surface by measuring lines and angles and applying the principles of mathematics or photogrammetry;

What the Board has said about UAS

Board Newsletter Article, Spring 2016

FAA and State regulations for flying

Board Rules for Surveying


North Carolina Board of Examiners for Engineers & Surveyors
10/4/2017
Forms | License Lookup | PE/PLS Renewals | Continuing Education | Enforcement | Businesses | Contact
Board Links
Enforcement
FAQ
Newsletters
Fees
Rules/Laws
Policies/Guidelines
Corrections
Licensees Only
Renew Online
(c)James West/JWestProductions.com The Freelon Group Architects
Notice
The Fall 2016 newsletter is now available.
Fall 2016 (eReader version)
Fall 2016 (pdf version)
For any Professional Engineer or Professional Land Surveyor that has not yet renewed their license for 2016, the last day to do so

The North Carolina Bulletin

The Newsletter of the North Carolina Board of Examiners for Engineers and Surveyors

May 2016 Spring Issue

Unmanned Aircraft Systems (UAS) in North Carolina

by Richard M. Benton, PLS
Board Vice Chair & Surveying Committee Chair

Popularity

“Unmanned Aircraft Systems (UAS), Unmanned Aerial Vehicle (UAV), Drone, no matter what you call them, it seems you can’t pick up a professional magazine anymore without being bombarded by advertisements and articles for this newly emerging technology. Currently UAS are being used for agriculture crop land analysis, quantities , stock pile measurement, topographic surveys, utility line inspection, mineral exploration, geophysical surveys, search and rescue and disaster analysis just to name a few.”

Regulation of the Flying

"The Federal Aviation Administration (FAA) has exclusive sovereignty over airspace in the United States (49 U.C. Code) including the airspace above private property. The FAA establishes the operating rules governing that airspace in the form of Federal Aviation Regulations (FAR's) which cover pilot and aircraft certification requirements."

North Carolina Department of Transportation Division of Aviation (NCDOT/DOA) regulation.

Regulation of the Flying

“Engineers and Surveyors using UAS for inspections, aerial photography, topographic surveys, etc. is considered commercial use even if intended for in-house use only.”

A PE or PLS must meet all regulations for flying, just as the pilots must meet all regulations for engineering and surveying with respect to any work product produced that falls within the definition of engineering or land surveying in NC Generals Statute 89C-3.

Regulation of the Flying

Any individual or company using UAS technology in NC must meet ALL Federal, State and Local requirements prior to its use on every project.

Failure to meet ALL Federal, State and Local requirements prior to any UAS use may result in a violation of Board Rule 21 NCAC 56 .0701(b): "*A licensee shall conduct the practice in order to protect the public health, safety and welfare.*"

Regulation of the Work Product

UAS mapping is photogrammetry

The difference is the aircraft and metric camera or sensor is being replaced with a smaller unmanned vehicle and a non-metric camera or sensor, it's still photogrammetry.

As with any Engineering or Surveying issue brought before the Board, the licensee will be required to explain his or her actions. An answer like *"the software does it for me"* is not a good idea.

Regulation of the Work Product

"It is the responsibility of the professional licensee to mitigate potential violations involving the use of UAS in North Carolina by ensuring all federal, state, and local requirements have been met prior to the use of UAS technology. It is important to note that UAS technology is like any other tool available to the professional and, therefore, must be used in a way that meets current engineering, surveying, and mapping standards and procedures."

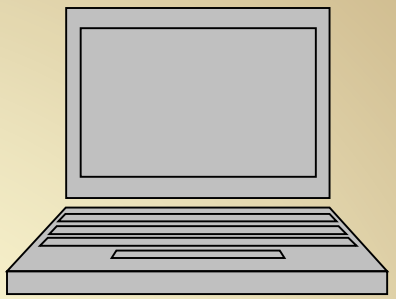
Regulation of the Work Product

"The Rules of Professional Conduct per 21 NCAC 56 .0701(g)(2) requires a licensee who has knowledge or reason to believe that another person or firm may be in violation of the Board Rules (21 NCAC 56) or of the North Carolina Engineering and Land Surveying Act (G.S. 89C), to present such information to the Board in writing in the form of a complaint and shall cooperate with the Board in furnishing such further information or assistance as may be required by the Board."

Regulation of the Work Product

"This should in no way be construed as an attempt to limit competition in this rapidly growing technology but as a duty to protect the public as charged under North Carolina General Statute Chapter 89C-2 *"In order to safeguard life, health, and property, and to promote the public welfare, the practice of engineering and the practice of land surveying in this State are hereby declared to be subject to regulation in the public interest."*

Policies/Guidelines



http://www.ncbels.org/policies.html

Policies explain a Board application of the Statutes or Rules, often in response to repeated questions.

The Guidelines give assistance from the Board to provide education on a topic, typically generated by the Board when a need is seen to further educate on an area of practice.

North Carolina Board of Examiners for Engineers & Surveyors

Forms | License Lookup | Renewals | Continuing Education | Enforcement | Businesses | Contact

Policies

3D Modeling Policy BP-0607-2 rev.1
Audiovisual System Design BP-0512-1 Rev.1
Commissioning Policy BP-0501-1 Rev.1
Commissioning Validation BP-0507-1
Conservation Easements Policy BP-1502-1
Construction Staking BP-1003-1
Design/Installation of Petroleum Storage Tanks BP-1603-1 Rev.1
Easement Policy for Existing and New Easements BP-1709-1
Elevated Recreational Facilities BP-1112-1
Engineering Surveys BP-1005-3 Rev. 2
Fire Alarm System Design BP-0709-1
Hydrographic Surveys Policy BP-1110-1
Information Transport System Design BP-0607-1
Inspections of Residential Buildings BP 1405-2

Policies (continued)

Oblique Area Imaging Policy BP-0510-2
On-Site Wastewater System Design BP-1007-1
Positional Tie Reporting Policy BP-1012-02 Rev.1
Responsible Charge for Equipment 0501-2
Roofing Systems BP-1405-1 Rev 2
Spill Prevention and Counter Measure Plans BP-1709-2
Stair Design and Structural Shop Drawings BP-1005-1
Stream Restoration Services BP-1005-2 Rev.1
Subsurface Utilities Location Data Policy BP-1012-01
Truss Placement - Commercial 9906-1 Rev 1
Truss Placement - Residential 0512-2 Rev 1
Volume Computation Surveys BP-1007-2
Wetlands Mapping BP-1005-4 Rev.2

Guidelines

Signing and Sealing Guidelines
Signing and Sealing Building Imaging Modeling/Integrated Project Delivery (BIM/IPD) Projects Guidelines(Rev)
Foundation Repair Company Guidelines
Survey Ties Guidelines (rev)
GIS Inclusions/Exclusions Guidelines
Incidental Streets and Storm Sewer Systems Design
Sample PLAT
Report of Survey Project Documentation Rev.1
Tie Guidelines and Report of Survey Presentation 11-22-2013
Seal Brochure

Mini-Brooks Act, Qualifications Based Selection, GS 143-64.31 et seq. (pdf slide presentations)

Basic Mini-Brooks with abbreviated Design-Build
Supplement of Design-Build Statutes with analysis

Policy Title and Number

Each policy has a descriptive title and a number that indicates that it is a Board Policy (BP) - 2 digit year and 2 digit month of approval – policy number in the month and a revision number if revised (Rev. 1).

Example:

Title: **Construction Staking Policy**

Policy Number: BP-1003-1
(Board Policy approved 2010, March policy # 1)

Policy Approval and Review

Each policy has the date of the Board meeting at which the policy was approved.

Each policy is to be reviewed every three years to see if still relevant or whether it requires revision, has been superseded or should be rescinded.

Example:

Date for Board Approval: 3/11/10 Date Approved: 3/11/10
Date to be Reviewed: 2013 Date Reviewed: _____

Policy Searches

Each policy has the category and keywords listed to allow for organizing the policies and for searching.

Example:

Category(s): Surveying Practice

Keywords: Construction Staking, Surveying

Highlighted Policies

Oblique Aerial Imaging Policy BP-0510-2

Volume Computation Surveys BP1007-2

Wetlands Mapping BP-1005-4 Rev 2

Policies

Oblique Aerial Imaging BP-0510-2

The service of oblique aerial imaging falls within the definition of the practice of land surveying in G.S. 89C – 3(7) based on the information reviewed by the Board on October 12, 2005. The making of the oblique image product where it involves geodesy (including the use of GPS and geodetic reference datums), photogrammetry, or geo-referenced to existing orthos, requires the education, training and experience of a licensed professional land surveyor under G.S. 89C. Further, the production of orthos is within the practice of land surveying.

Such services require that the individuals in responsible charge of the work and the company be licensed with the Board and comply with the Standards of Practice for Land Surveying in North Carolina (21 NCAC 56.1600).

Policies

Volume Computation Surveys BP1007-2

The practice of providing a volume computation survey (sometimes referred to as a quantity survey) falls within the definition of land surveying as defined in GS 89C-3(7)a. and shall be done under the responsible charge of a Professional Land Surveyor. This includes, but is not limited to, the measuring and reporting of quantities of dredging, cut and fill and stock piles.

Policies

Wetlands Mapping BP-1005-4 Rev 2

Wetlands Survey: A survey showing the boundaries of an area delineated as “jurisdictional waters of the US." Wetland Boundaries shall be tied by course and distance to either 1) property corners that are properly monumented and verified, or 2) project boundaries that have been properly monumented, or 3) NC State Plane Coordinates System. This shall be done in a manner that permits future surveyors to readily retrace the wetland boundary. The calculated ratio of precision before adjustments or statement of positional accuracy of such ties must be consistent with the land use classification of the parcel being surveyed as described in Board Rule 21-56.1603.

Policies

Wetlands Mapping BP-1005-4 Rev 2 (Cont'd)

Data collection and platting of these types of wetland boundaries must be performed by or under the direct supervision of a ~~surveyor~~PLS. A PLS or PE may only accept wetlands survey data from a PLS for the purpose of showing the information on survey plats, engineering drawings (other than Preliminary Planning drawings), permits or reports.

Policies

Wetlands Mapping BP-1005-4 Rev 2 (Cont'd)

Any location data generated by delineators is only for the use of the PLS in performing a survey of the wetland boundary and should be noted with a disclaimer to that effect. The preliminary wetland map with a disclaimer by the delineators, that the location data is not to be relied upon for accuracy and is only for appropriate use by a PLS or PE, may be used by a PE for Preliminary Planning Purposes. If equipment other than survey grade accuracy equipment is used on the survey, a statement indicating the equipment, procedure, and position tolerances (21-56.1608) used for the work must be clearly stated on the plat or work product. Only surveyed wetlands may be placed on a property plat.

Policies

Wetlands Mapping BP-1005-4 Rev 2 (Cont'd)

Data provided by a Government Agency can be depicted as long as the source of the information used is disclosed and denoted as lines not surveyed within the plat or report.

The mapping of ~~conservation easements,~~ buffers or other boundaries shall be done by, or under the responsible charge of, a PLS and conform to the same requirements as stated for wetland boundaries.

Guidelines

GIS Inclusions/Exclusions Guidelines

Development of the guidelines
Authoritative
Stated Accuracy
The “Chart”

GIS – What does or does not require a PLS?

Development of Inclusions/Exclusions Chart

- The Surveying Committee of the Board
- Based upon the Model Law of the NCEES
- In conjunction with the NC Geographic Information Coordinating Council (GICC).

Board Guideline – GIS Mapping
http://www.ncbels.org/forms/gisinc_excl.pdf

How and when to use GIS data.

GIS – What does or does not require a PLS?

If "authoritative" or to a "stated accuracy"

"Authoritative" as used in the Chart

Authoritative: Authoritative shall mean presented as trustworthy and competent for reliance upon by the public or if provided to a stated accuracy.

Examples of Authoritative are:

Measurements and mapping applications suitable for engineering design, determination of boundaries (including, but not limited to, ownership boundaries, easements, political boundaries, jurisdictional boundaries), the locations of fixed works or topography, enforcement of regulations that pertain to the location of improvements or fixed works, or the certification of declaration of positional accuracy of any spatial data therein.

GIS Mapping – PLS required (or not)

GIS Inclusions/Exclusions Guidelines - April 2008, Revised October 2011

North Carolina Board of Examiners for Engineers and Surveyors

This chart, while not all inclusive, assists in determining items of GIS data that are included or excluded from the definition of Land Surveying in G.S. 89C-3(7).The definition includes all location data that is issued for an authoritative purpose. Authoritative shall mean presented as trustworthy and competent for reliance upon by the public or if provided to a stated accuracy.

Board Description	GICC Data Layer Description	Land Surveying Committee Responses
Orthophotography	Large-scale scanned and rectified aerial photographs	Inclusion
Cadastral	County-based private and public property boundaries including easements	Inclusion
Roads	Centerlines, including rights-of-way	Inclusion
Municipal Boundaries	City/town boundaries	Inclusion
County Boundaries	County borders	Inclusion
ETJs	Extra-territorial jurisdictions – areas not in a municipality, but under authority of the city or town	Inclusion
Surface Waters	Locations and names of streams, rivers, lakes, ponds, etc., including mean high water marks	Inclusion - Locations and names of streams, rivers, lakes, ponds, etc., including mean high water marks and when the survey is done to determine authoritative location of stream, waterway or location of mean high water.
Geodetic Control	Horizontal and vertical survey control locations	Inclusion
Elevation	Ground elevations (depicted as contours, X/Y/Z points, elevation models, TINs?)	Inclusion
Land Use	Cadastral-based land use	Exclusion
Land Cover	Statewide land cover - 1996	Exclusion
Flood Zones	Areas inundated by flood waters (1% annual chance, .2%annual chance, flood ways)	Inclusion
Soils	Soil Survey Geographic (SSURGO) database produced by US Dept. of Agriculture, Natural Resources Conservation Service	Inclusion if used to determine authoritative location of soils. Determination of soils to be done by Soil Scientists.
Public Lands	Non-taxable lands maintained in county cadastral databases	Inclusion
Railroads	Locations of railroad lines including rights-of-way	Inclusion
Airports	Airport/airfield property boundaries and easements	Inclusion
Schools	Point locations of public and non-public grade schools	Exclusion
Colleges/Universities	Point locations of state universities and private colleges and universities	Exclusion
Hospitals	Point locations of hospitals	Exclusion
Storm Surge Inundation	Estimated coastal areas inundated by hurricane storm surge	Inclusion for PEs and PLSs. Models are developed by PEs using data collected by PLS.
Surface Water Intakes	Point locations where communities draw raw water from a lake, river, or stream, treat it, and distribute treated water to customers	Exclusion
NPDES	National Pollutant Discharge Elimination System -locations of individually permitted wastewater discharged into surface waters	Exclusion unless federal, state or local authority requires survey.

Police Stations	Point locations of police stations	Exclusion
Fire Stations	Point locations of fire stations	Exclusion
Landfills	Point locations of municipal/county landfills	Exclusion
Watersheds	Water supply watersheds	Inclusion
Wetlands	Wetlands areas from the US Fish and Wildlife Service, National Wetlands Inventory	Inclusion
Hazardous Disposal Sites	Areas identifying locations of uncontrolled and unregulated, hazardous waste sites (formerly called	Inclusion
Building Footprints	Perimeter outlines of buildings	Inclusion when authoritative location is required, such as Land Title Surveys, Brownfield Surveys, etc.
Future Land Use	Cadastral-based, potential land use based on current zoning	Exclusion
Water Lines	Water pipe distribution network and accompanying	Inclusion
Sewer Lines	Sanitary sewer pipe network and accompanying features	Inclusion
Stormwater Lines	Stormwater network and accompanying features	Inclusion
NC House Districts	Boundaries of NC House Districts	Exclusion
NC Senate Districts	Boundaries of NC Senate Districts	Exclusion
US Congressional Districts	Boundaries of US Congressional Districts	Exclusion
Census Boundaries	2000 US Census boundaries for tracts, blocks, and block groups	Exclusion
Power Transmission Lines	Transmission network and accompanying features	Exclusion for inventory applications. Inclusion where survey is for authoritative location or a stated accuracy.
Natural Gas Pipelines	Transmission network and accompanying features	Exclusion for inventory applications. Inclusion where survey is for authoritative location or a stated accuracy.
Septic Tanks	Point locations of septic features	Exclusion for inventory applications. Inclusion where survey is for authoritative location or a stated accuracy.
Telecommunication Lines	Telephone, cable television, and other communication features such as towers	Exclusion for inventory applications. Inclusion where survey is for authoritative location or a stated accuracy.
Wells	Point locations	Exclusion for inventory applications. Inclusion where survey is for authoritative location or a stated accuracy.
Mineral Rights Boundaries		Inclusion if for authoritative location or stated accuracy of the boundary.
Mining Resources		Exclusion
Greenways		Inclusion when the survey is to determine the fee simple or easement corridor of the greenway.
Sidewalks		Exclusion
Cemeteries		Exclusion if general point location for inventory purpose of locating cemetery. Inclusion if the boundaries of the cemeteries are being determined or established.
Archaeological Sites		Exclusion
Historic Sites and Structures		Exclusion

So What Now?

Great opportunities for collaboration between UAS pilots and PLS surveyors.

Provides the advanced technology tools and the professional knowledge and license of the PLS to best serve the client with accurate efficient mapping and provide for the public protection.

Firms can combine both activities, as has been done by some photogrammetric firms. Licensing with the Board is required.

LICENSING and COMPLIANCE FOR A SURVEYING BUSINESS

If anyone in your firm performs surveying services for customers or clients, even as part of your primary service or product, then the firm must be licensed with the Board.

Rule applies to businesses offering surveying services for North Carolina projects, including businesses located or headquartered in other states.

Forming and Licensing a Business Entity

Forming a Business Entity

Types of Entities and Requirements

Initial Licensing with the Board

Firm Licensure

A firm applying for licensure will fall within one of the following classifications:

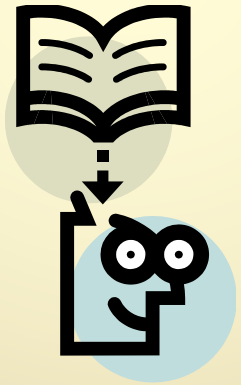
- Professional Corporation [G. S. 55B]
- Professional Limited Liability Company [G. S. 57D]
- Partnership (Includes General Partnerships, Limited Partnerships & Limited Liability Limited Partnerships) [G. S. 59]
- Sole Proprietorship
- Pre-69 Corporation
- Chapter 87 Corporation [G. S. 87

Firm Licensure

Link to Business Firm information
http://www.ncbels.org/businesses.html
including the

Contact Mark Mazanek, Director of Firm Licensure at mmazanek@ncbels.org with questions and to receive an emailed application packet.

QUESTIONS



UAS Implementation at Duke Energy

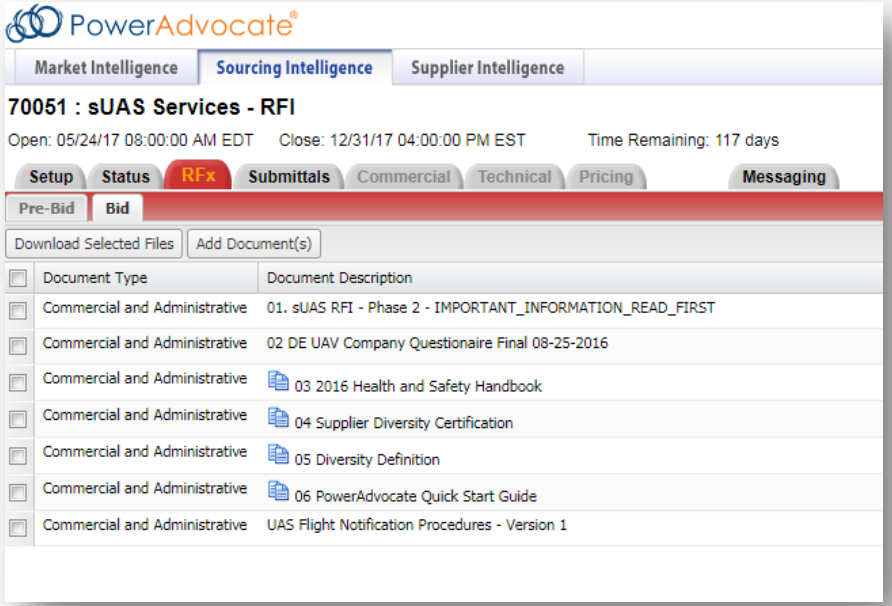




DUKE ENERGY®

- Development of
  - Standard Operating Procedures
  - Safety Management System
  - UAS Use Policy
- Structured approach to training
  - Online ground school (educate on safe operations & prepare for FAA Part 107 written test)
  - Hands on training to build expertise
- Subject Matter Expertise for UAS

All third party contractors desiring to use any aerial asset (plane, helicopter, drone) are required to be vetted by the aviation department prior to conducting work for Duke Energy.



To: **Potential UAS Service Providers**

Subject: **Duke Energy Insurance Requirement**

Dear Sir or Madam:

Your firm has been identified as a potential respondent to the UAS Service Provider review process.

The purpose of the Request for Information is to identify qualified suppliers to be placed on the UAS approved service provider list for Duke Energy.

UAS Service Providers for Duke Energy must meet the Insurance requirements listed below.:

1. Do you have or will you provide aviation liability coverage of at least $10 million for each occurrence? **YES/NO**
2. Will your insurance carrier name Duke Energy as an additional insured to the aviation liability policy on a primary and non-contributory basis? **YES/NO**
3. Do you have or will you provide professional liability/errors and omissions insurance with limits of at least $1 million for each claim or wrongful act? **YES/NO**

Leverage:

- Lean Startup Mentality
- Agile Approach to Organizational Development
- Ability to Grow & Mature With The Market
- Shared Resources and Expertise

Deliver:

- Safer Operations
- Risk Mitigation
- Innovative Solutions to BU Challenges
- Operational Cost Reductions

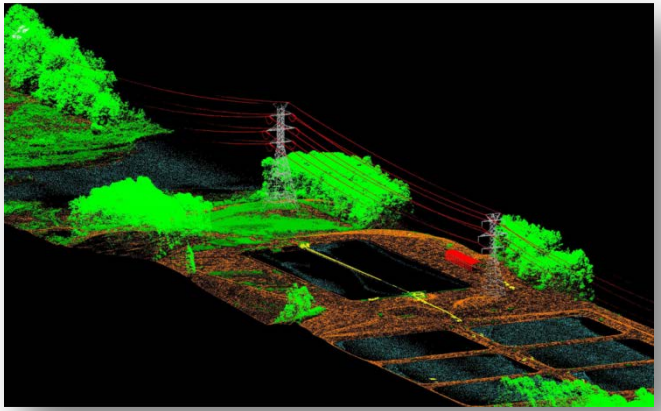
Notable Use Cases

- Solar Plant Inspection
- Transmission Line Inspection
- Distribution Line Inspection
- Economic Development
- Corporate Communications
- Disaster/ Emergency Response

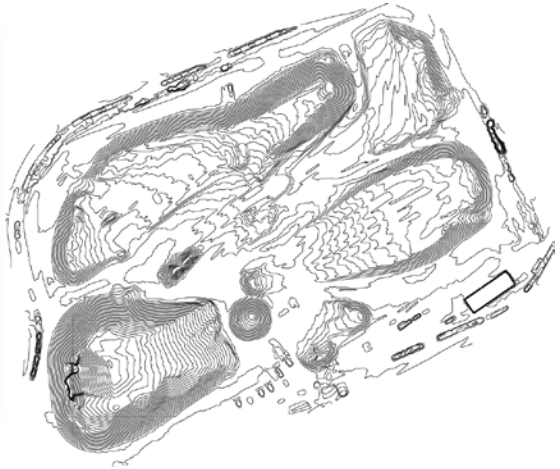
Notable Data Products

- 2D/ 3D orthomosaic and volume estimates
- Transmission Line Stringing
- High definition video and stills
- Temperature mapping
- IR images of solar panels to detect “hot spots”

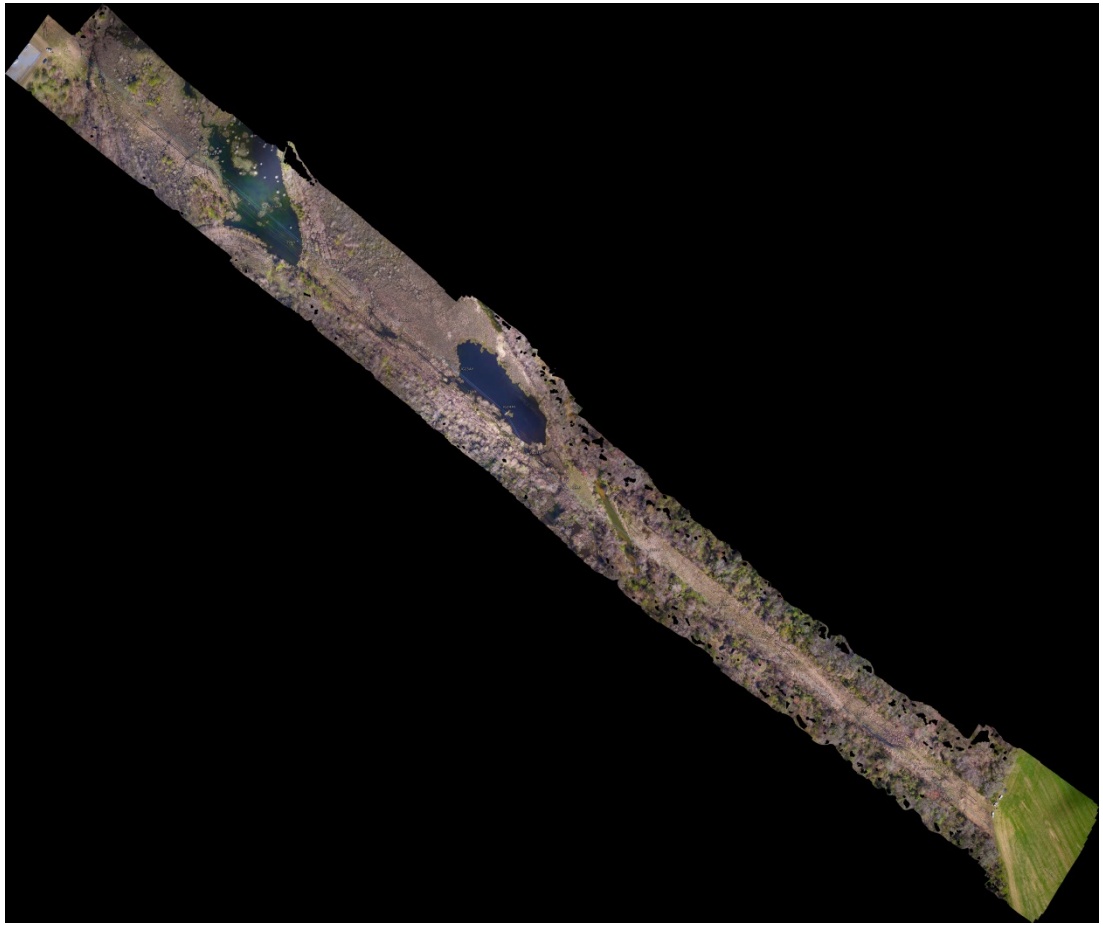
LiDAR

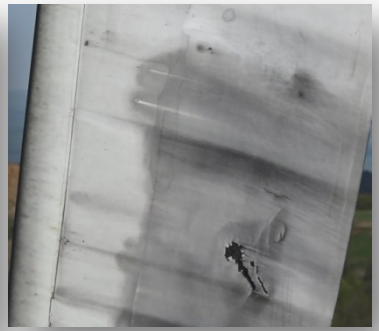


Topographic
(1m per contour)

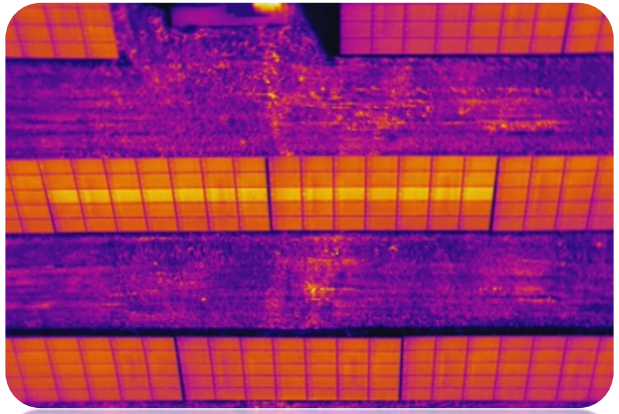


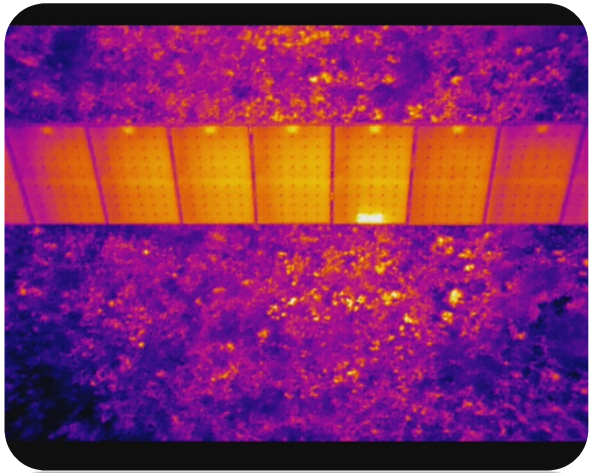
Volumetric Calculations

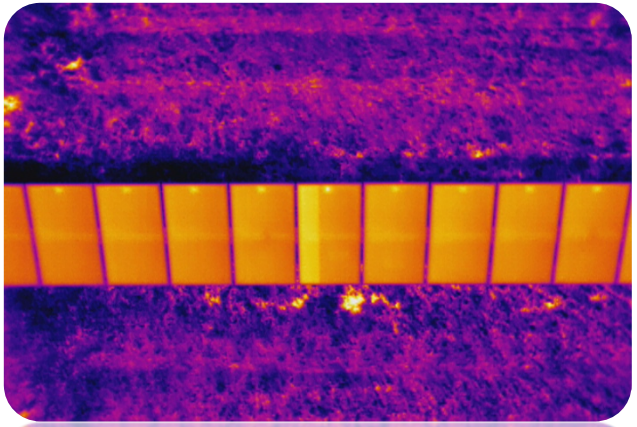


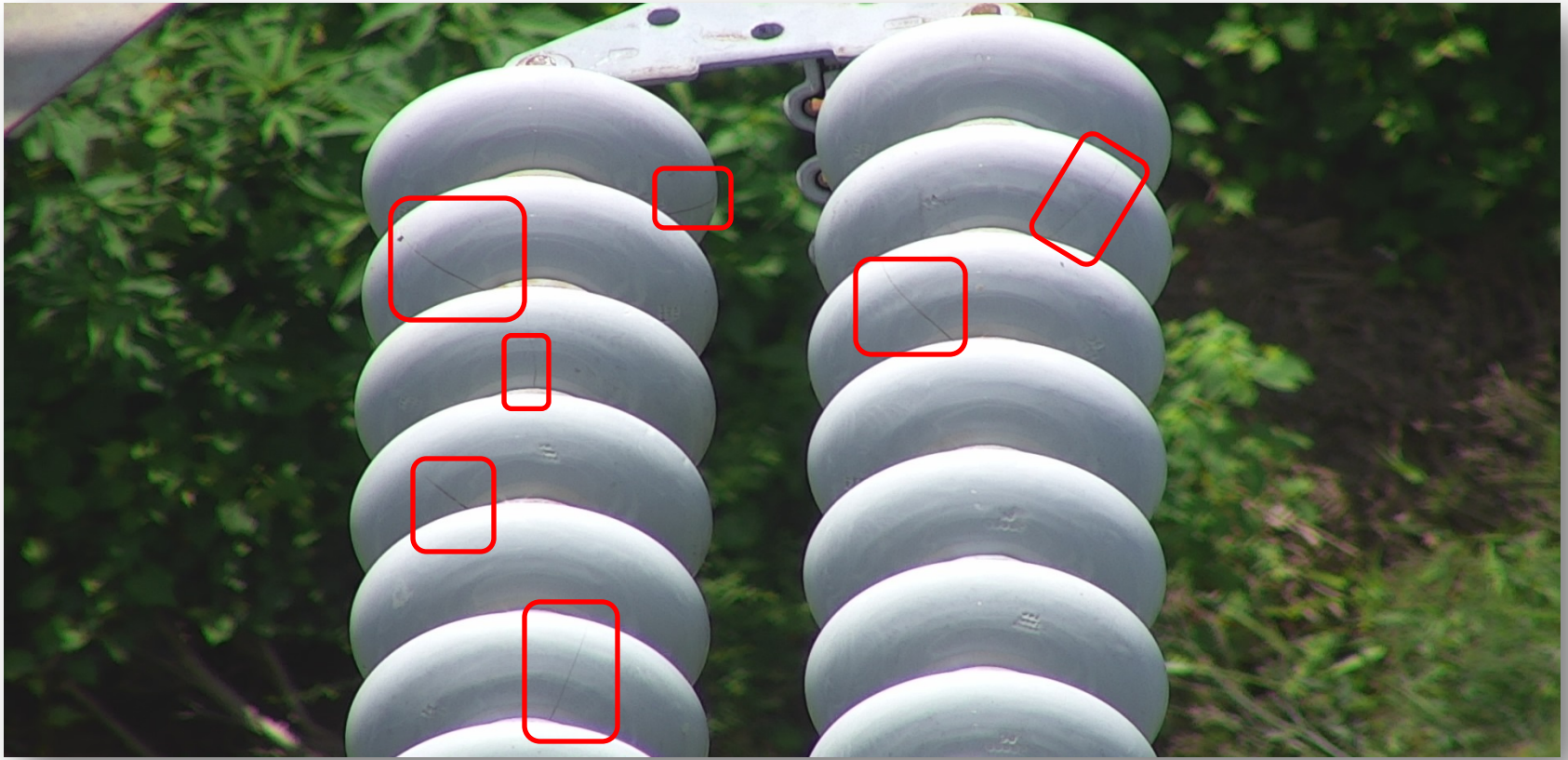


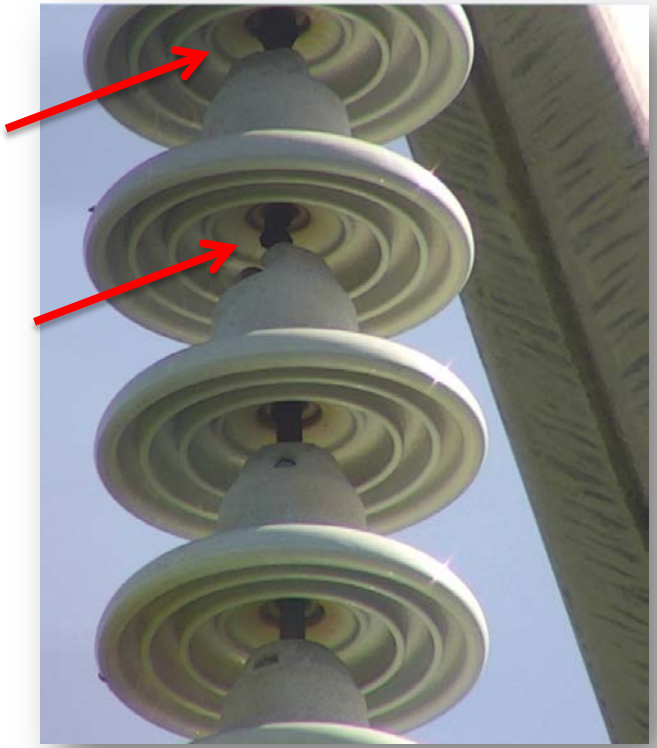
Solar Array Thermal Inspection











Storm Damage Assessments

DUKE ENERGY®

NORTH CAROLINA
Department of Transportation

Considerations for Generating Photogrammetric Survey Products in North Carolina with Cameras on UAS Platforms

Keith Johnston, PE, PLS

October 12, 2017

Presentation Outline

- Governing Authority for Photogrammetric Surveys in North Carolina
- Photogrammetric Surveying Functions & Products
- Metric versus Non-Metric Cameras
- Geometric Accuracy Assessment for Photogrammetric Surveys
- Examples of Product Quality

Governing Authority for Photogrammetric Surveys in North Carolina

Governing Authority for Photogrammetric Surveys in North Carolina

- NCGS 89C-3(7)a. defines “Practice of Land Surveying” in part as:

(7) Practice of land surveying. –

a. Providing professional services such as consultation, investigation, testimony, evaluation, planning, mapping, assembling, and interpreting reliable scientific measurements and information relative to the location, size, shape, or physical features of the earth, improvements on the earth, the space above the earth, or any part of the earth, whether the gathering of information for the providing of these services is accomplished by conventional ground measurements, by aerial photography, by global positioning via satellites, or by a combination of any of these methods, and the utilization and development of these facts and interpretations into an orderly survey map, plan, report, description, or project. The practice of land surveying includes the following:

Governing Authority for Photogrammetric Surveys in North Carolina

- 21 NCAC 56.1606(a)(3) defines “Specifications for Topographic and Planimetric Mapping, including Ground, Airborne, and Spaceborne surveys” in part as:

"Airborne and spaceborne surveys" are defined as the use of photogrammetry, LIDAR, IFSAR, or other similar measurement technologies for obtaining reliable information about physical objects and the environment, including terrain surface, through the process of recording, measuring, and interpreting images and patterns of electromagnetic radiant energy and other phenomena. This Rule establishes minimum allowable photogrammetric production procedures and standards for photogrammetric mapping and digital data production.

Photogrammetric Surveying Functions & Products

- Camera Calibration – determine internal camera geometry
- Aerotriangulation – determine position and orientation of camera at mid-exposure point
- Stereocompilation - manually measure graphic planimetric (buildings, roads, etc) and digital terrain model (DTM) data (break lines and mass points) using overlapping image pairs
- Orthophoto Generation – differentially rectify individual image frames and mosaic into single image map
- Elevation Data Generation – manual or automated elevation measurements (DTM or Point Cloud)

Metric versus Non-Metric Cameras

- Metric aerial mapping cameras have precise, accurate interior geometry
  - Fixed focal length lens
  - Defined principal point offset
  - Defined radial and decentering lens distortion
  - Defined pixel element size in tenths of microns
  - 100’s to 400’s of megapixels
  - Weight hundreds of pounds
  - Produced one at a time
  - **CALIBRATED!**

Metric versus Non-Metric Cameras

- Non-metric cameras do not have precise, accurate interior geometry
  - 10-20 megapixels
  - Weight a few pounds
  - Mass produced
  - **Not calibrated**

Metric versus Non-Metric Cameras

- Metric aerial mapping cameras - multiple camera heads with panchromatic, red, green, blue, and NIR CCD (charged coupled device) arrays
- Interfaced with gyro stabilized mount with survey grade GNSS-IMU
  - position and orientation at exposure mid pulse
- Cost is varies with largest format cameras at $1,000,000 +

Metric versus Non-Metric Cameras

- Non-metric cameras are composed of a single red, green, blue CMOS (complementary metal-oxide semiconductor) array
- Not interfaced with gyro stabilized mount
- Typically low grade GNSS without IMU
  - No exposure mid pulse time data
- Cost is around $500 + $2,000

- More information on CCD versus CMOS sensors can be found at: http://electronics.howstuffworks.com/cameras-photography/digital/question362.htm

Metric versus Non-Metric Cameras

Geometric Accuracy Assessment for Photogrammetric Surveys

- 21 NCAC 56.1606(h) states

A certificate, substantially in the following form, shall be affixed to all maps or reports: " I, _____, certify that this project was completed under my direct and responsible charge from an actual survey made under my supervision; that this_____ (insert as appropriate: ground, airborne or spaceborne) survey was performed at the ___ percent confidence level to meet Federal Geographic Data Committee Standards; that this survey was performed to meet the requirements for a topographic/planimetric survey to the accuracy of Class ____ and vertical accuracy when applicable to the Class ___ standard, and that the original data was obtained on _____(date)_____; that the survey was completed on ___(date)_____; that contours shown as [broken lines] may not meet the stated standard; and all coordinates are based on_____ 'NAD 83' and realization (date of adjustment of coordinate system) or 'NAD 27' and all elevations are based on _____ (NGVD 29, NAVD 88, or other)."

Geometric Accuracy Assessment for Photogrammetric Surveys

- National Map Accuracy Standards (1947)
  - https://pubs.usgs.gov/fs/1999/0171/report.pdf
  - USDOT Reference Guide Outline - Specifications for Aerial Surveys and Mapping by Photogrammetric Methods for Highways (1968)
  - Could not locate hyperlink
- ASPRS Accuracy Standards for Large-Scale Maps (1990)
  - http://www.asprs.org/wp-content/uploads/2012/01/1990_jul_1068-1070.pdf

Geometric Accuracy Assessment for Photogrammetric Surveys

- FGDC-STD-007-1998 (1998)
  - Applicable to planimetric and topographic maps
  - Establishes the methodology to test horizontal and vertical accuracy
  - Requires 20 independent check points from higher order survey
  - Contains formulas to separately compute horizontal and vertical accuracy
    - RMSE (Root Mean Square Error) – 1 sigma (68.3%) confidence level
    - Accuracy at the 95% confidence level
  - https://www.fgdc.gov/standards/projects/accuracy/part3/chapter3

Geometric Accuracy Assessment for Photogrammetric Surveys

- ASPRS Positional Accuracy Standards for Digital Geospatial Data (2014)
  - Builds on accuracy testing methodology from FGDC-STD-007-1998
    - RMSE (Root Mean Square Error) – 1 sigma (68.3%) confidence level
    - Accuracy at the 95% confidence level
  - Applicable to digital orthoimagery, digital planimetric data and digital elevation data (all sensor technology)
    - Also includes additional accuracy measures, such as orthoimagery seam lines, aerial triangulation accuracy, …., delineation of low confidence areas for vertical data, and the required number and spatial distribution of checkpoints based on project area
  - http://www.asprs.org/a/society/committees/standards/Positional_Accuracy_Standards.pdf

Geometric Accuracy Assessment for Photogrammetric Surveys

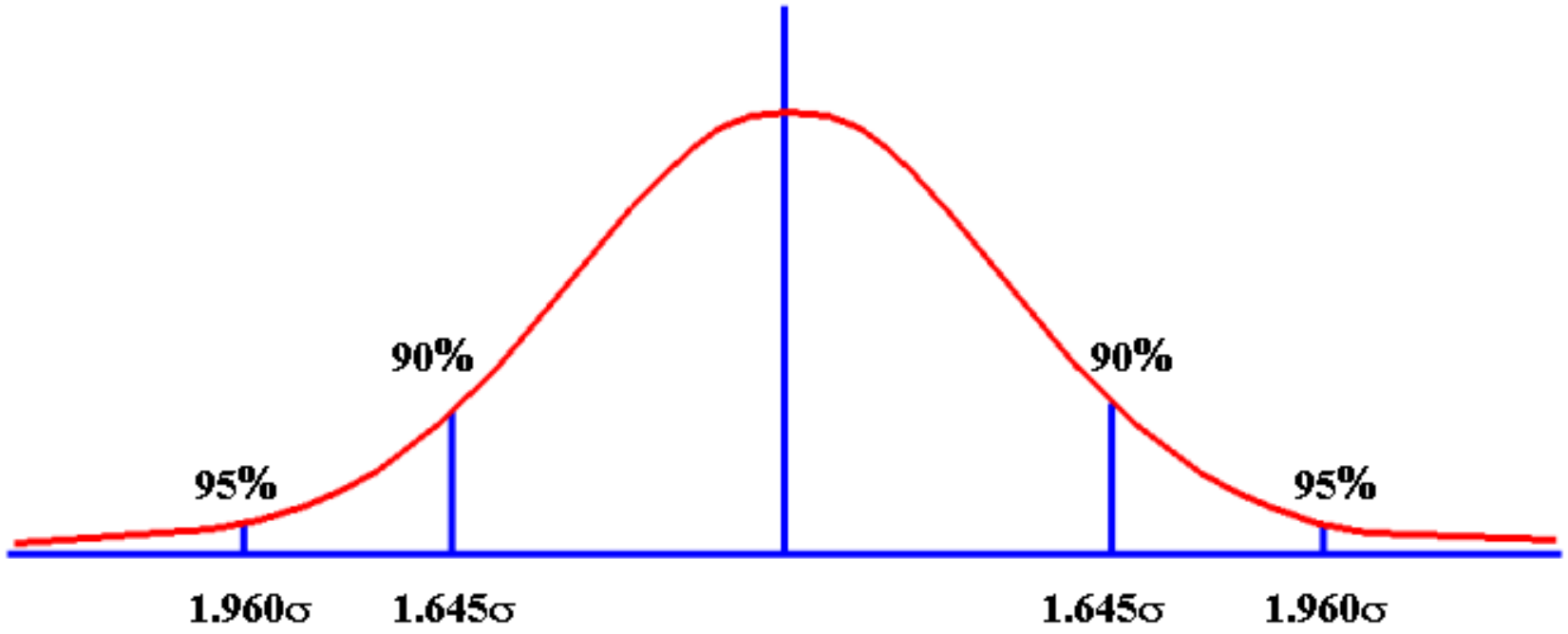
- ASPRS Positional Accuracy Standards for Digital Geospatial Data (2014)

TABLE C.1 RECOMMENDED NUMBER OF CHECKPOINTS BASED ON AREA

Project Area (Square Kilometers)	Horizontal Accuracy Testing of Orthoimagery and Planimetrics	Vertical and Horizontal Accuracy Testing of Elevation Data sets		
	Total Number of Static 2D/3D Checkpoints (clearly-defined points)	Number of Static 3D Checkpoints in NVA[9]	Number of Static 3D Checkpoints in VVA	Total Number of Static 3D Checkpoints
≤500	20	20	5	25
501-750	25	20	10	30
751-1000	30	25	15	40
1001-1250	35	30	20	50
1251-1500	40	35	25	60
1501-1750	45	40	30	70
1751-2000	50	45	35	80
2001-2250	55	50	40	90
2251-2500	60	55	45	100

Geometric Accuracy Assessment for Photogrammetric Surveys

- Normal Distribution, Confidence Level, and the Bell Shaped Curve
  - 1 sigma (1σ) level equals 68.3% of area under the curve ➔ RMSE

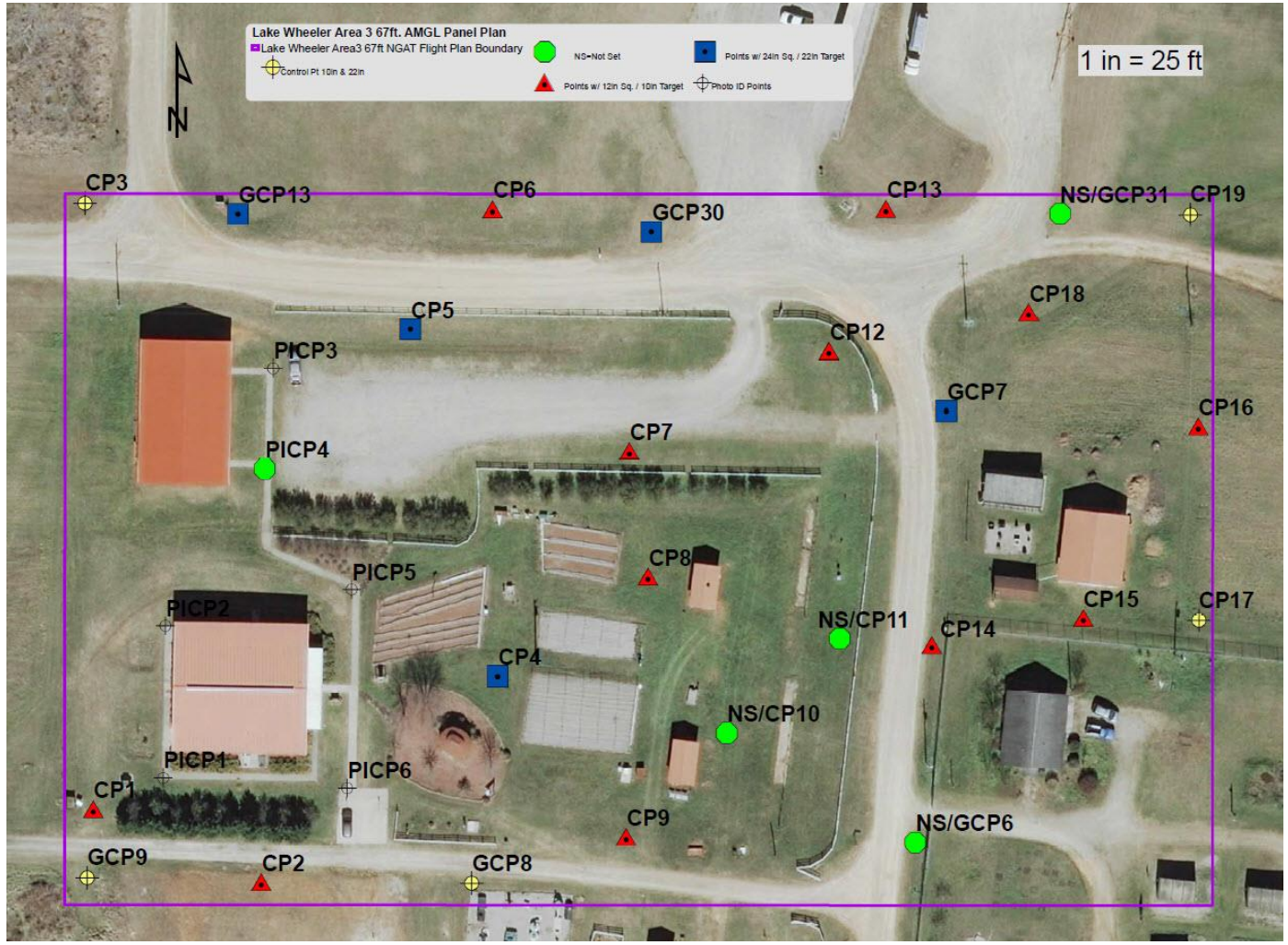


Geometric Accuracy Assessment for Photogrammetric Surveys

- NCSU Lake Wheeler Farm
  - Trimble ZX5 multicopter with Olympus E-PL7 camera
  - June 1, 2016 flight
  - 80% forward overlap and 80% side overlap
  - Nominal 0.5 inch pixel from approximately 167 feet above ground
  - 5 control points all signalized targets
  - 21 independent check points all signalized targets
  - Signalized targets 10 inch and 22 inch in diameter
  - Processed data set using Agisoft Photoscan
  - Agisoft image quality estimate at approximately 0.7

Geometric Accuracy Assessment for Photogrammetric Surveys

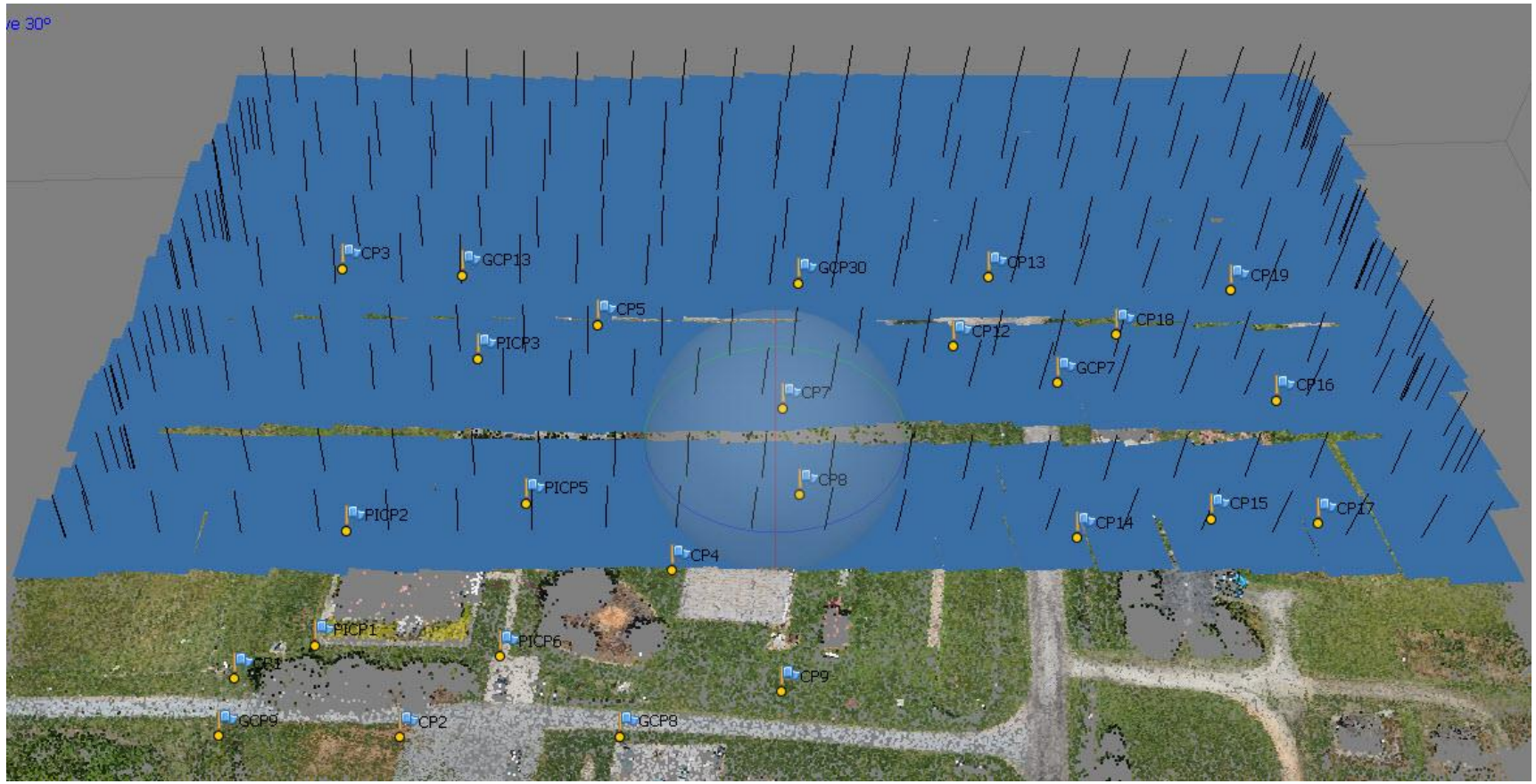
NCSU Lake Wheeler Farm



Geometric Accuracy Assessment for Photogrammetric Surveys

NCSU Lake Wheeler Farm

- 9 flight lines
- 238 images



Geometric Accuracy Assessment for Photogrammetric Surveys

NCSU Lake
Wheeler Farm

Aerotriangulation

Results

Input Weights

- 0.03 ft for control
- 0.1 pixel image
- No graduation selection applied

5 Control Points

Control Point Statistics	Point ID	X error (ft)	Y error (ft)	Z error (ft)	Error (ft)	Projections	Error (pix)
No. Points =		5	5	5	5	5.0	5
Min (ft) =		-0.11	-0.05	-0.17	0.11	7.0	0.25
Max (ft) =		0.10	0.06	0.13	0.21	26.0	0.44
Mean (ft) =		0.00	0.00	0.00	0.16	16.4	0.34
Std Dev (ft) =		0.08	0.05	0.16	0.04	6.8	0.08
RMSE (ft) =		0.07	0.05	0.14	0.16	17.5	0.35
FVA (ft) =				0.27			
RMSE R (ft) =		0.08					
Case 1 95% CE(ft) =		0.14					
Case 2 ~ CE(ft) =		0.14					

21 Check Points

Control Point Statistics	Point ID	X error (ft)	Y error (ft)	Z error (ft)	Error (ft)	Projections	Error (pix)
No. Points =		21	21	21	21	21.0	21
Min (ft) =		-0.18	-0.12	-0.27	0.09	8.0	0.20
Max (ft) =		0.26	0.13	0.09	0.29	24.0	0.49
Mean (ft) =		-0.03	0.01	-0.09	0.18	13.1	0.33
Std Dev (ft) =		0.12	0.06	0.10	0.06	3.7	0.09
RMSE (ft) =		0.12	0.06	0.13	0.19	13.6	0.34
FVA (ft) =				0.26			
RMSE R (ft) =		0.14					
Case 1 95% CE(ft) =		0.23					
Case 2 ~ CE(ft) =		0.22					

Geometric Accuracy Assessment for Photogrammetric Surveys

NCSU Lake Wheeler Farm

Aerotriangulation Results

Input Weights

- 0.0066 ft for control
- 0.1 pixel image
- 0.2 graduation selection applied

5 Control Points

Control Point Statistics	Point ID	X error (ft)	Y error (ft)	Z error (ft)	Error (ft)	Projections	Error (pix)
No. Points =		5	5	5	5	5.0	5
Min (ft) =		-0.04	-0.05	-0.04	0.03	7.0	0.10
Max (ft) =		0.07	0.03	0.03	0.08	26.0	0.23
Mean (ft) =		0.00	0.00	0.00	0.05	16.4	0.17
Std Dev (ft) =		0.04	0.04	0.03	0.02	6.8	0.06
RMSE (ft) =		0.04	0.03	0.03	0.06	17.5	0.18
FVA (ft) =				0.05			
RMSE R (ft) =		0.05					
Case 1 95% CE(ft) =		0.09					
Case 2 ~ CE(ft) =		0.09					

21 Check Points

Control Point Statistics	Point ID	X error (ft)	Y error (ft)	Z error (ft)	Error (ft)	Projections	Error (pix)
No. Points =		21	21	21	21	21.0	21
Min (ft) =		-0.08	-0.14	-0.09	0.01	8.0	0.08
Max (ft) =		0.20	0.06	0.06	0.21	24.0	0.29
Mean (ft) =		0.00	-0.02	0.00	0.08	13.1	0.16
Std Dev (ft) =		0.07	0.05	0.04	0.05	3.7	0.06
RMSE (ft) =		0.07	0.05	0.04	0.09	13.6	0.17
FVA (ft) =				0.07			
RMSE R (ft) =		0.08					
Case 1 95% CE(ft) =		0.14					
Case 2 ~ CE(ft) =		0.14					

Geometric Accuracy Assessment for Photogrammetric Surveys

NCSU Lake Wheeler Farm Orthophoto & Point Cloud Results

Input Weights

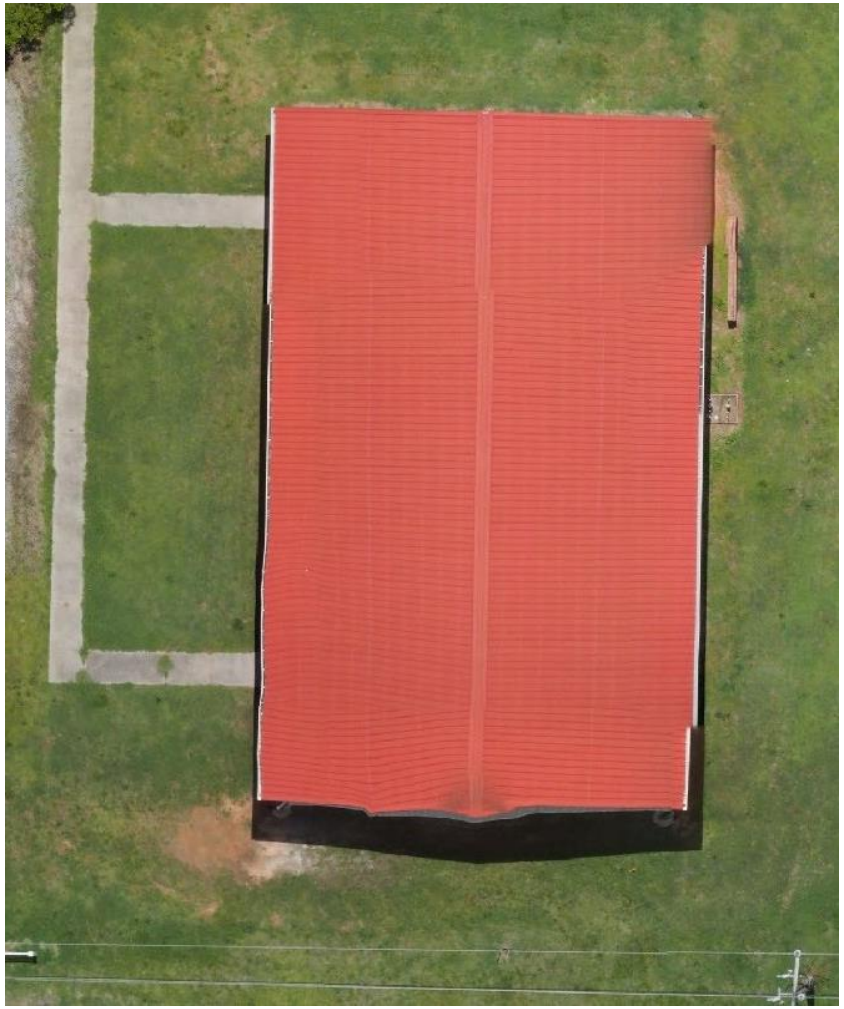
- 0.0066 ft for control
- 0.1 pixel image
- 0.2 graduation selection applied

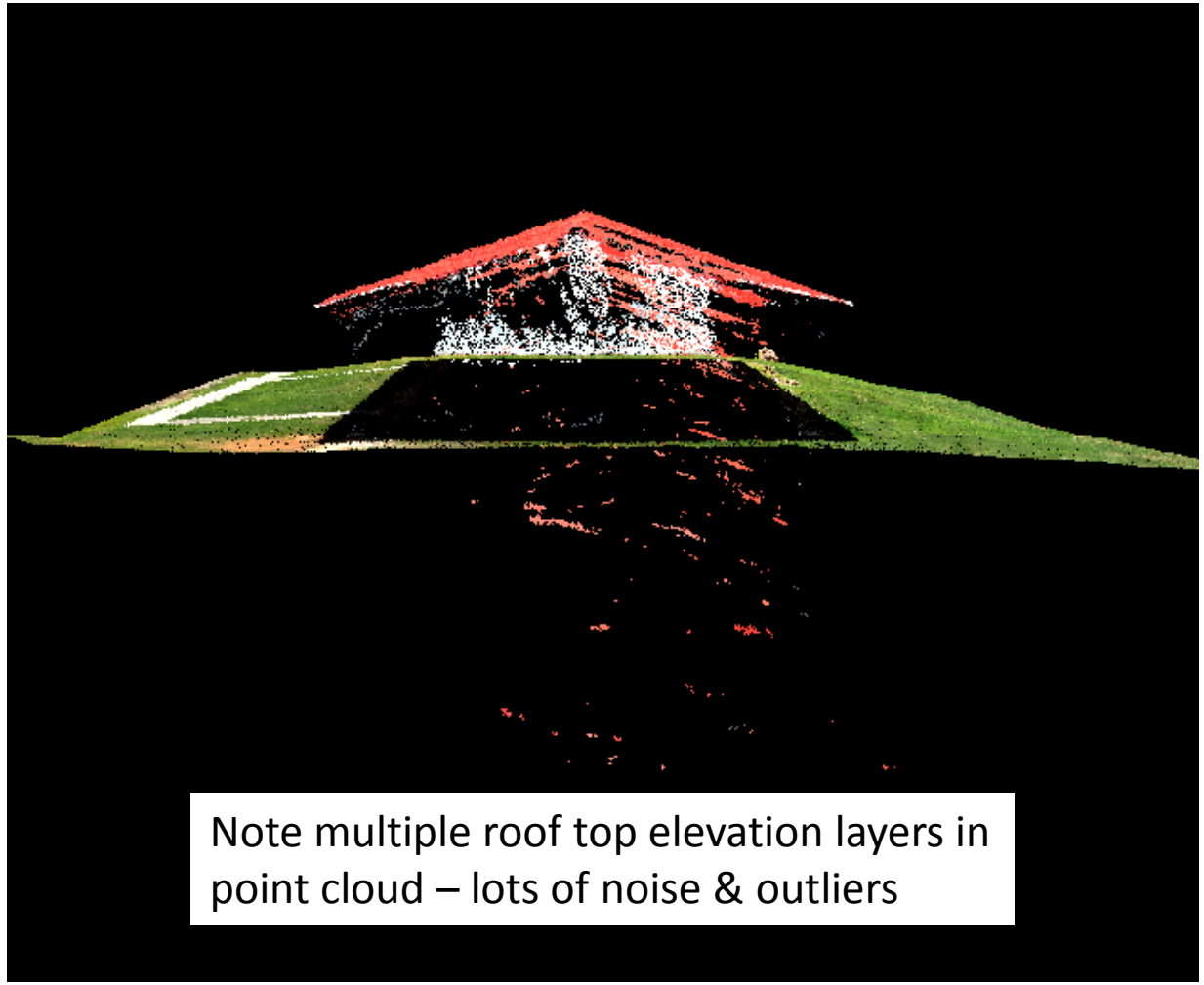
Control Point Statistics	Orthophoto X error (ft)	Orthophoto Y error (ft)	Point Cloud Z error (ft)
No. Points =	21	21	21
Mean (ft) =	0.01	0.04	0.01
RMSE (ft) =	0.08	0.06	0.05
FVA (ft) =			**0.10**
RMSE R (ft) =	0.10		
Case 1 95% CE(ft) =	**0.17**		
Case 2 ~ CE(ft) =	**0.17**		

Examples of Product Quality

- Point Cloud
  - Noise and outliers
  - Particularly noticeable on features with low contrast
  - Particularly noticeable on features elevated above ground
- Orthophoto
  - Distorted features
  - Blurriness

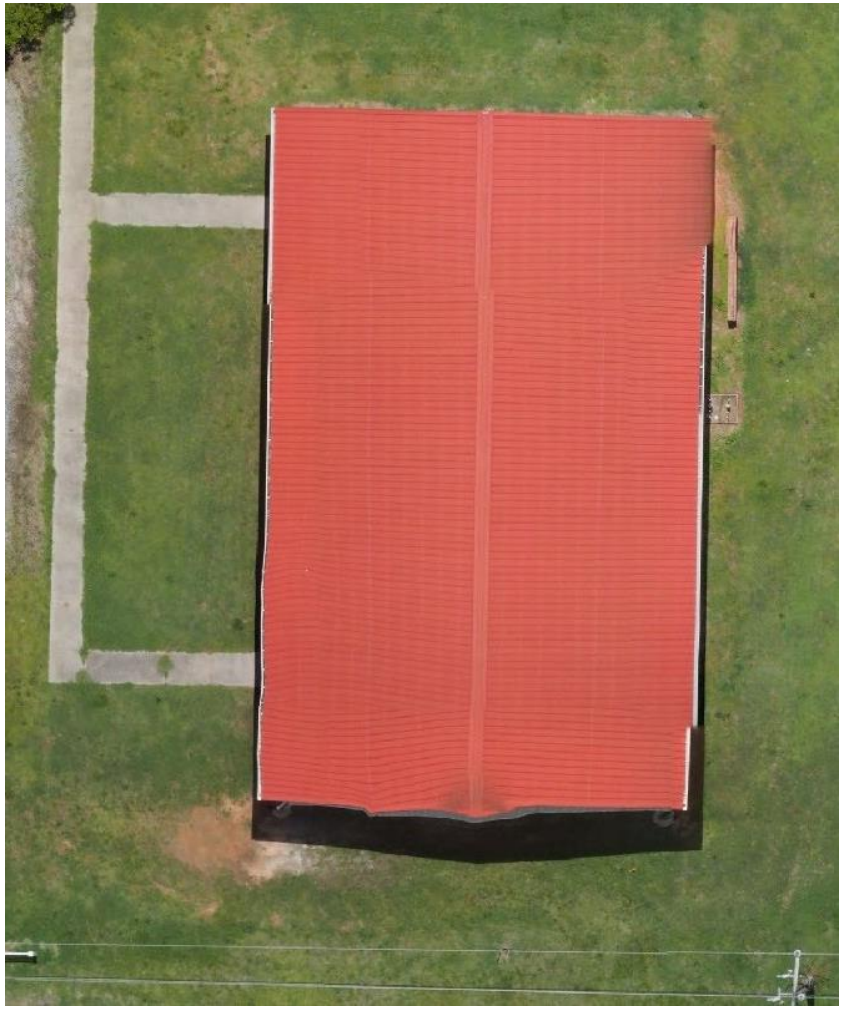
Examples of Product Quality – Point Cloud

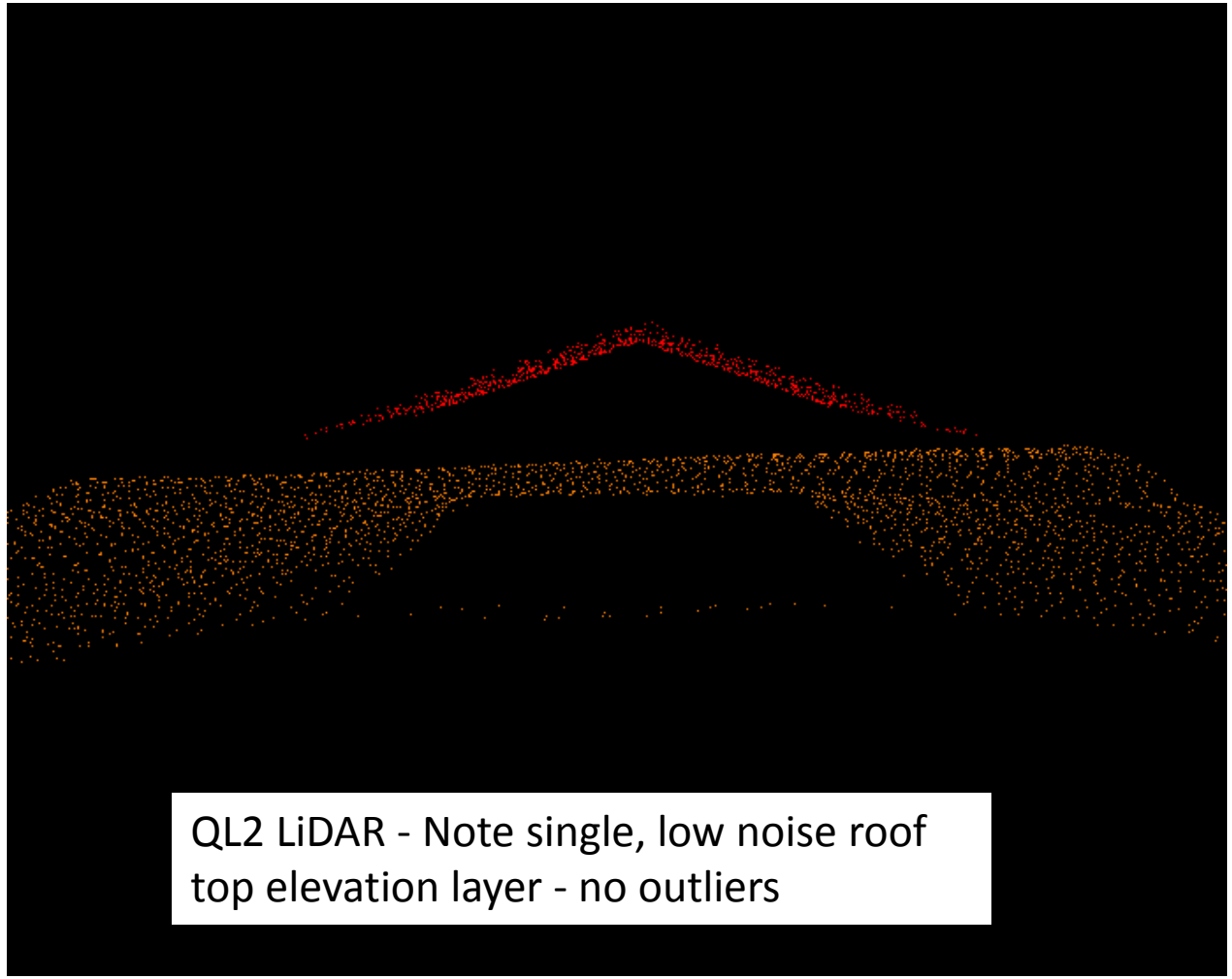




Note multiple roof top elevation layers in point cloud – lots of noise & outliers

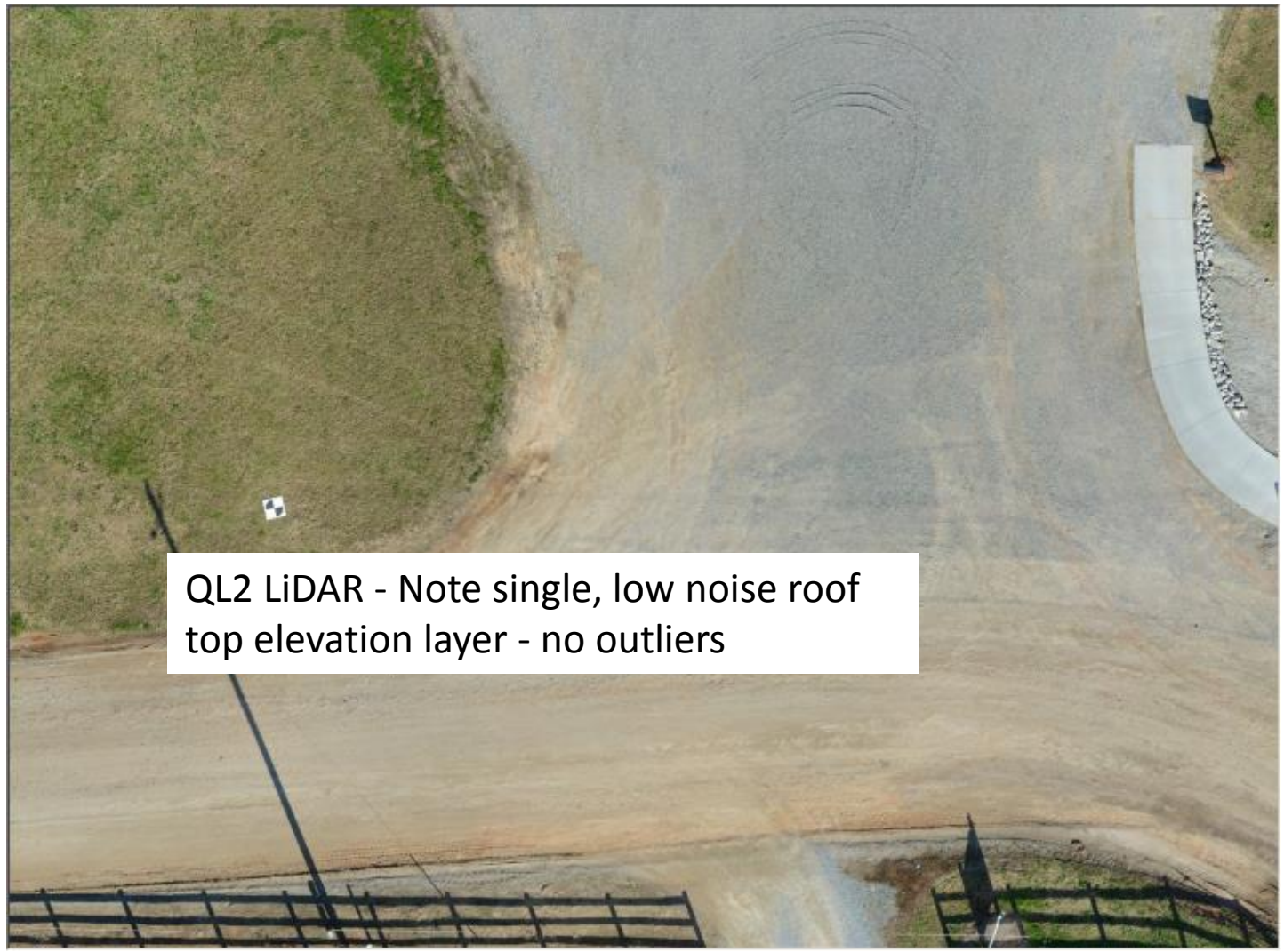
Examples of Product Quality – Point Cloud





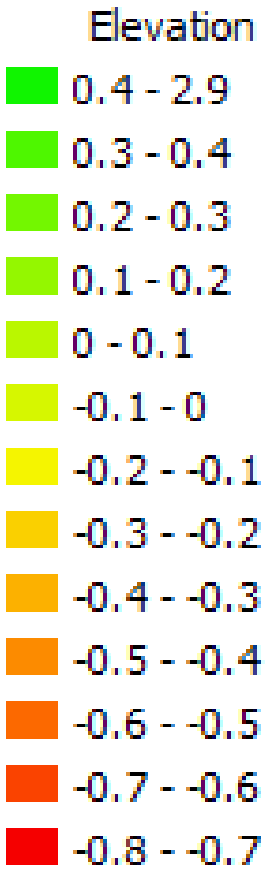
QL2 LiDAR - Note single, low noise roof top elevation layer - no outliers

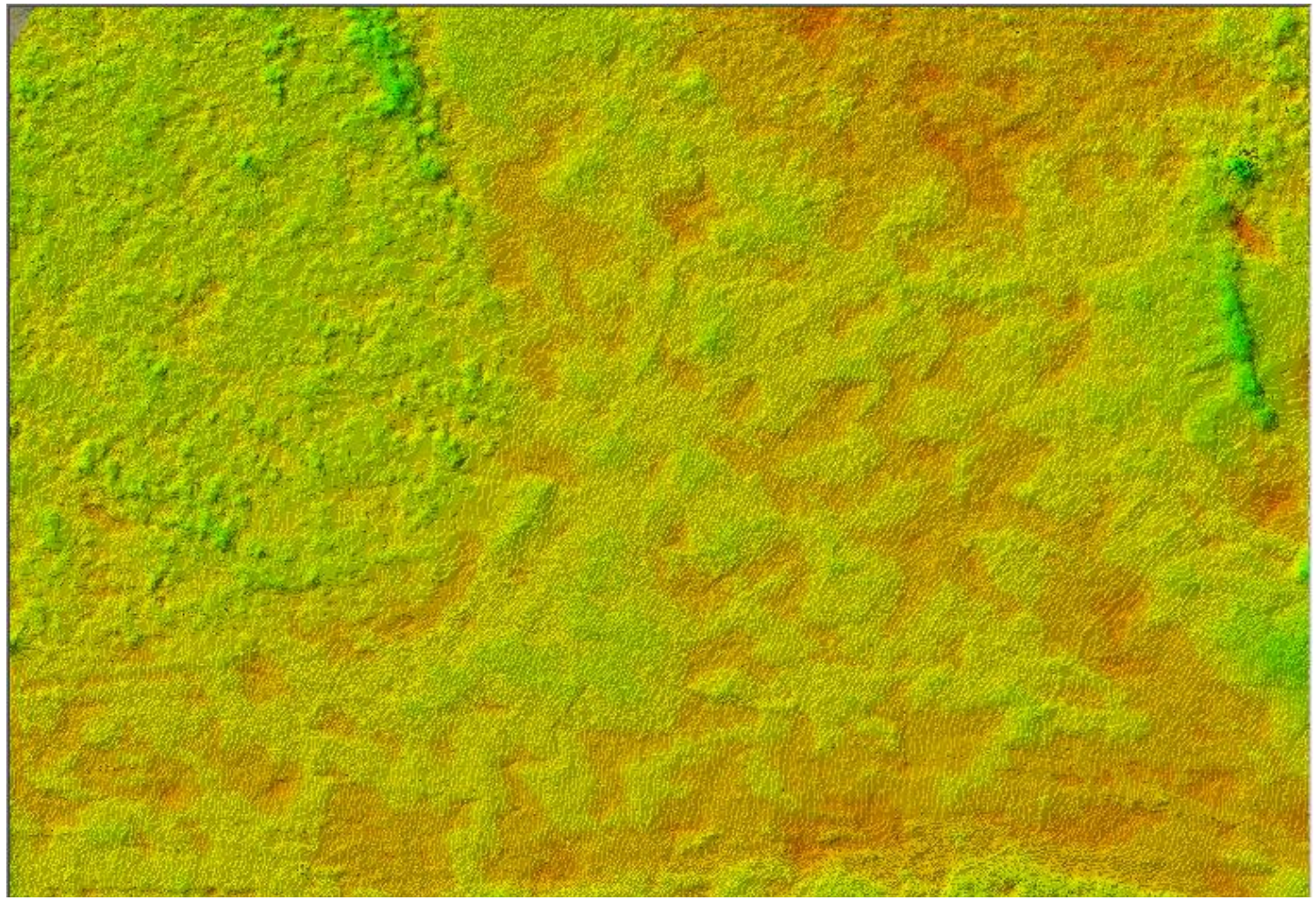
Examples of Product Quality – Point Cloud



Examples of Product Quality – Point Cloud

QL2 LiDAR minus Point Cloud

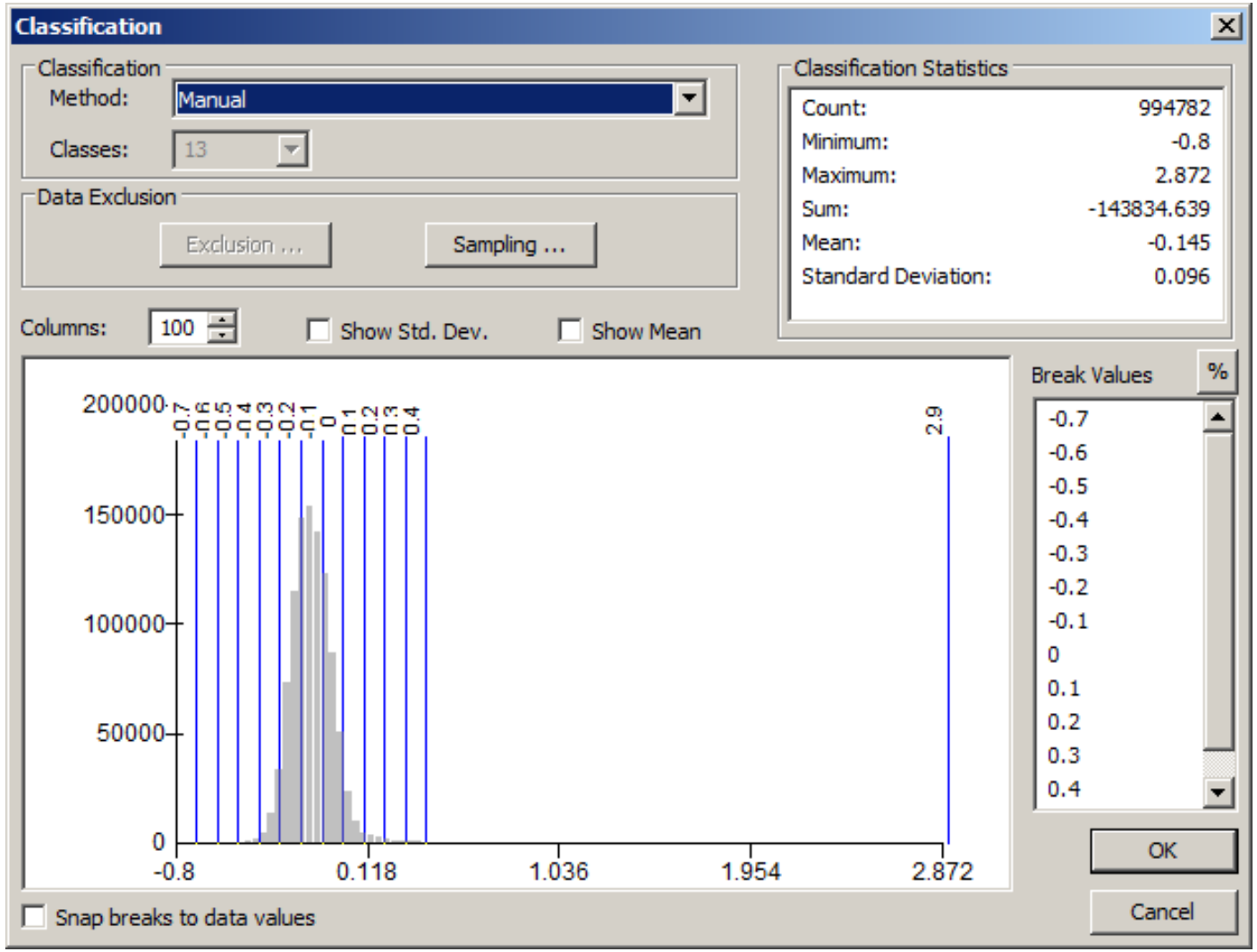




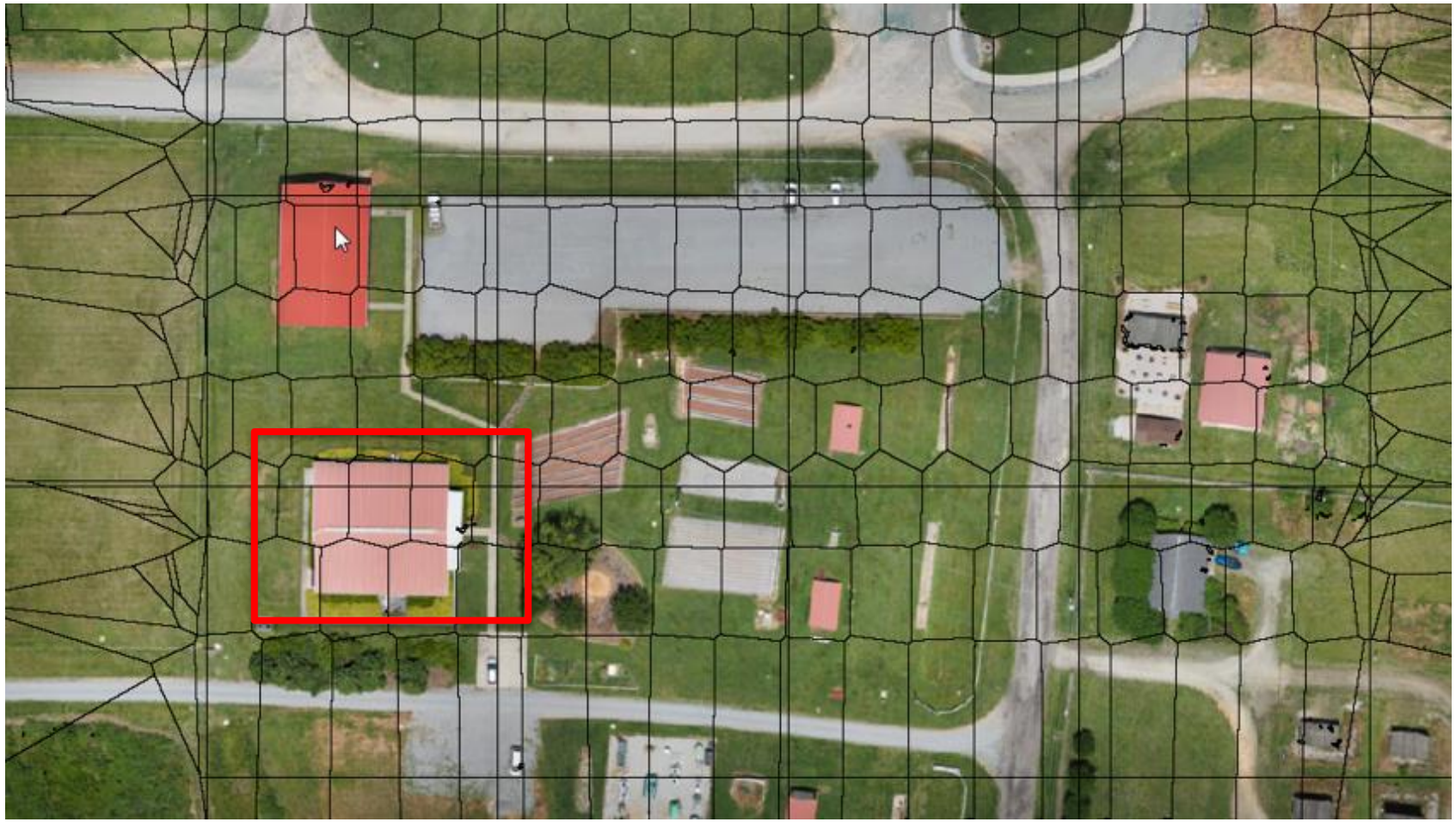
Negative value means UAS Point Cloud is below QL2 LiDAR

Examples of Product Quality – Point Cloud

QL2 LiDAR minus Point Cloud

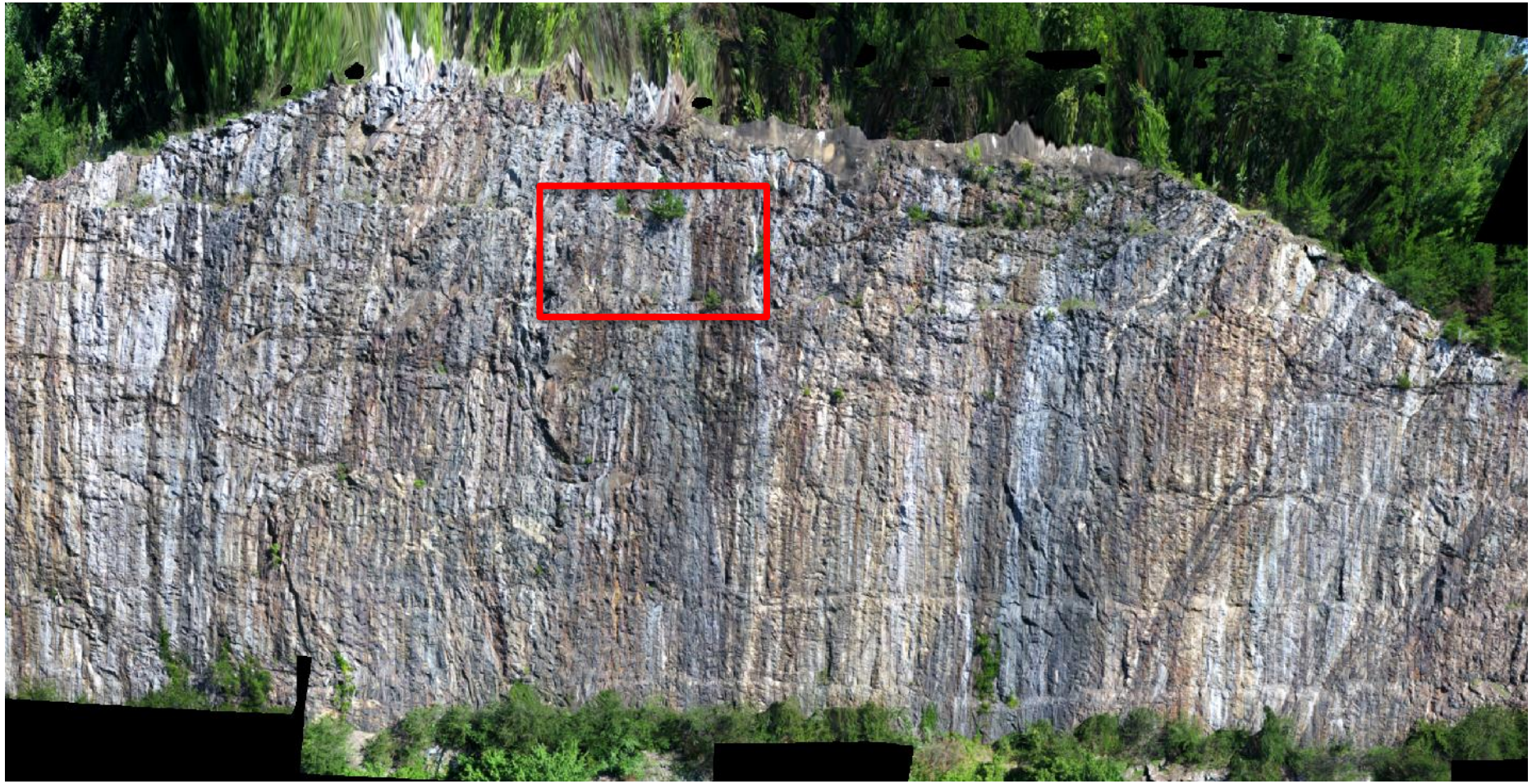


Examples of Product Quality – Distorted Features



Examples of Product Quality – Distorted Features

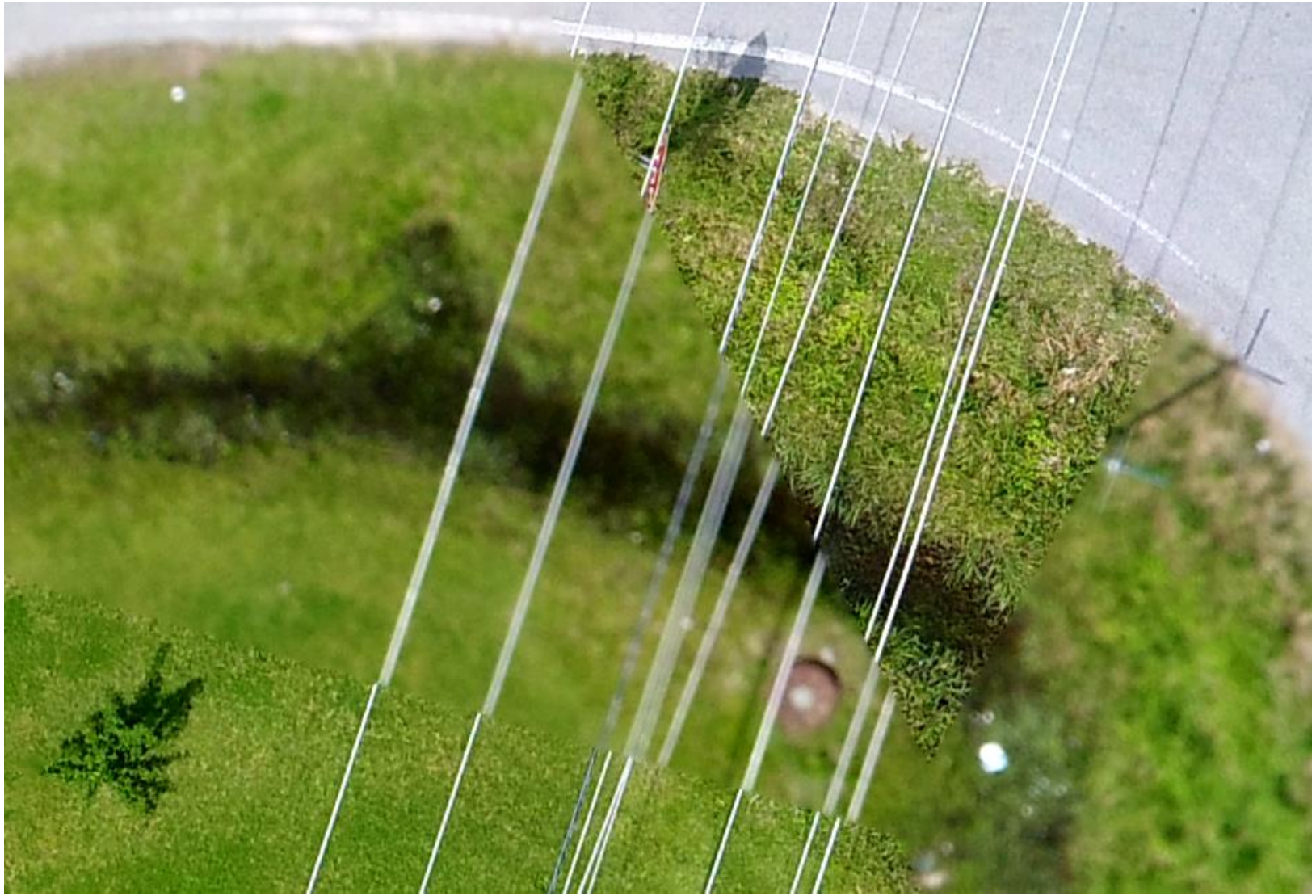
Examples of Product Quality – Distorted Features



Examples of Product Quality – Distorted Features

Examples of Product Quality - Blurriness

Examples of Product Quality - Bluriness



Questions

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NCDOT State Photogrammetric Engineer

kjohnston@ncdot.gov

NCDOT Drone Workshop

October 12, 2017

Amit Ganjoo
CEO

About Us

DRONE AGNOSTIC, Low cost, Open, scalable and adaptable to future requirements and regulation changes

"Open" Drone Operations Platform(s)

→

Tied in with key stakeholders

Highly Experienced Team

Official NASA Collaborator

→

Fully Functional Field tested Platform(s)

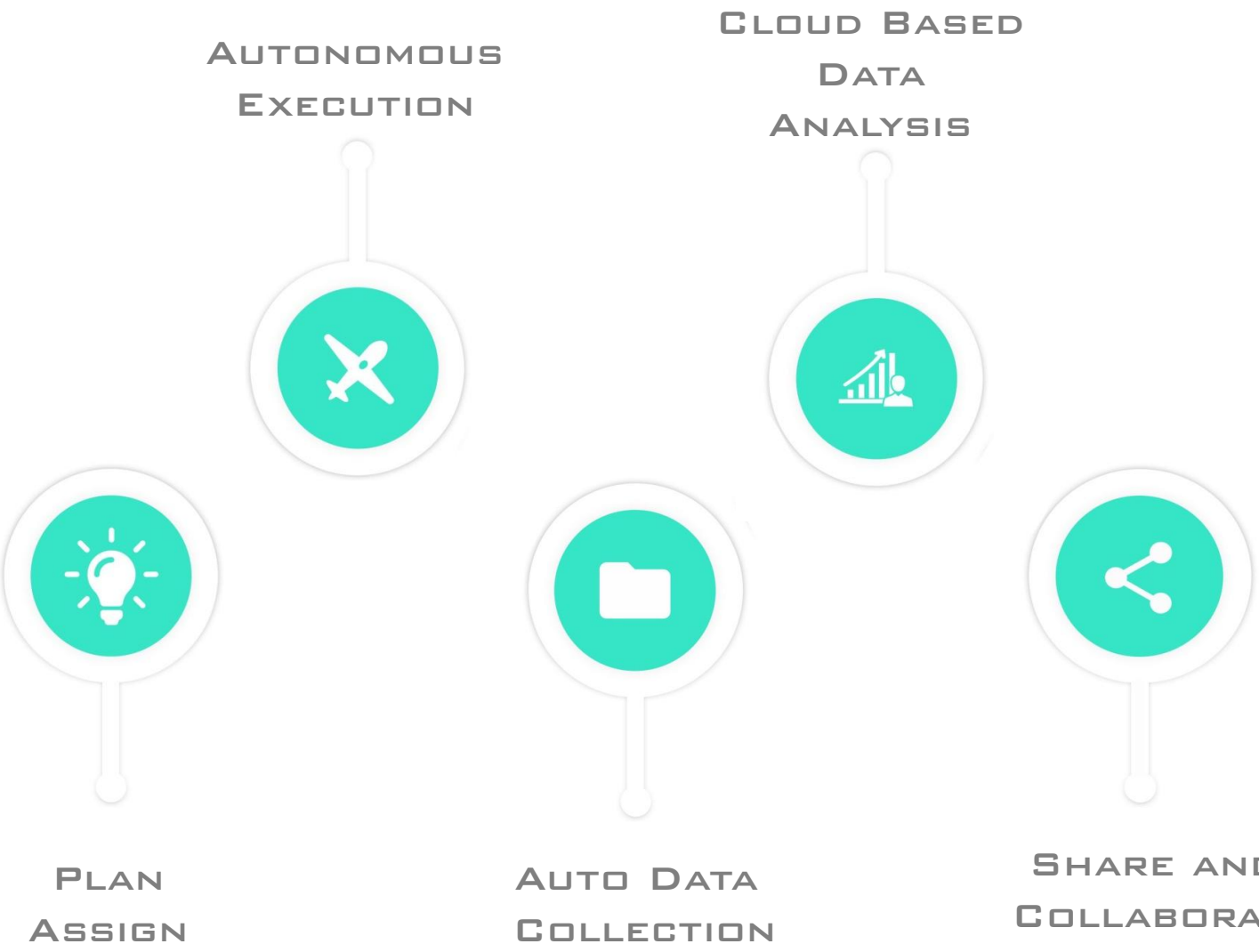
Two Complementary Platforms For LOS and BVLOS Operations

DroneOSS™ & DroneUSS™

ANRA TECHNOLOGIES

DroneOS(TM)

Workflow Management

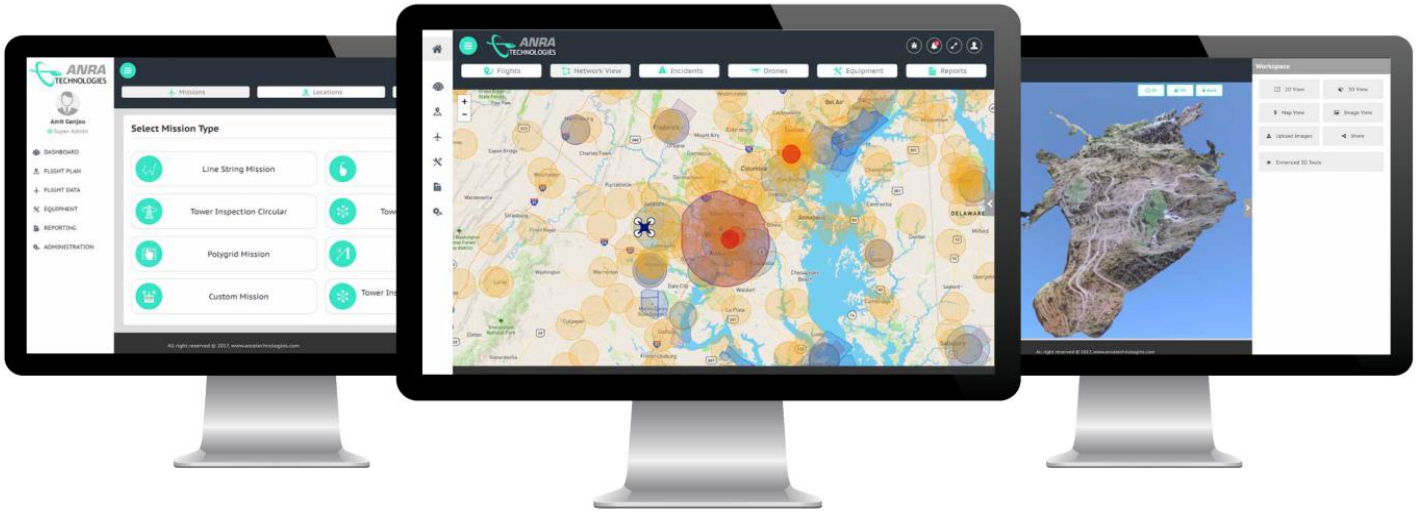


An off the shelf, real-time, field proven, cloud based Regulation Compliant end to end drone operations platform

ANRA TECHNOLOGIES

DroneOS(TM)

Workflow Management



Multiple Drone Control, Real Time Media and Data

Airspace and Traffic Management

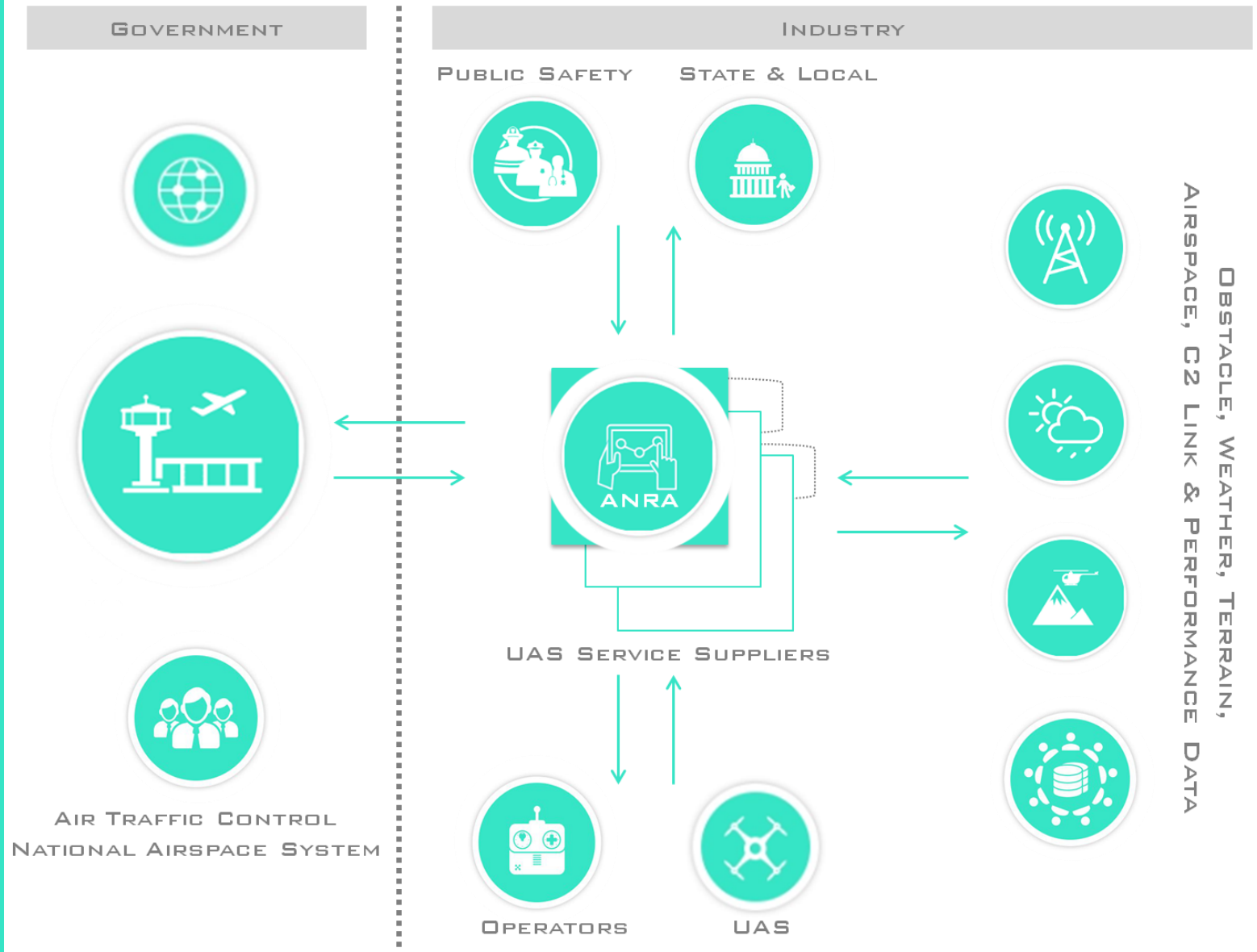
Separation Assurance, Flight Data Management

Incident Management, Fleet Management

Compliance And Reporting

ANRA TECHNOLOGIES

DroneUSS(TM)
UTM System



ANRA TECHNOLOGIES

UAS Traffic Management (UTM)

- Overview
  - System will allow safe, efficient, and fair access to the low altitude airspace for small UAS.
  - A key component within UTM will be the set of USS Service Suppliers, which support UAS operators in planning, executing, and communicating their operations throughout the UTM System.
  - Much of what would be considered "traditional" Air Traffic Management will actually be performed collaboratively by this set of USSs and not the ANSP.
-

ANRA TECHNOLOGIES

Key Assumptions

- What is needed for UTM?
  - planning of UAS operations
  - Deconfliction of the UTM airspace
  - Providing supplementary data to UAS Operators during operations
  - Bridging communication between UAS Operators and ANSPs
  - Authentication & Authorization
  - Registration and Remote Identification
  - Life cycle management

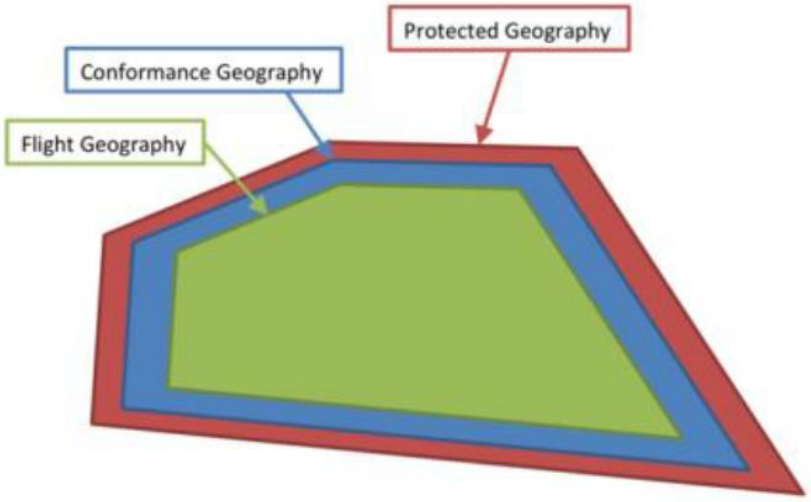
ANRA TECHNOLOGIES

Basic Mantras

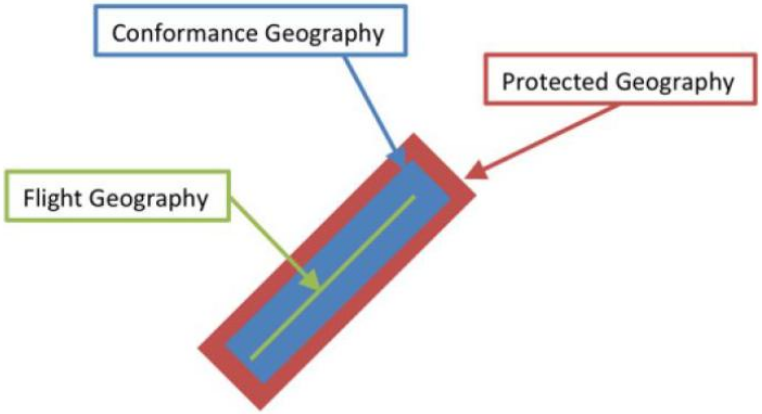
- **Flexibility where possible and structure where necessary**
  - much flexibility is offered to operators and operations where there is no demand and no capacity imbalance.
  - When the demand is over capacity as in case of multiple UAS wanting to operate at the same airspace at the same time, then structures such as corridors, altitude for direction, and crossing restrictions will be incorporated.
- **Risk based approach where geographical needs and use cases will dictate the performance**
  - based on the risks on the ground or in the air (e.g., remote airspace vs. congested urban airspace) as well the area of operations needed to support the use case (e.g., surveillance of pipeline or electric wires vs. deliveries all the way to the door step)

ANRA TECHNOLOGIES

Flight Geographies



Polygon

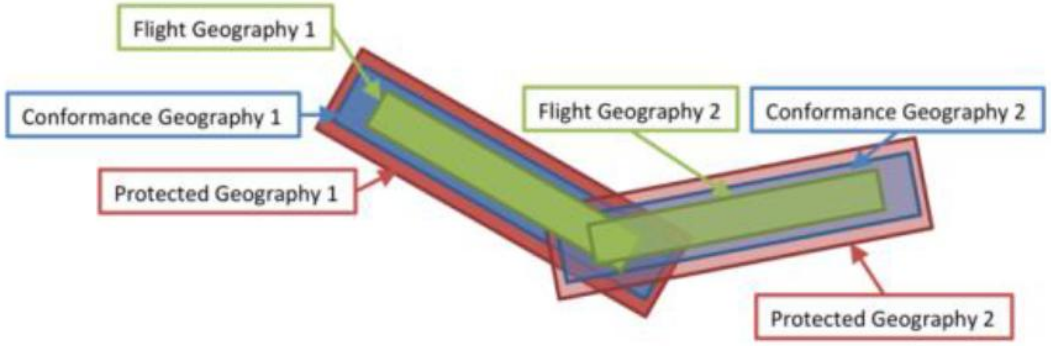


Linestring

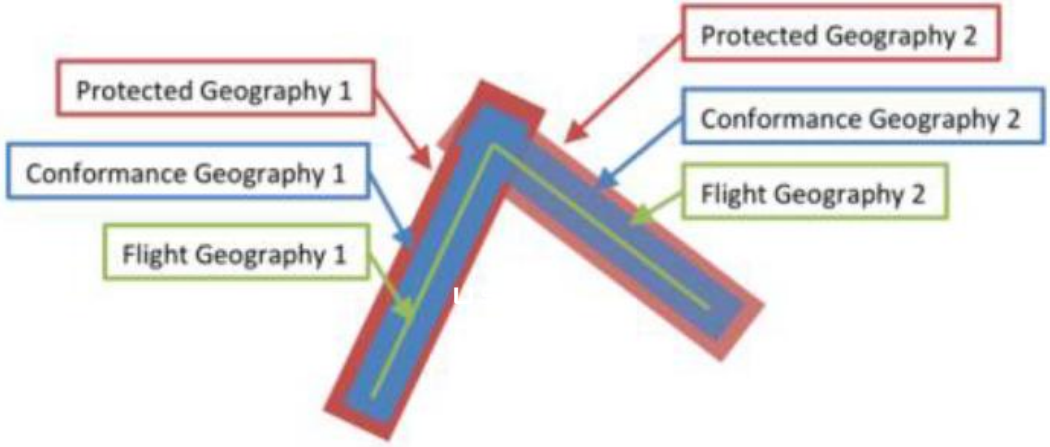
Courtesy: NASA

ANRA TECHNOLOGIES

Flight Plan & Airspace Reservations



Polygon

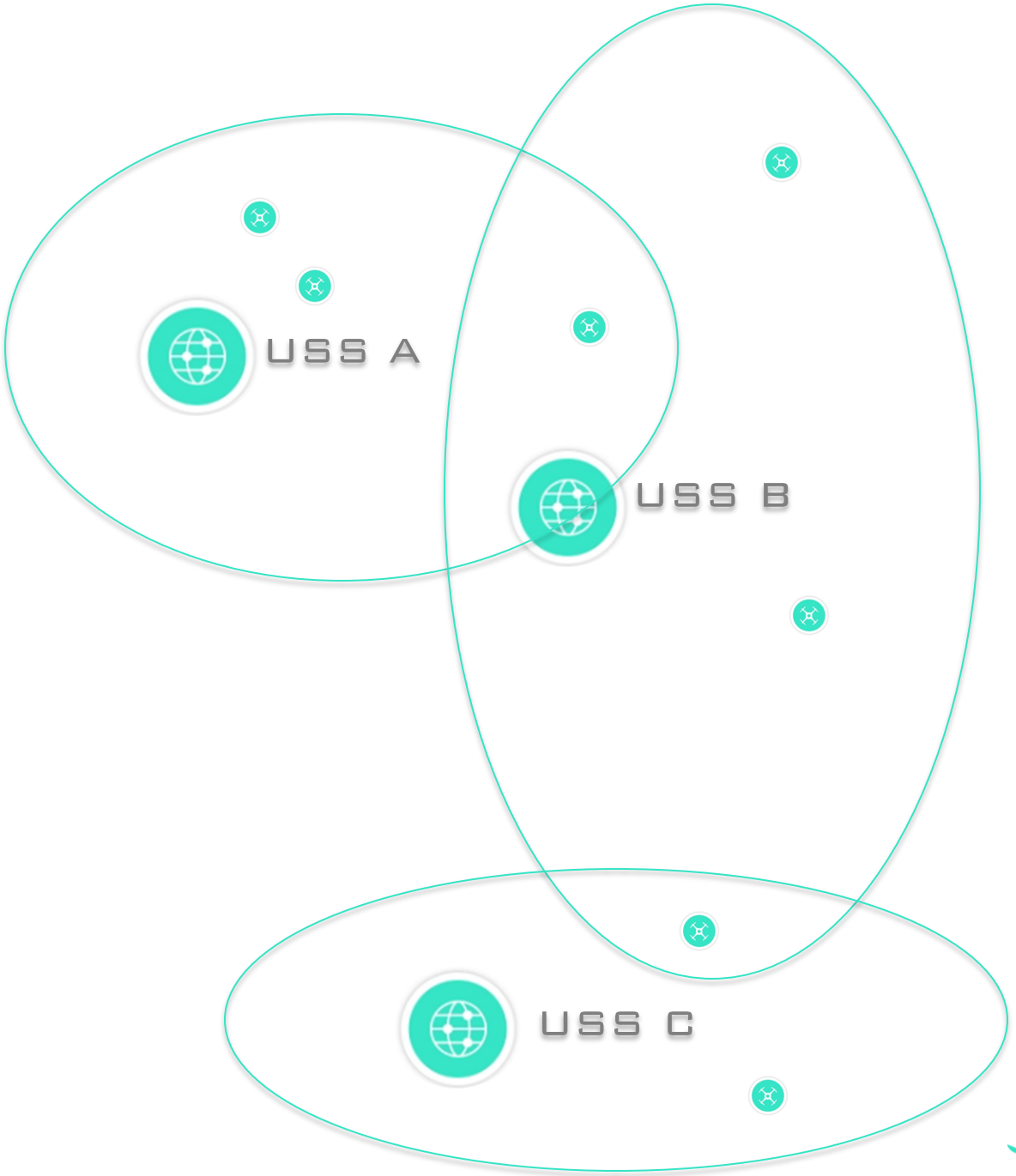


Linestring

Courtesy: NASA

ANRA TECHNOLOGIES

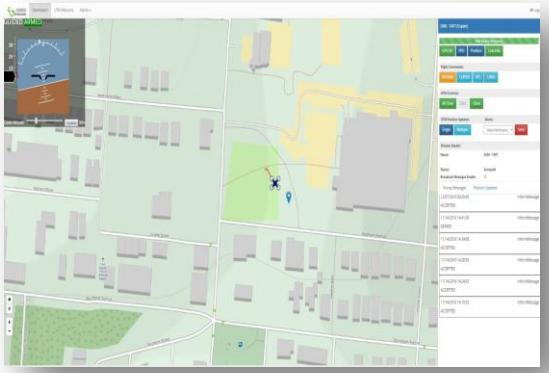
USS Operational Areas

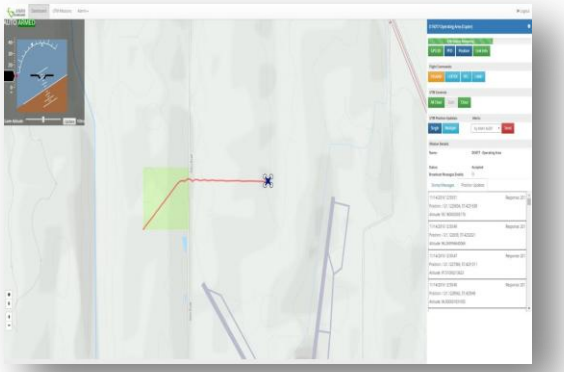


ANRA TECHNOLOGIES

DroneUSS Features

- Operator Interface
- Public Portal
- UREP capability
- WX and Other Data services
- USS Discovery Service
- USS-to-USS negotiation
- End-to-end UREP
- FIMS Negotiation
- Remote ID
- USS-USS Negotiation



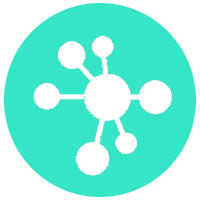


ANRA TECHNOLOGIES

Registration and Remote ID

- Required for the human stakeholders
  - Law Enforcement and Public

- to make strategic decisions related to mission management
  - launch, execution, and/or termination of airspace operations.



- ensure Authenticity
  - Only authenticated and approved UAS can operate in the given airspace.

- .

ANRA TECHNOLOGIES

Managing Authority

RID Allocation Management

RID color list Management

Issuing Authority

UAS Service Suppliers

RID Allocation Requests

RID Allocation Whitelists

RID Allocation Confirmations

RID Database

Blacklists

RID Allocation Requests

RID Status Queries

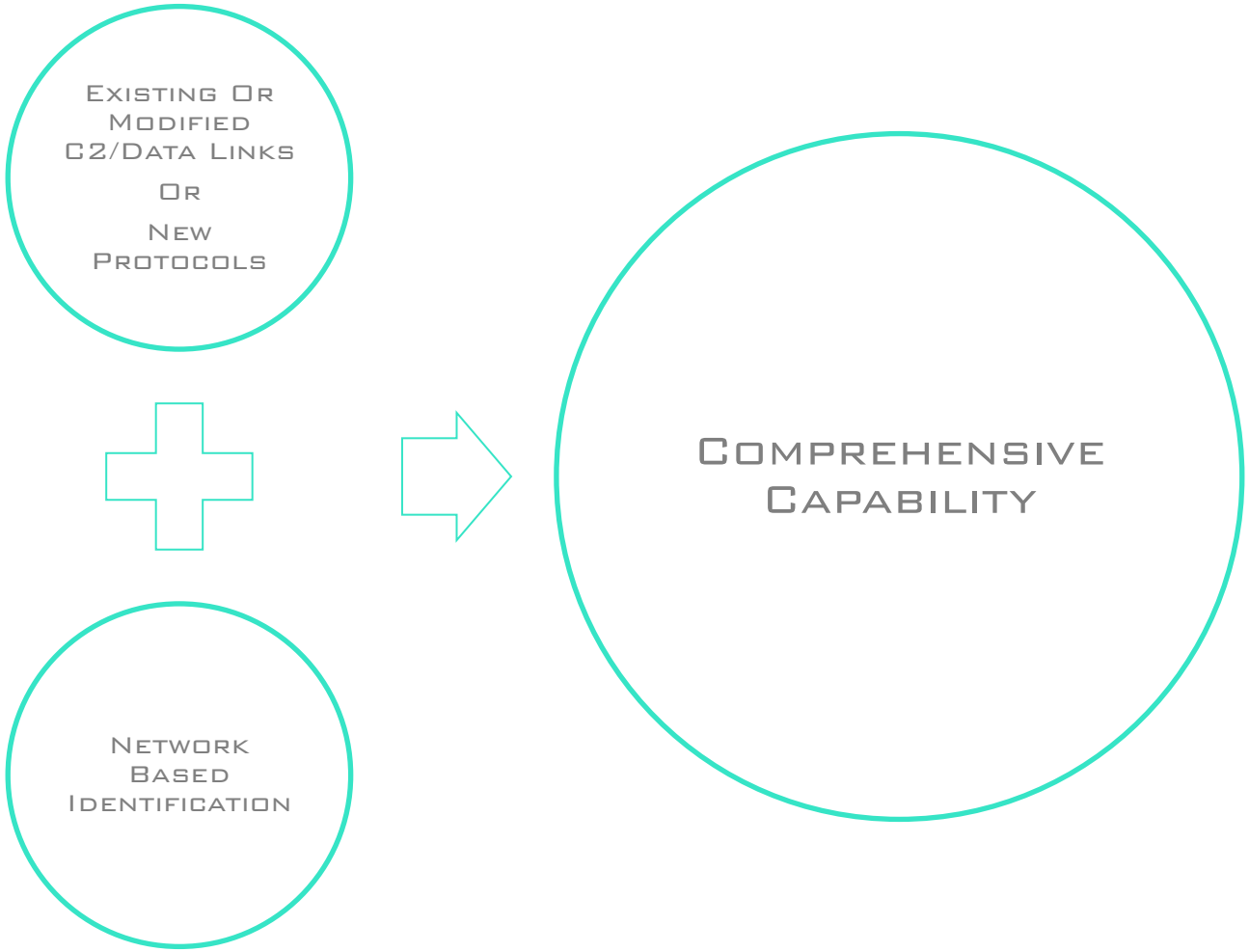
Drone Manufactur-ers

IMEI Like

Lookup Service Users

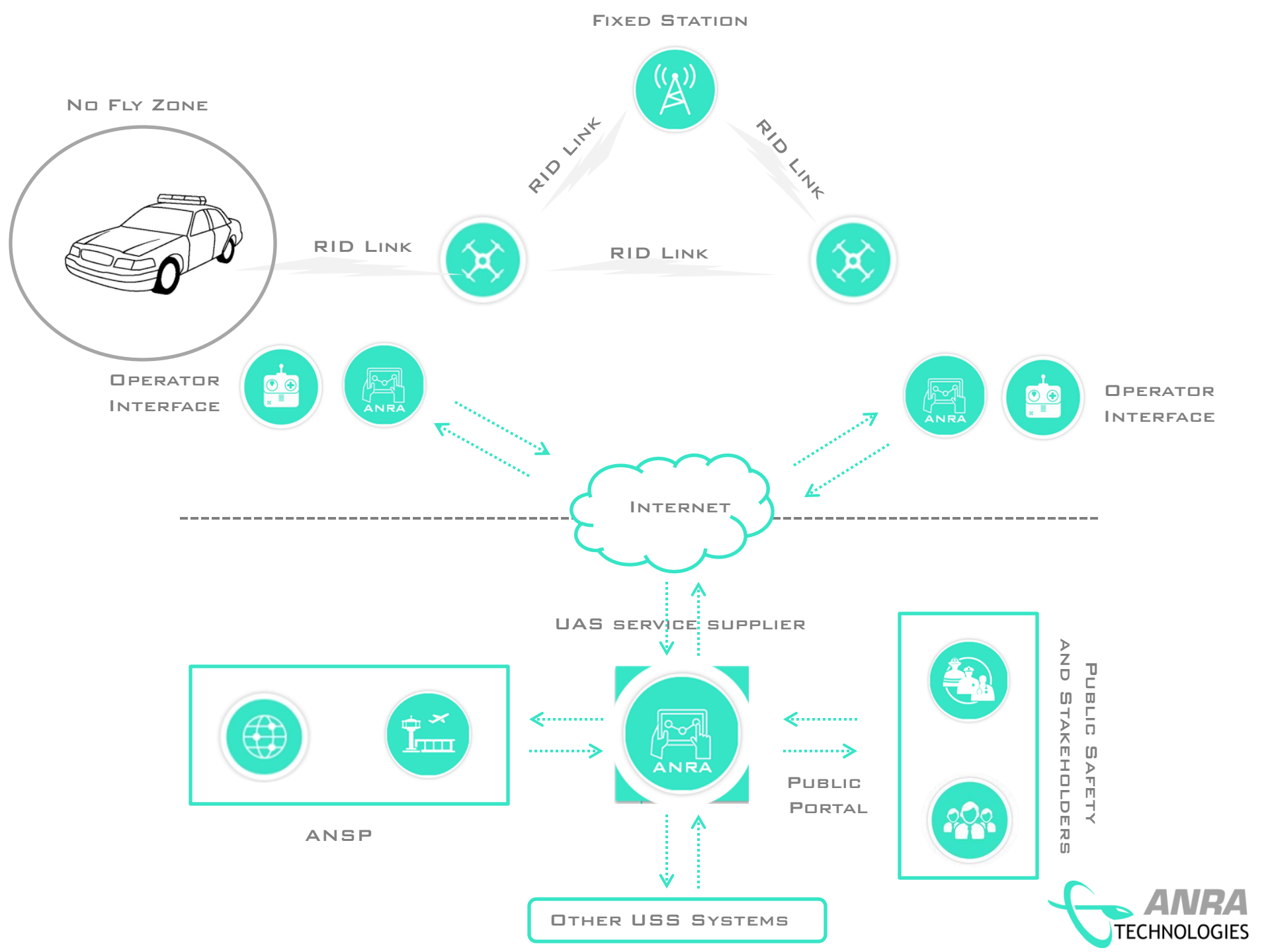
ANRA TECHNOLOGIES

Identification Channels



No one solution fits all – Need multi pronged approach

ANRA TECHNOLOGIES


Fixed Station
No Fly Zone
RID Link
RID Link
RID Link
RID Link
Operator Interface
ANRA
ANRA
Operator Interface
Internet
UAS service supplier
ANRA
ANSP
Public Portal
Public Safety and Stakeholders
Other USS Systems
ANRA TECHNOLOGIES

Contact Us

Amit Ganjoo

Founder and CEO
ANRA Technologies

aganjoo@anratechnologies.com
+1.703.239.3206

ANRA TECHNOLOGIES


GSC
SURVEYING
GO
UNMANNED
EXPERT UAV SYSTEMS
BENCHMARK
TOOL AND SUPPLY, INC

ABOUT GO UNMANNED

Go Unmanned was founded in 2015 as a division of Benchmark Tool & Supply. We offer commercial-grade, fixed-wing and multi-rotor drones and unmanned aerial vehicles (UAVs) for the construction, surveying, engineering, agriculture, inspection and emergency services fields.

GO UNMANNED
EXPERT UAV SYSTEMS

GO UNMANNED
EXPERT UAV SYSTEMS

FLIGHT OPS CHECKLIST

Go Unmanned Flight Ops Checklist

Company:_____ **Date:**_____

To be completed PRIOR to departure to site

Location(s), Address or Lat/Long: _____

AIRSPACE

Nearest Airport: _____ Direction and Range:_____ Freq:_____

Platform Registration: ☐ Platform Log: ☐ UAS Certficate: ☐ Valid ID: ☐

Illness ☐ Medication ☐ Stress ☐ Alcohol ☐ Fatigue ☐ Eat/Hydration ☐

Expected On-Site Weather: Time:_____ Winds Dir_____ Spd:_____ Lowest Cloud Base:_____

DISPATCH/MANAGEMENT PPR:_____

To be completed on site and within 15 minutes PRIOR to Takeoff

WEATHER www.aviationweather.gov	*RADAR*	No Precipitation within 10 nm ☐		
	*METAR/ATIS UTC:*_____	WINDS Dir:_____ Vel____	Visibility:_____SM	TEMP:_____DEW:_____ Lowest Cloud Base:_____FT

Crew/Crew Resource Management

Remote Pilot-In-Command: _____

Pilot at Contols: _____

Visual Observer: _____

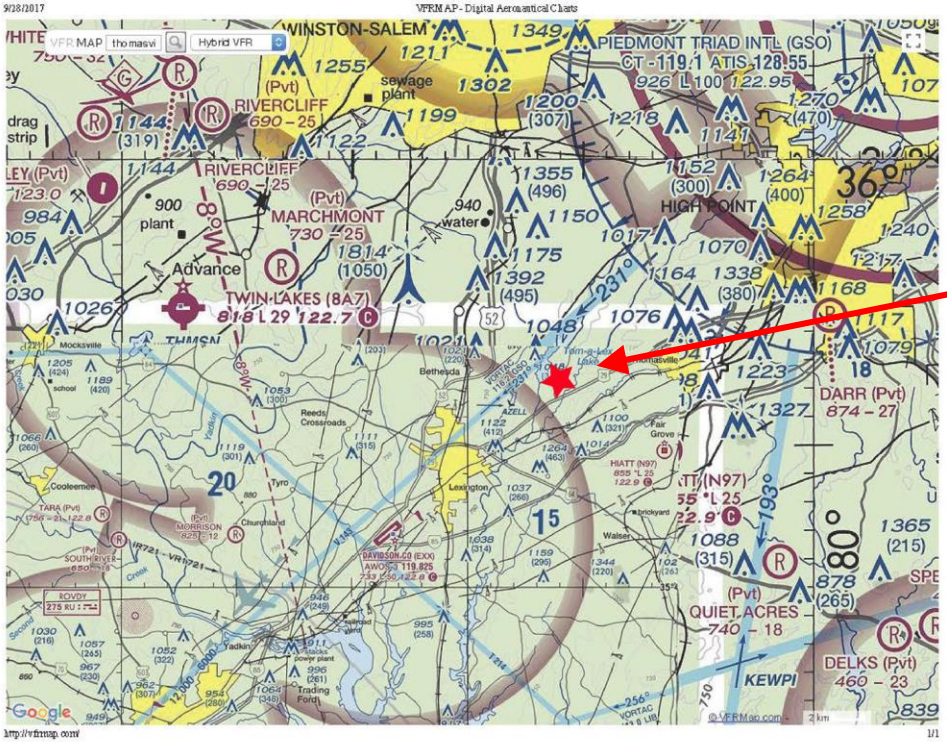
Trainee: _____

Trainee: _____

Mission Brief *To be briefed in full presence of crew*	Mission ☐	Altitude(s) ☐	Communication process/ Channels/ Radio Check (if used) ☐
	Duration ☐		Lost Comms Procedures ☐
	Obstructions and Hazards ☐		Call Signs ☐
Emergency Procedures	Lost Link, Fly Away EP: ☐		Return to home verified fuctioning properly: ☐

GO UNMANNED
EXPERT UAV SYSTEMS

CLASS G AIRSPACE



GO UNMANNED
EXPERT UAV SYSTEMS

FLIGHT MISSION

- The intent of our mission is to safely obtain data of this outdoor courtyard.
- With this data, engineers and construction professionals will have a georeferenced 3D model of the site.

GO UNMANNED
EXPERT UAV SYSTEMS

CONTACT

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Matt Mulhern
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mmulhern@benchmarksupply.com

GO UNMANNED
EXPERT UAV SYSTEMS


GSC
SURVEYING
GO
UNMANNED
EXPERT UAV SYSTEMS
BENCHMARK
TOOL AND SUPPLY, INC

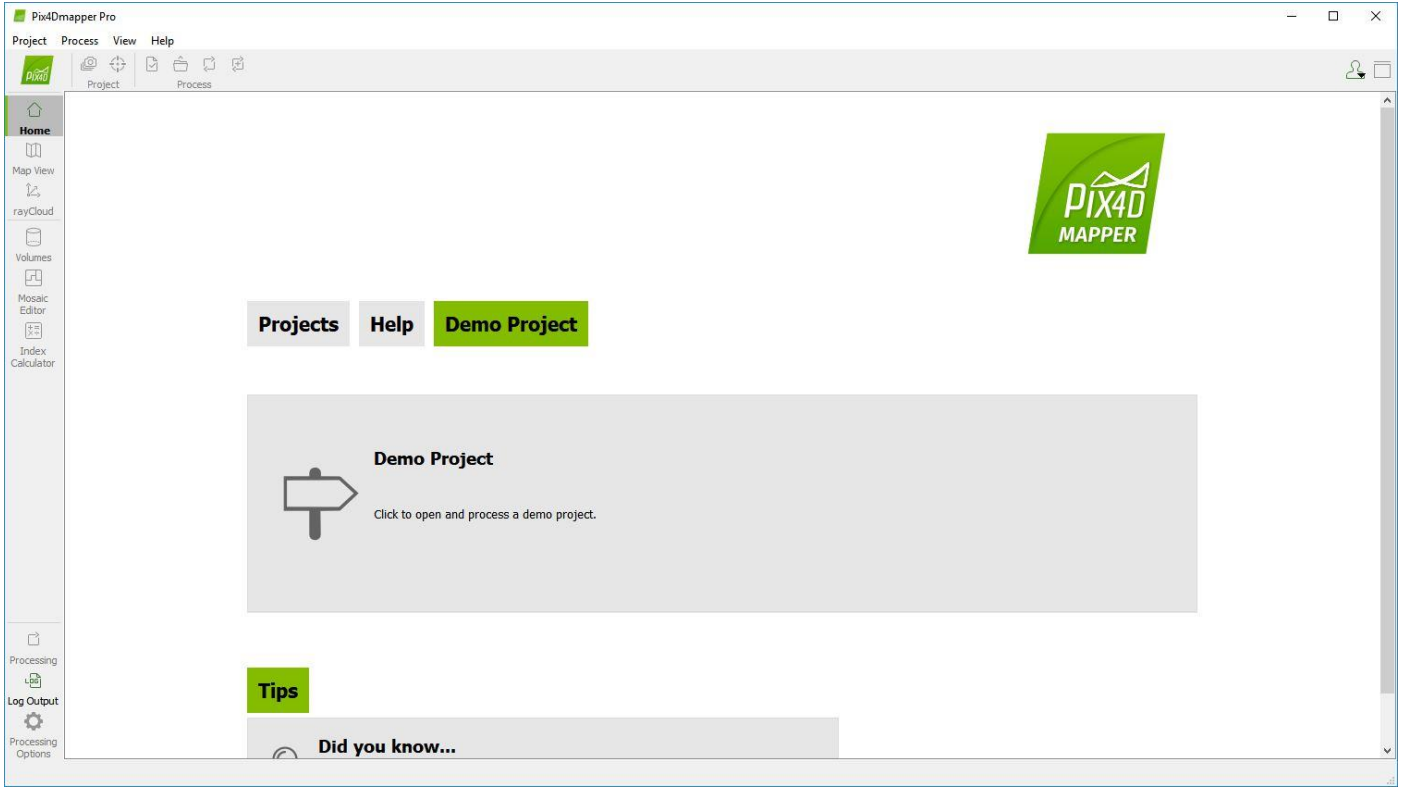
ABOUT GSC SURVEYING

- GSC Surveying was started in 1999 by Greg Crowder, specializing in highway construction surveying.
- Benchmark Tool & Supply, Inc. was started in 2004 by Greg Crowder and Chuck Harris as a leader in machine control technology. In 2014, they added a UAV Division to Benchmark called Go Unmanned, Inc.

GSC SURVEYING

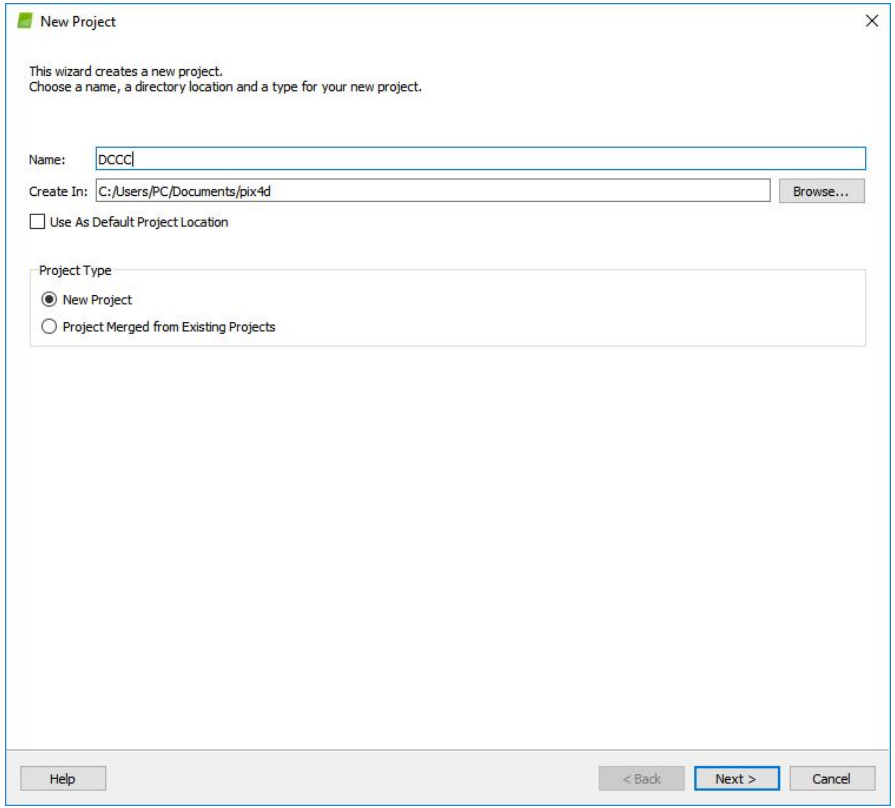
GSC SURVEYING

PIX4D PROCESSING



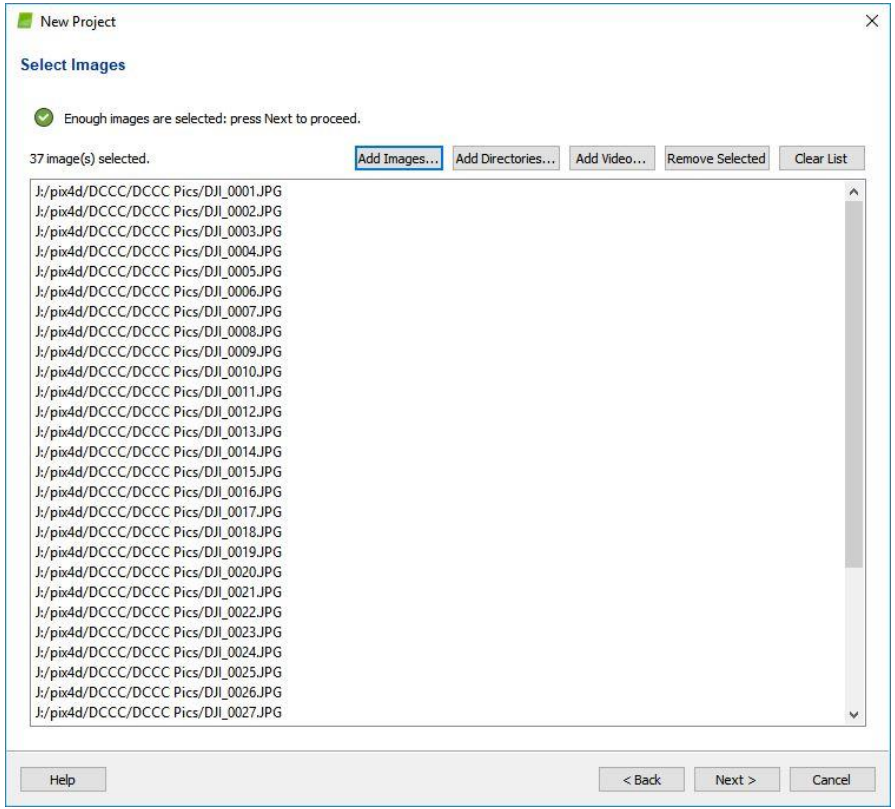
GSC SURVEYING

CREATE PROJECT



GSC SURVEYING

IMPORT PHOTOS



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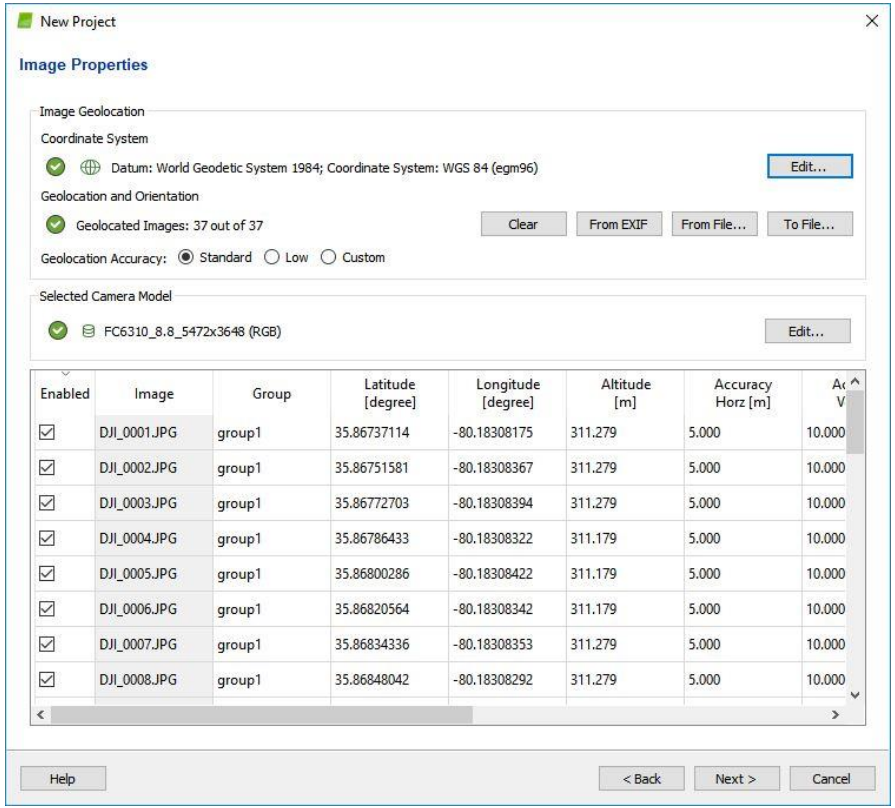
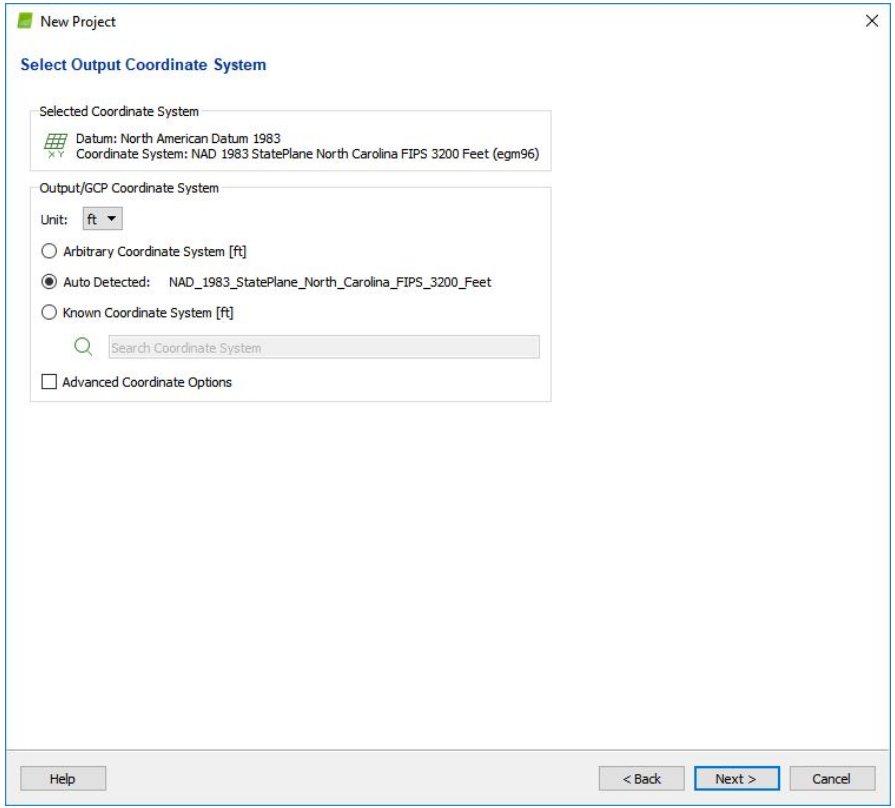
CAMERA PARAMETERS



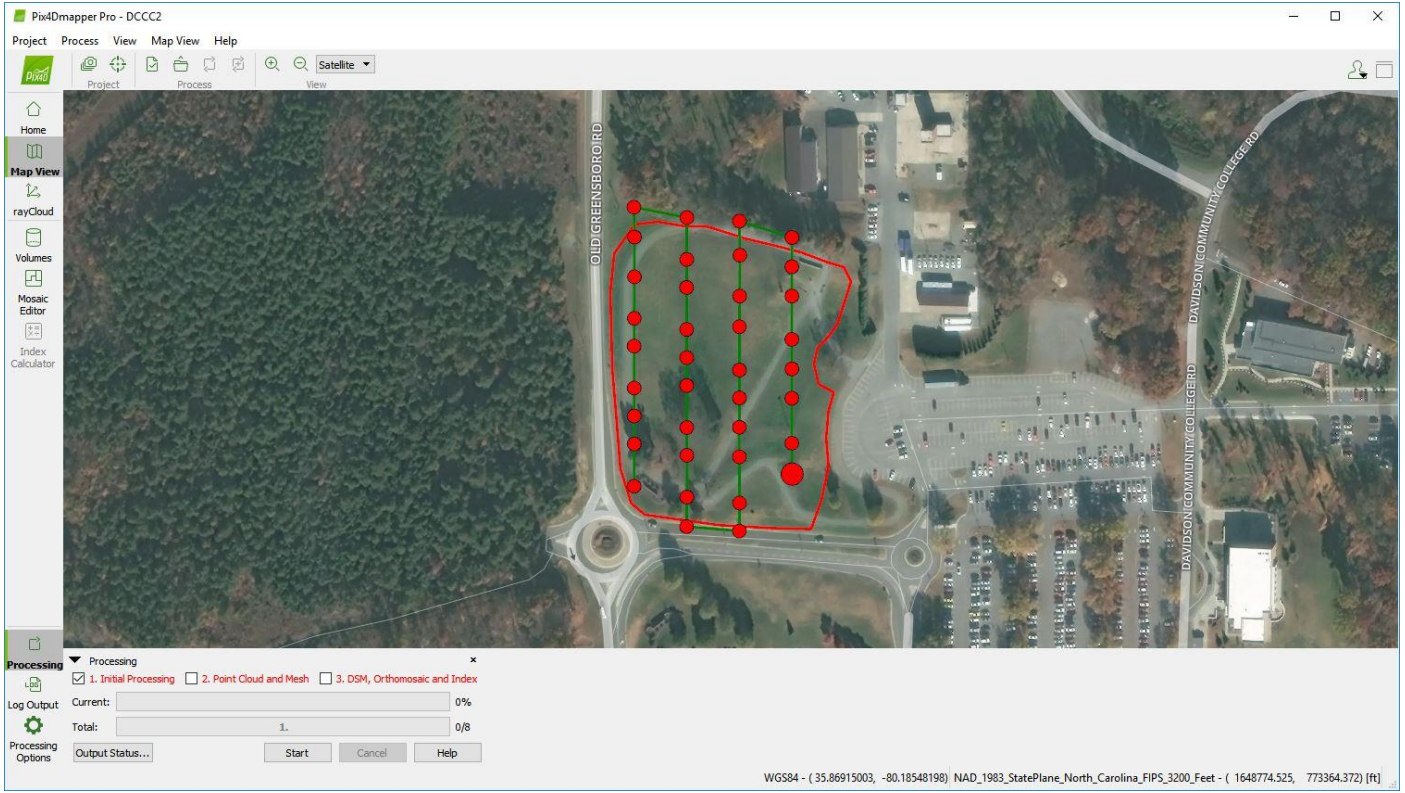
GSC SURVEYING

COORDINATE SYSTEM



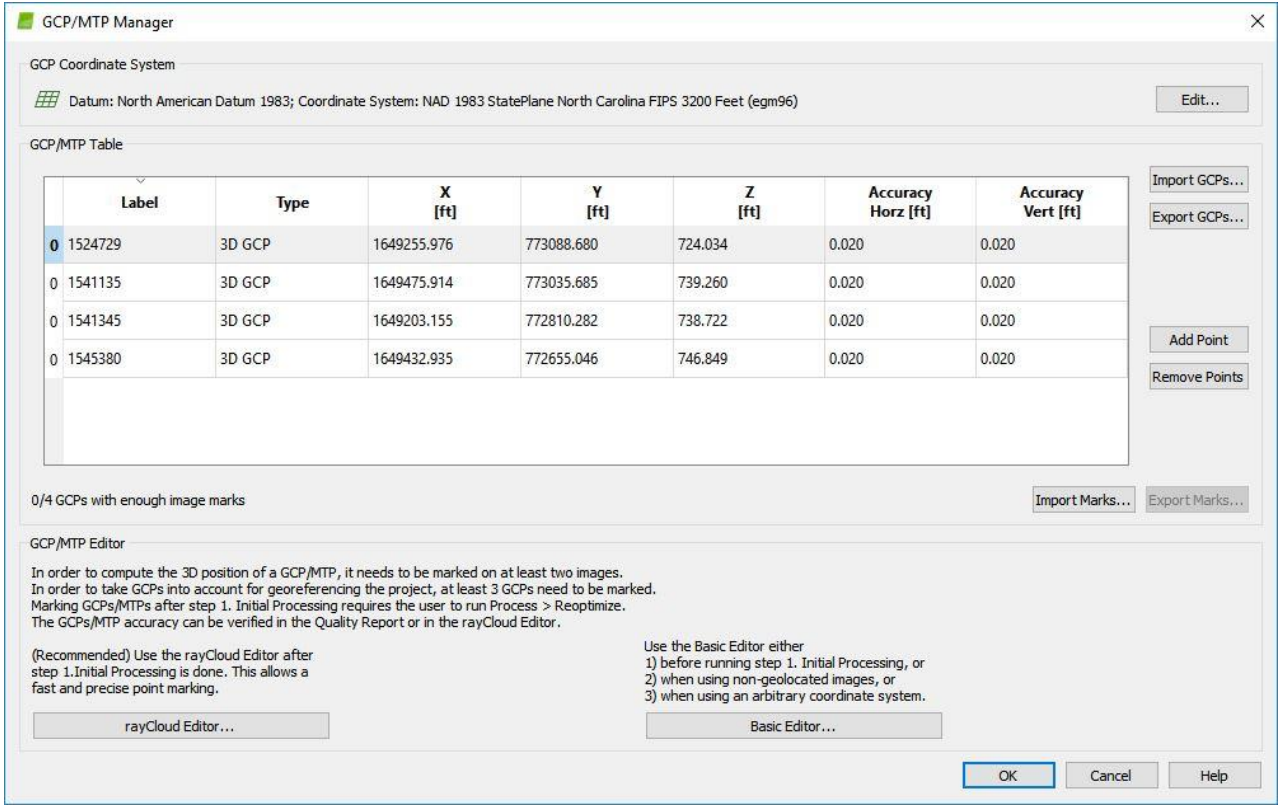
GSC SURVEYING

INSPECT DATA



GSC SURVEYING

GROUND CONTROL & PROCESS



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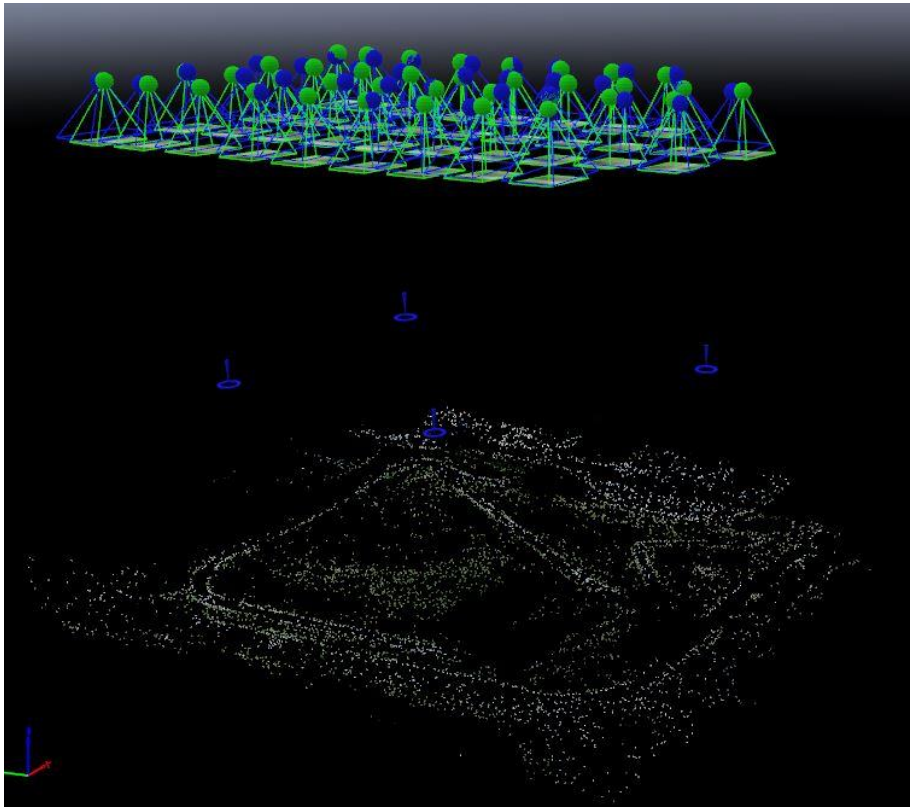
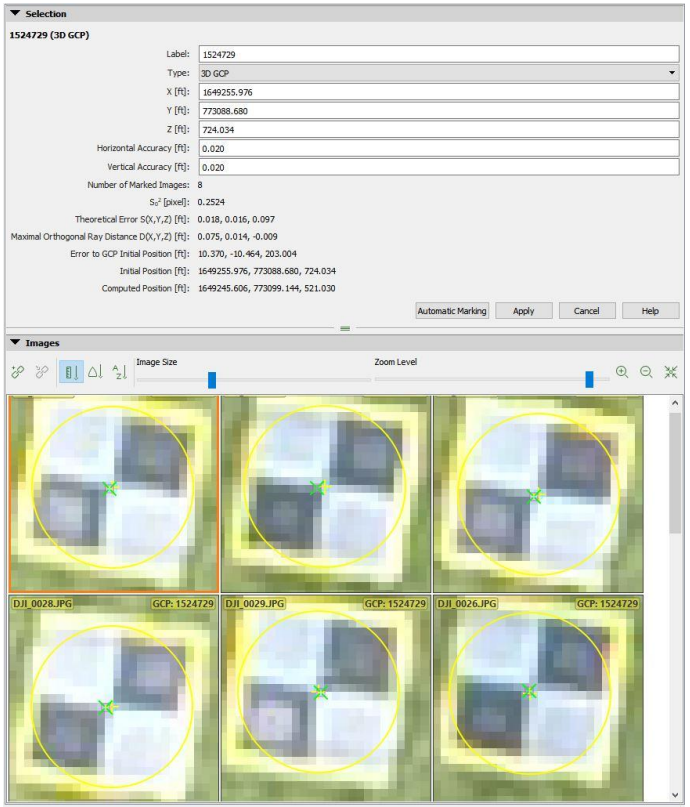
GROUND CONTROL EXPLAINED

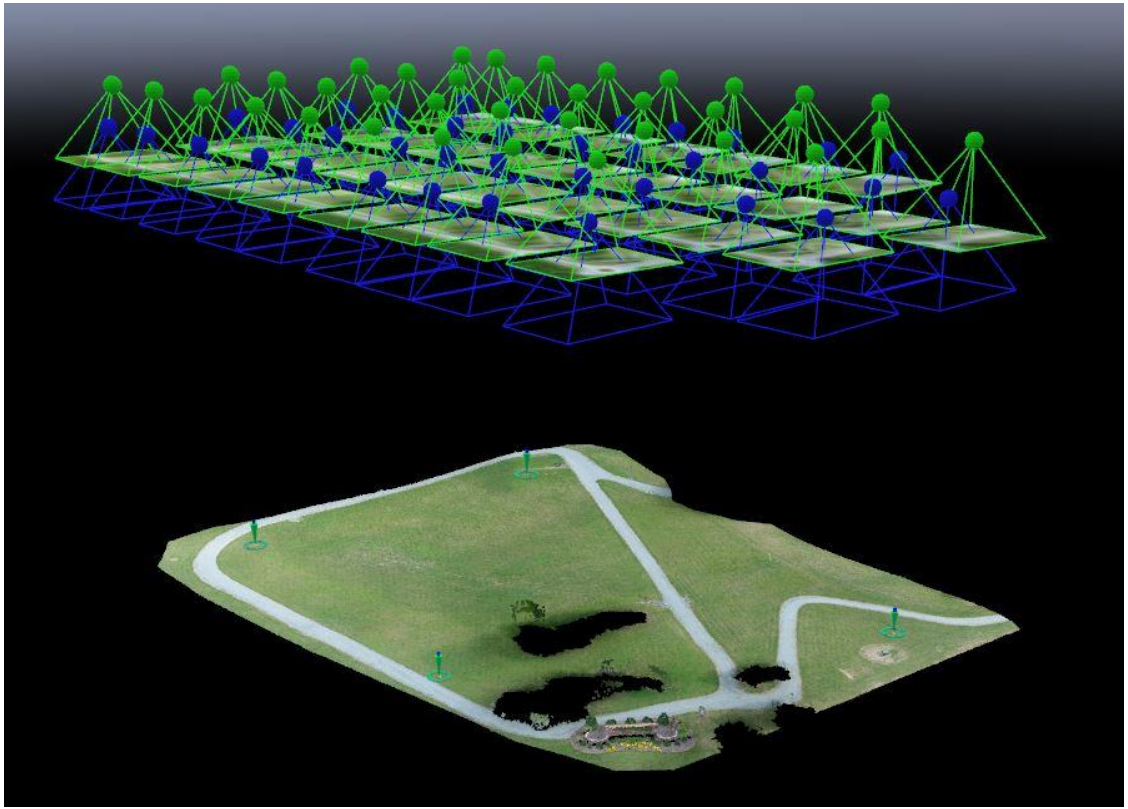


GSC SURVEYING

MARK POINTS

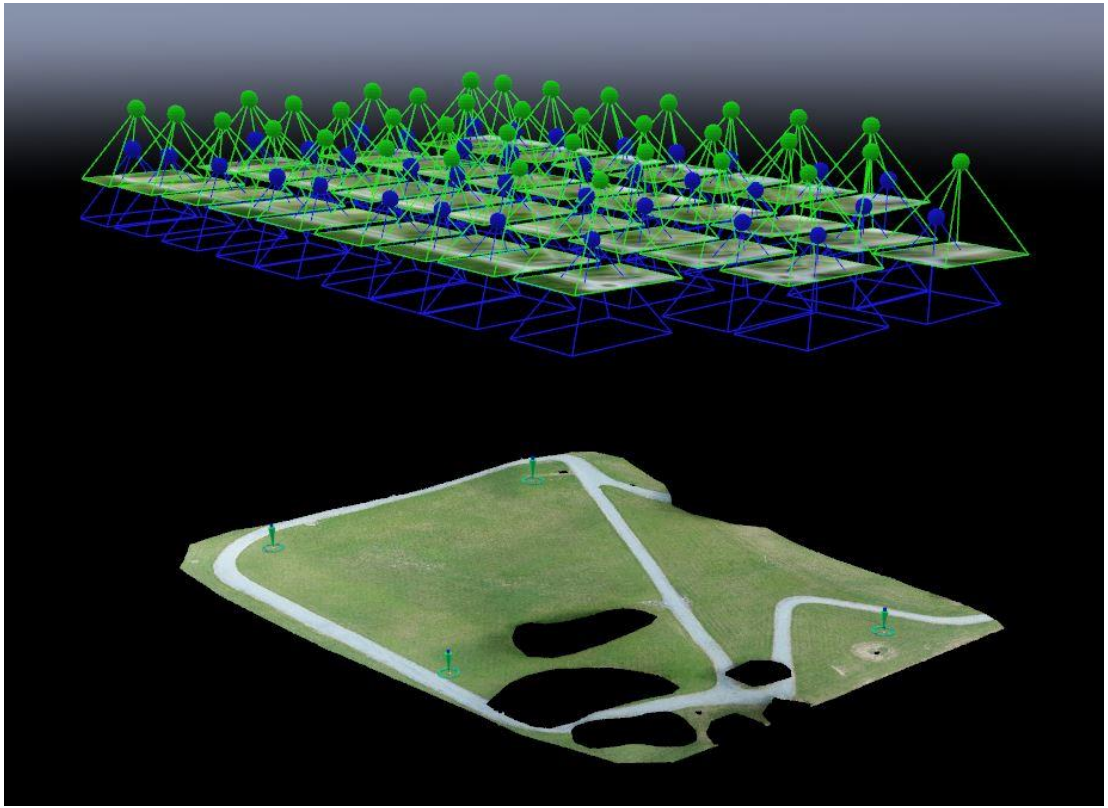

Selection
1524729 (3D GCP)
Label: 1524729
Type: 3D GCP
X [ft]: 1649255.976
Y [ft]: 773088.680
Z [ft]: 724.034
Horizontal Accuracy [ft]: 0.020
Vertical Accuracy [ft]: 0.020
Number of Marked Images: 8
s_0^2 [pixel]: 0.2524
Theoretical Error S(X,Y,Z) [ft]: 0.018, 0.016, 0.097
Maximal Orthogonal Ray Distance D(X,Y,Z) [ft]: 0.075, 0.014, -0.009
Error to GCP Initial Position [ft]: 10.370, -10.464, 203.004
Initial Position [ft]: 1649255.976, 773088.680, 724.034
Computed Position [ft]: 1649245.606, 773099.144, 521.030
Automatic Marking
Apply
Cancel
Help
Images
Image Size
Zoom Level
DJI_0028.JPG
GCP: 1524729
DJI_0029.JPG
GCP: 1524729
DJI_0026.JPG
GCP: 1524729

DENSIFIED POINT CLOUD



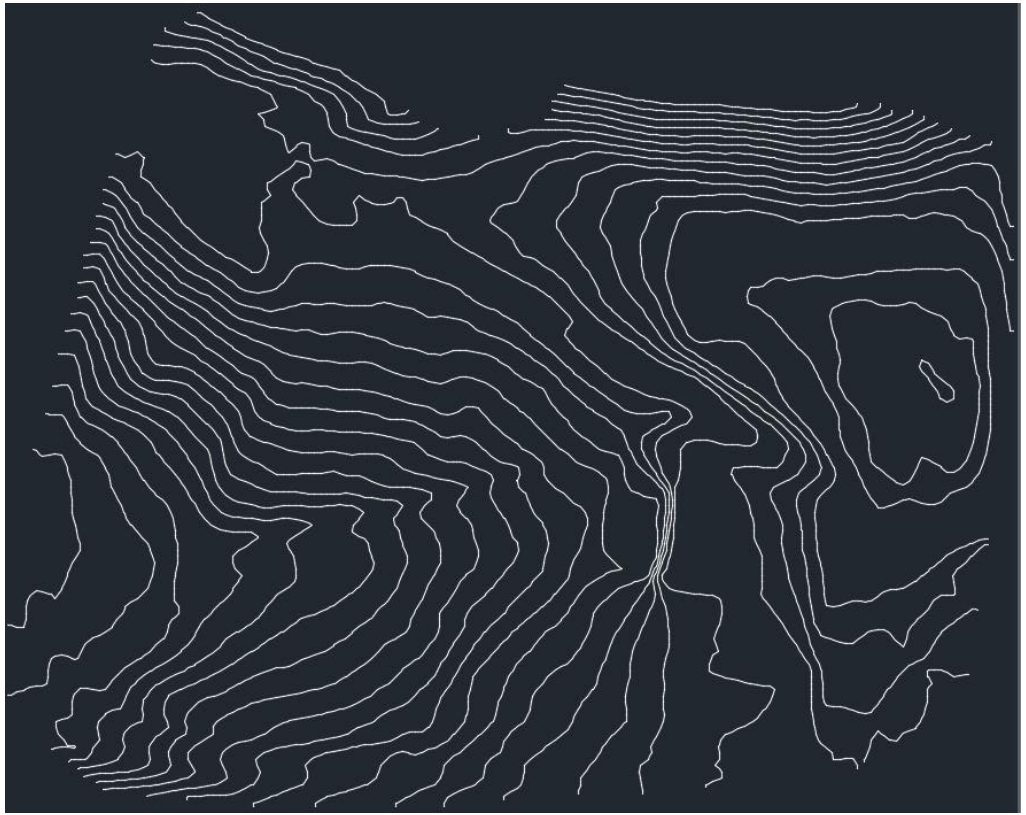
GSC SURVEYING

FINISHED POINT CLOUD



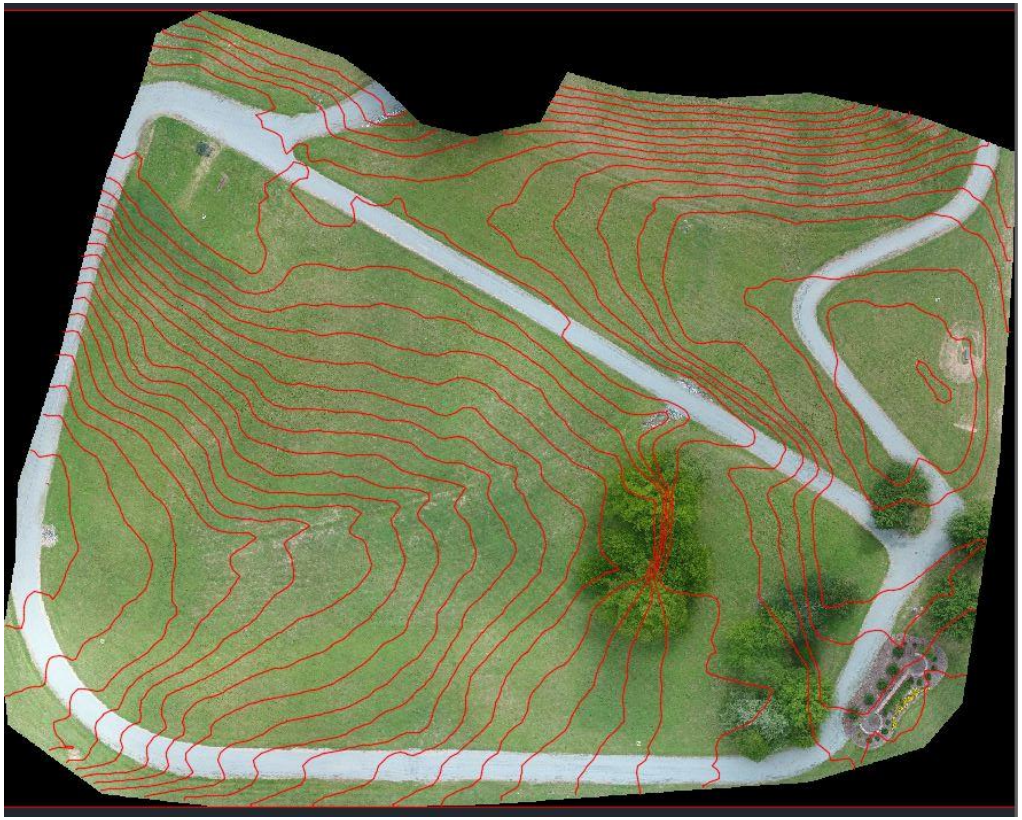
GSC SURVEYING

DATA OUTPUT



GSC SURVEYING

DATA OUTPUT



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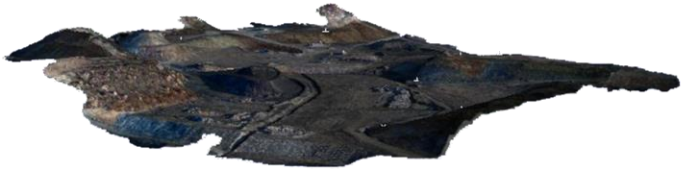
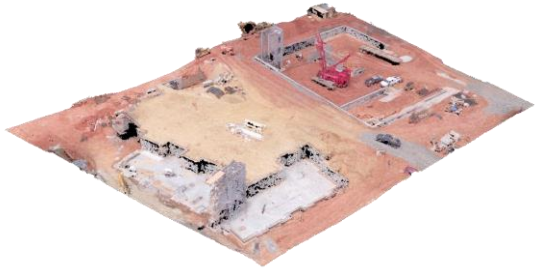
UAVS USES IN CONSTRUCTION



- As-builts / Progress
- Quantity Checks
- Borrow Pit Surveys
- Documentation

GSC SURVEYING

AS BUILTS / PROGRESS



- Capture data throughout the entire process
- Keep track of work that has been completed
- Share data with stakeholders and team members

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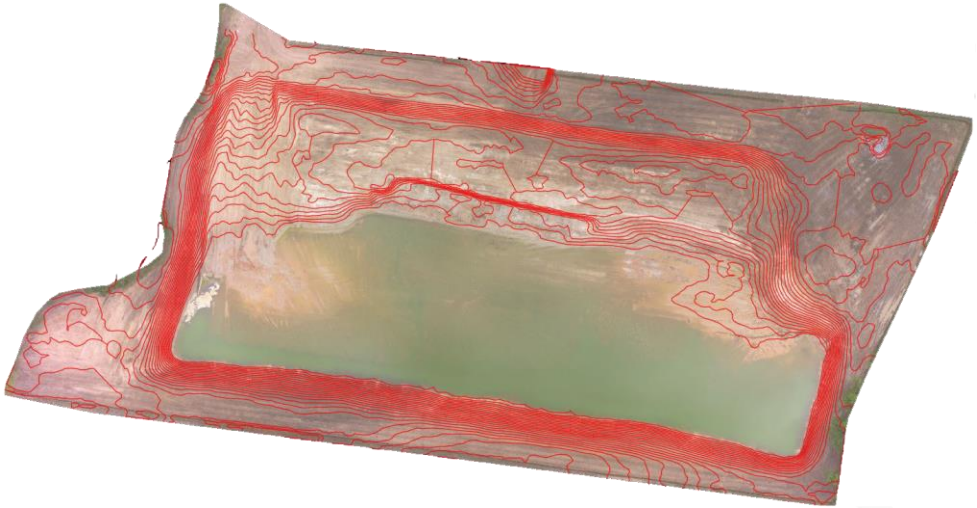
BORROW PIT SURVEYS



- Cover large areas in less time
- Safer than walking in pit
- Higher detail than traditional methods

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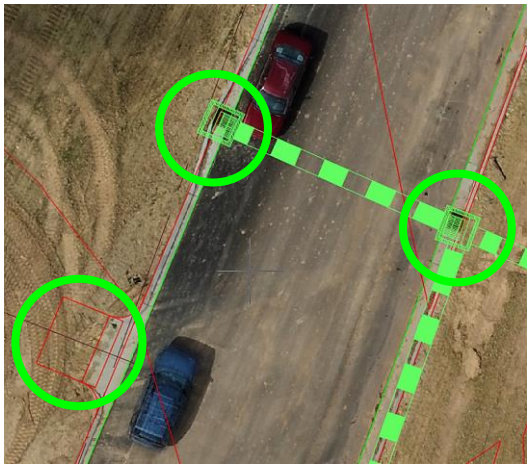
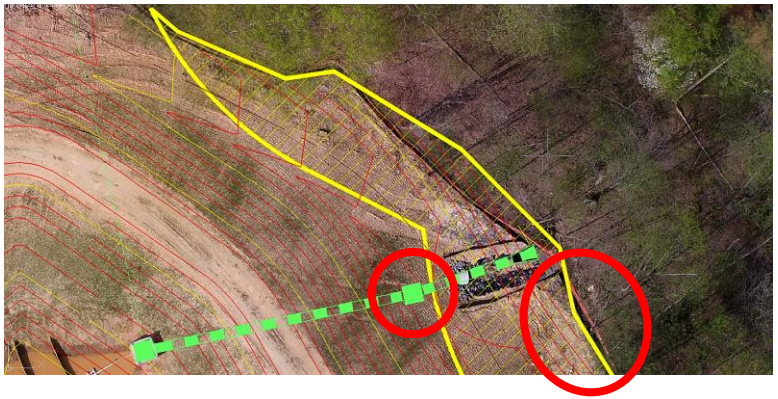
DOCUMENTATION

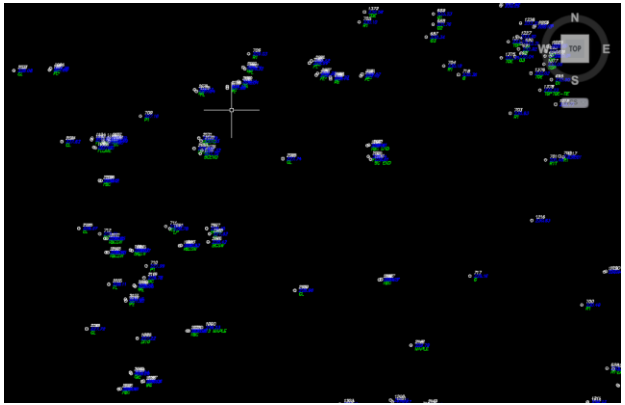




- Document work
- Identify Conflicts
- Compare design to as-built conditions

GSC SURVEYING

SURVEYING



Traditional Base & Rover

- Surveyor walks around with a GPS rover and stakes out points

UAV Aerial Mapping

- Blanketed coverage of a site.
- More information that you can collect traditionally.

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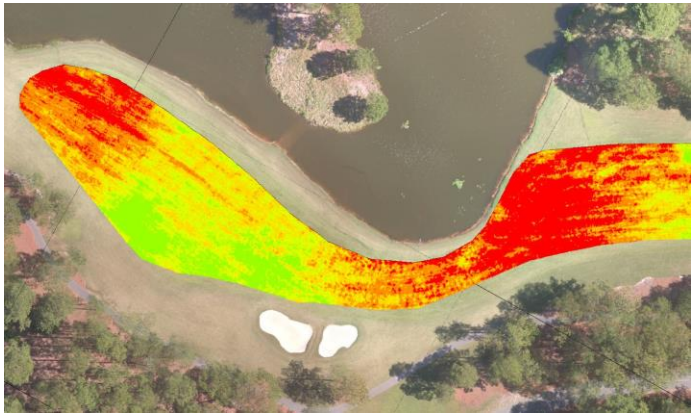
INSPECTION

- Increased Safety
- Avoid climbing dangerous slopes
- Peripheral photos

GOLF COURSES



- Delineation of spray areas for automated sprayers
- High resolution imagery for golf course designers
- NDVI imagery for turf health

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ADDITIONAL APPLICATIONS

- Pipeline Inspection
- Building Inspection
- Equipment Inventory
- Safety Records
- Mining Exploration
- Insurance
- Bridge Mapping
- Pinpoint Gas Leaks
- Inspect Electrical Equipment
- Solar Farm Inspection
- Collect Wetland Data
- Inspect Dams
- Monitor Shoreline Erosion
- Map Roadways
- Disaster Response
- Search and Rescue
- Crop Scouting

GSC SURVEYING

CONTACT

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Tyler Holloway
Technician
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GSC SURVEYING

SURVAE

SURVAE

An intelligent video platform.

See things.

Go places...

...with intelligent video & imagery.

Record data-enabled video...

...and share it on the SURVAE platform.

Video Player

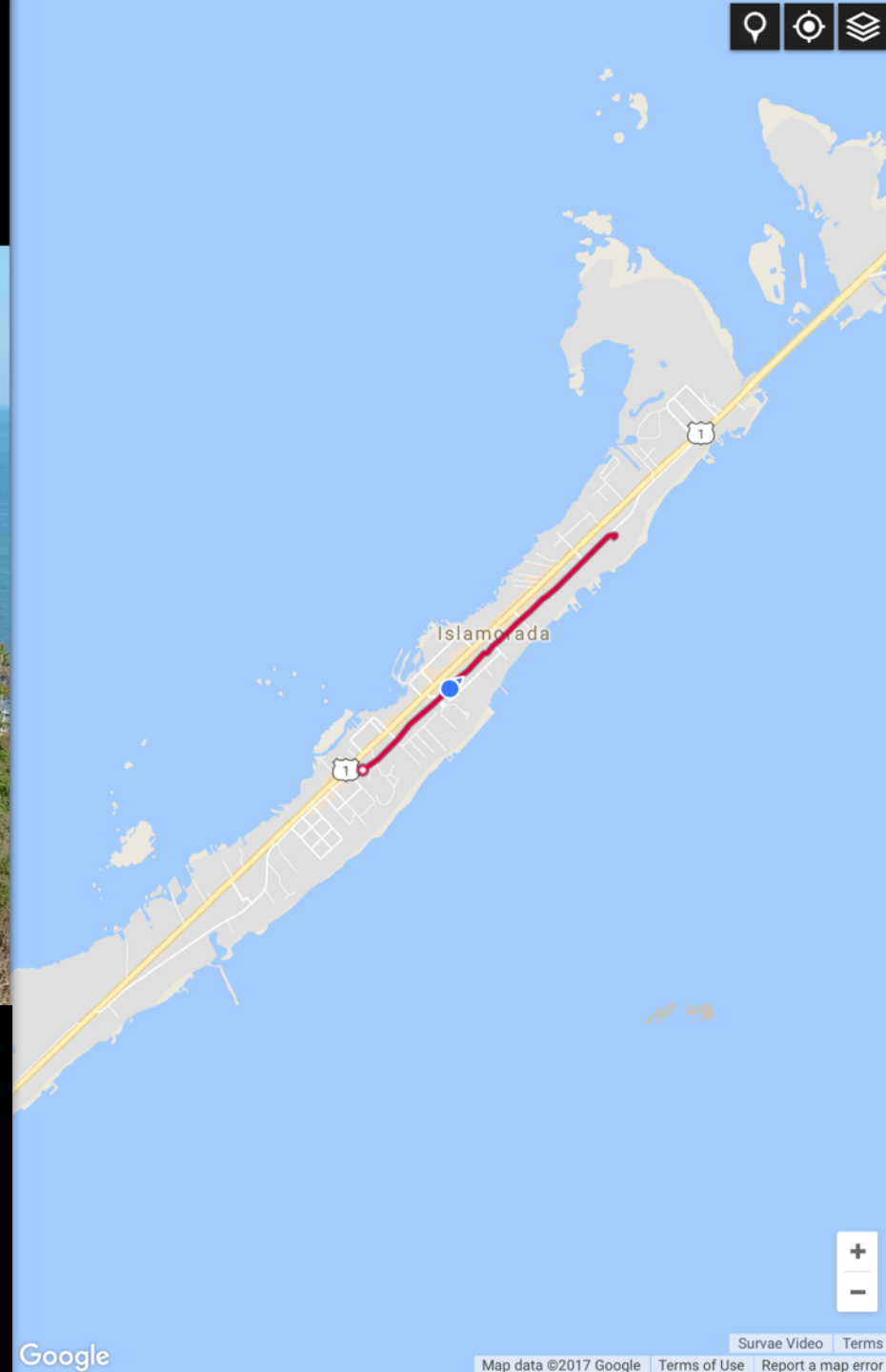
The SURVAE video player has a map...

...with the recorded video route.

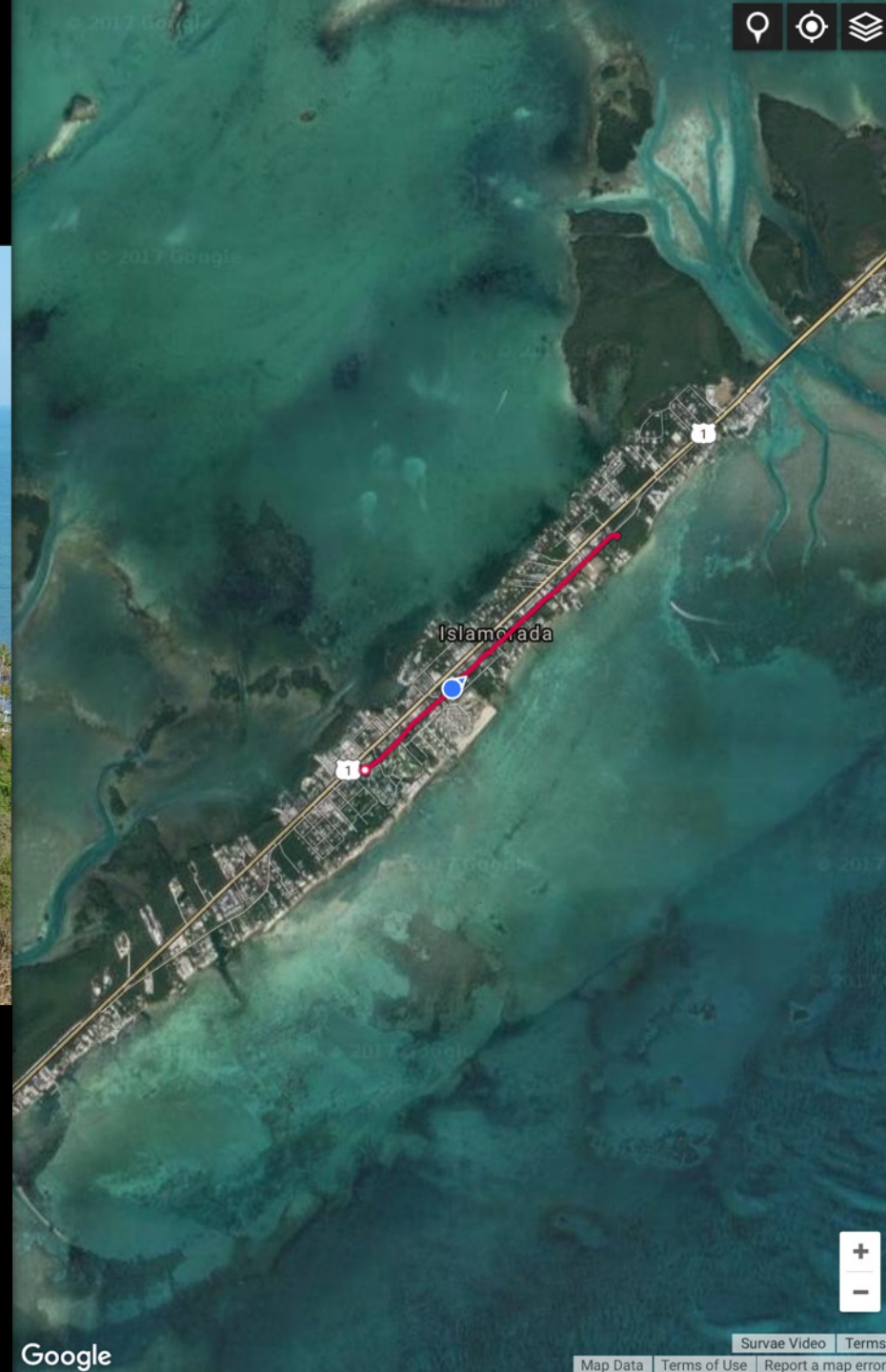
Hover over the route to preview a location.

Click to go to that place.

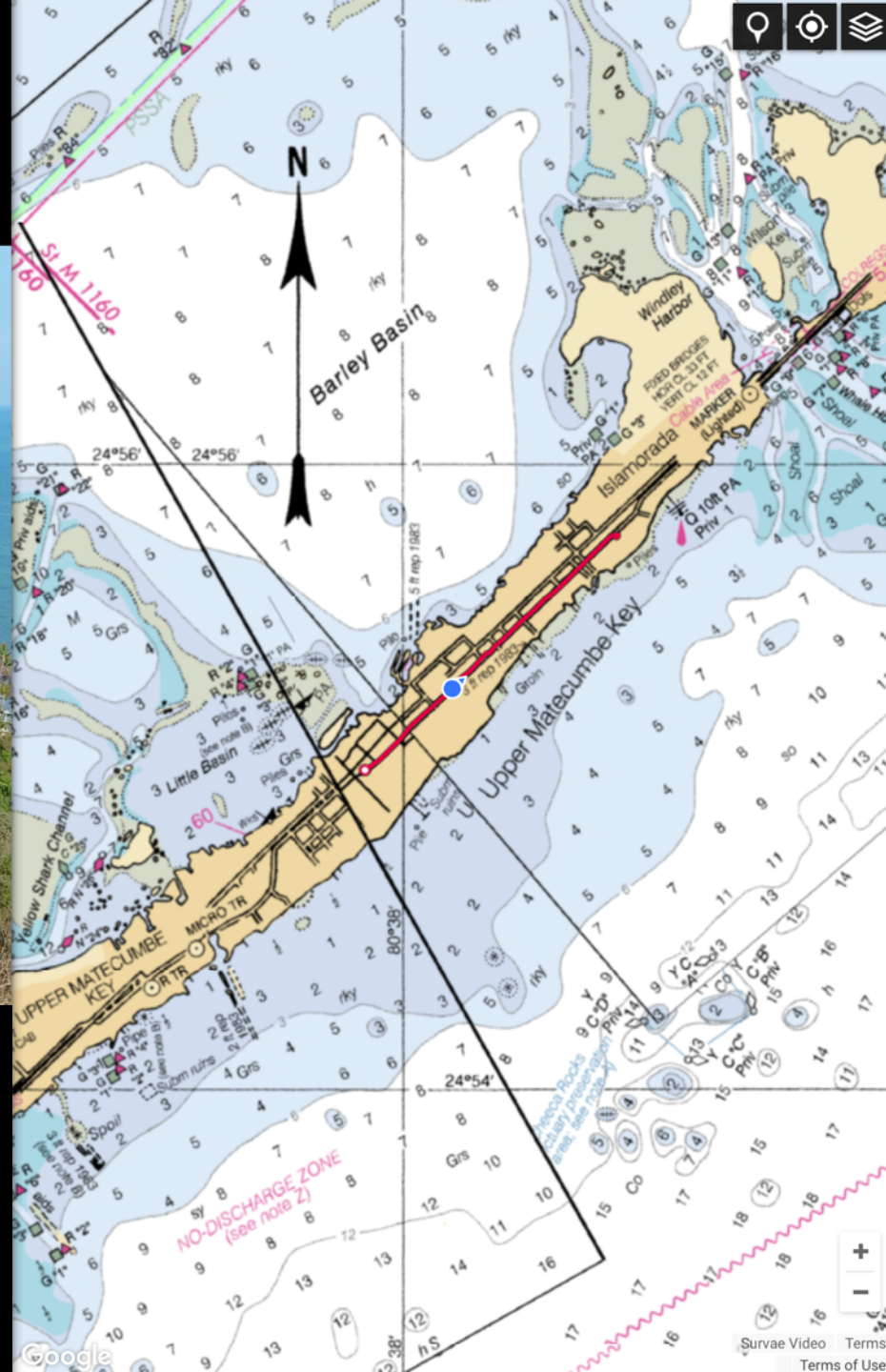
The video player map provides context...



...and has a large view option.

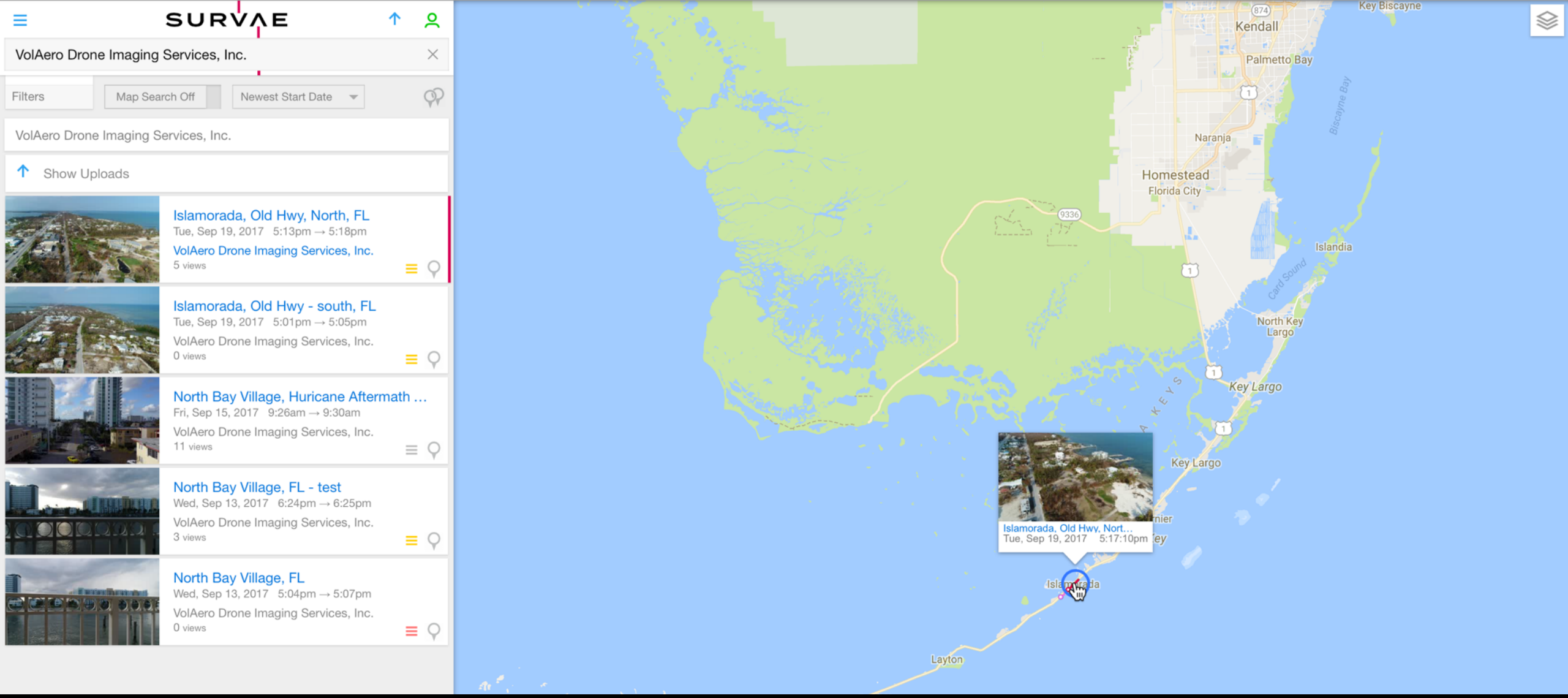


Standard map selection.



Specialized maps & layers.

Video Search



Map-based search, powered by data.

SURVAE

VolAero Drone Imaging Services, Inc.

Filters | Map Search Off | Newest Start Date

VolAero Drone Imaging Services, Inc.

Show Uploads

Islamorada, Old Hwy, North, FL
Tue, Sep 19, 2017 5:13pm → 5:18pm
VolAero Drone Imaging Services, Inc.
5 views

Islamorada, Old Hwy - south, FL
Tue, Sep 19, 2017 5:01pm → 5:05pm
VolAero Drone Imaging Services, Inc.
0 views

North Bay Village, Huricane Aftermath ...
Fri, Sep 15, 2017 9:26am → 9:30am
VolAero Drone Imaging Services, Inc.
11 views

North Bay Village, FL - test
Wed, Sep 13, 2017 6:24pm → 6:25pm
VolAero Drone Imaging Services, Inc.
3 views

North Bay Village, FL
Wed, Sep 13, 2017 5:04pm → 5:07pm
VolAero Drone Imaging Services, Inc.
0 views

Islamorada, Old Hwy, Nort...
Tue, Sep 19, 2017 5:17:10pm

Kendall
Palmetto Bay
Naranja
Homestead
Florida City
Key Biscayne
Biscayne Bay
Islandia
Card Sound
North Key Largo
Key Largo
Key Largo
Layton
Duck Key
Marathon
Cudioe Key
Big Pine Key
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Map data ©2017 Google, INEGI
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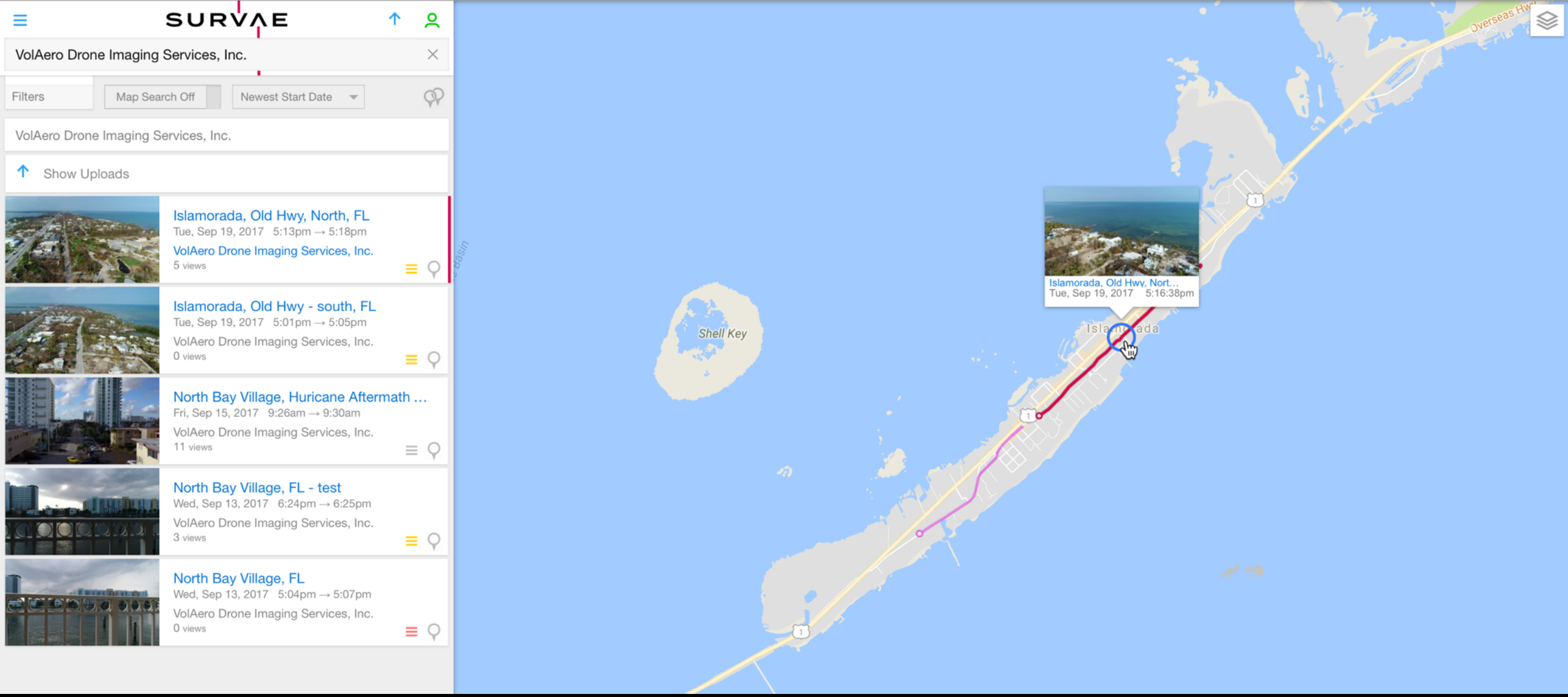
Terms



Manage and share your videos.

SURVAE

VolAero Drone Imaging Services, Inc.

Filters | Map Search Off | Newest Start Date

VolAero Drone Imaging Services, Inc.

Show Uploads

Islamorada, Old Hwy, North, FL
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VolAero Drone Imaging Services, Inc.
3 views

North Bay Village, FL
Wed, Sep 13, 2017 5:04pm → 5:07pm
VolAero Drone Imaging Services, Inc.
0 views

Islamorada, Old Hwy, Nort...
Tue, Sep 19, 2017 5:16:38pm

Shell Key

Islamorada

Overseas Hwy

Overseas Hwy

Google

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Map data ©2017 Google | 500 m | Terms of Use | Report a map error

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Make more informed decisions.
Share great stories.

survae.com

North Carolina State Highway Patrol
Collision Reconstruction Unit
Trooper Brian Leventhal

What is Collision Reconstruction?

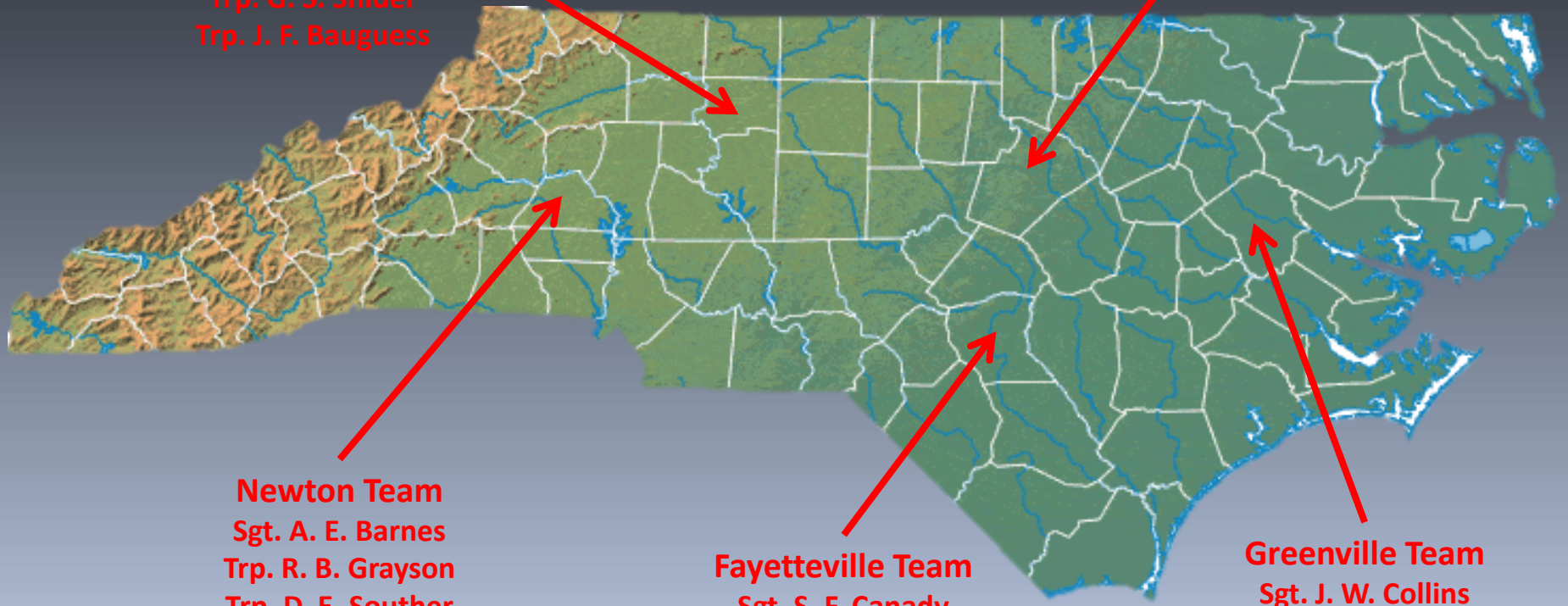
Collision Reconstruction is the scientific process of investigating, analyzing, and drawing conclusions about the causes and events during a vehicle collision.

We are Investigators!

Collision Reconstruction Unit

Winston Team
F/Sgt. A. A. Justice
Sgt. B. K. Palmiter
Trp. D. H. Deal
Trp. G. S. Snider
Trp. J. F. Bauguess

Cary Team
Sgt. W. C. Johnson
Trp. B. N. Leventhal
Trp. R. W. Murphy
Trp. J. O. Melton



Newton Team
Sgt. A. E. Barnes
Trp. R. B. Grayson
Trp. D. E. Souther
Trp. J. P. Contas
Trp. C. J. Rogers

Fayetteville Team
Sgt. S. F. Canady
Trp. J. C. Toon
Trp. J. H. Dixon
Trp. X. S. McPherson

Greenville Team
Sgt. J. W. Collins
Trp. R. L. Cummings
Trp. D. W. Emory

Our Mission

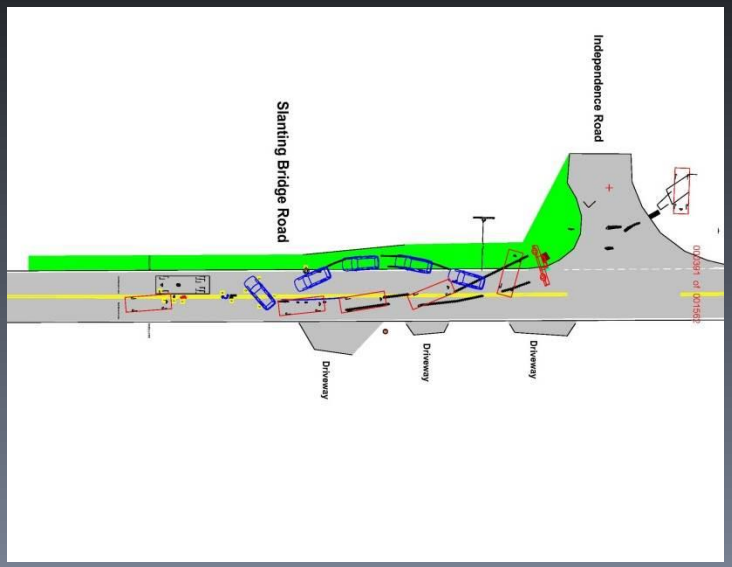
- Collision Reconstruction
- Crime Scene Documentation
- Respond to Natural Disasters
- Respond to Public Disturbances

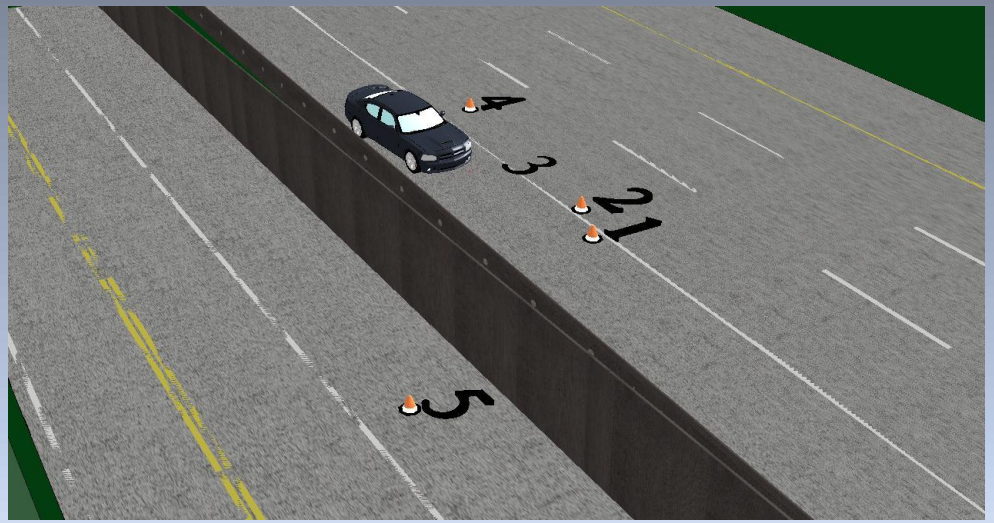
Previous Methods of Measurement & Documentation

200’ Measuring Tape

Nikon Total Station

Finished Product





Current Method of Measurement & Documentation

Pros

- Accurate
- Detailed
- Measurable
- 3D Images

Cons

- Time Consuming

FARO Focus3D X330
Laser Scanner

Finished Product

More Efficient Method of Measurement & Documentation

Finished Product

Pros

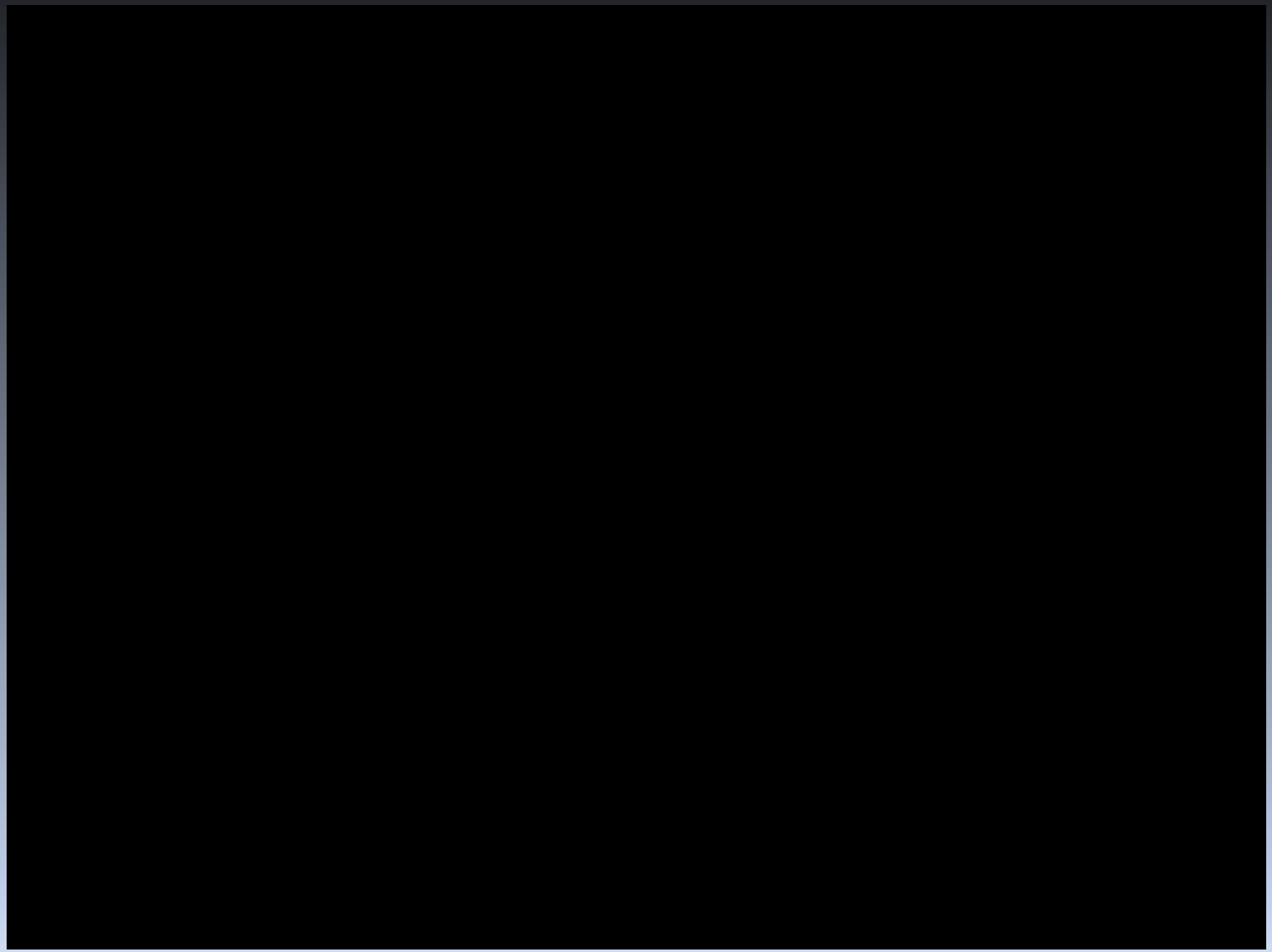
- Accurate
- Detailed
- Measurable
- 3D Images

Cons

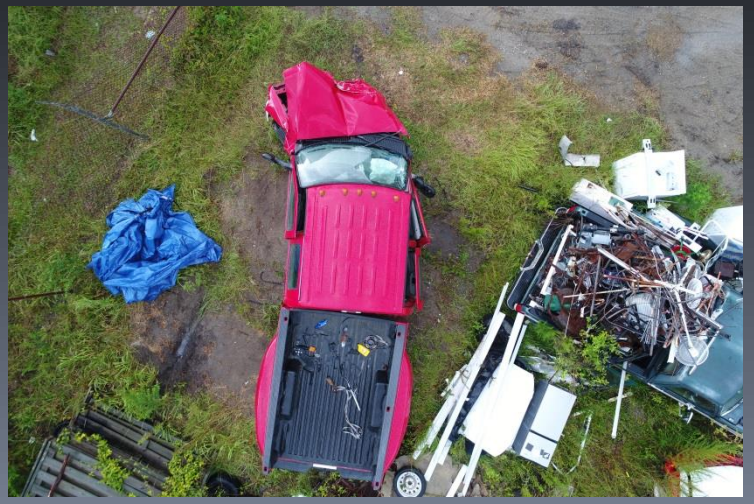
- ~~Time Consuming~~

Images and data provided by the UAS Program Office Division of Aviation – NCDOT from the Collision Scene Reconstruction using Unmanned Aircraft Systems Study

Finished Product Fly Through



A New Perspective



Study of Collision Scene Reconstruction using Unmanned Aircraft Systems

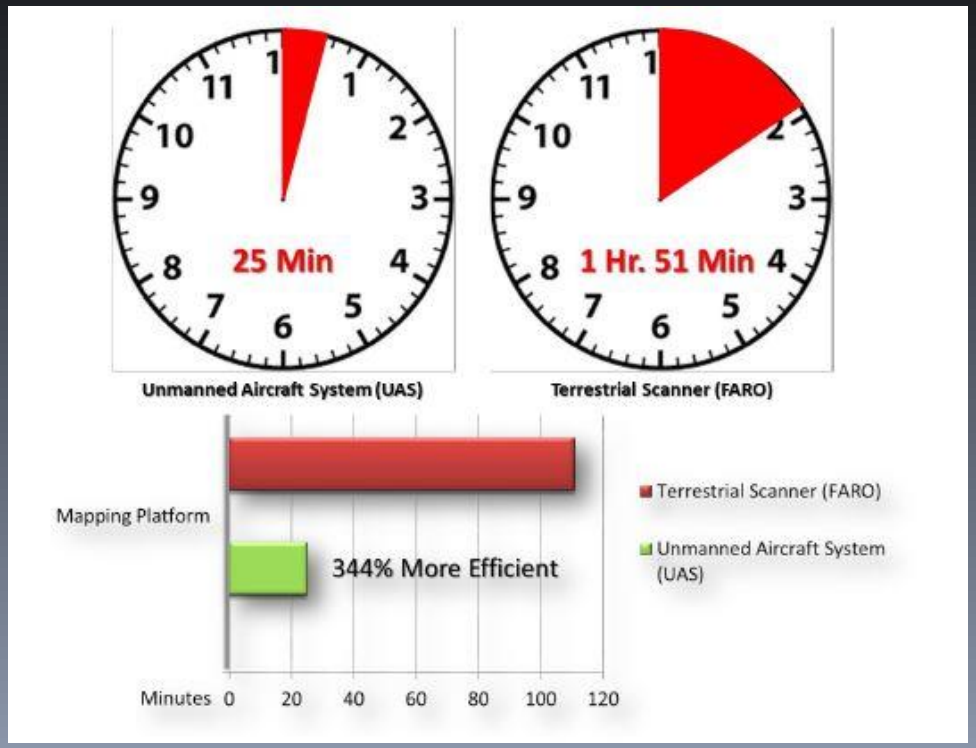
- Study conducted on May 22, 2017 at the Buncombe County Public Safety Training Facility
- UAS Program Office, Division of Aviation – NCDOT
- NCSHP Collision Reconstruction Unit
- 40 mph head-on collision
- Scene was mapped by NCDOT DOA UAS Flight Team using 3 different UAS's (DJI Mavic Pro, Phantom 4, & Inspire 2)
- NCSHP Collision Reconstruction Unit mapped the same scene with the FARO Focus3D X330 Laser Scanner

Accuracy

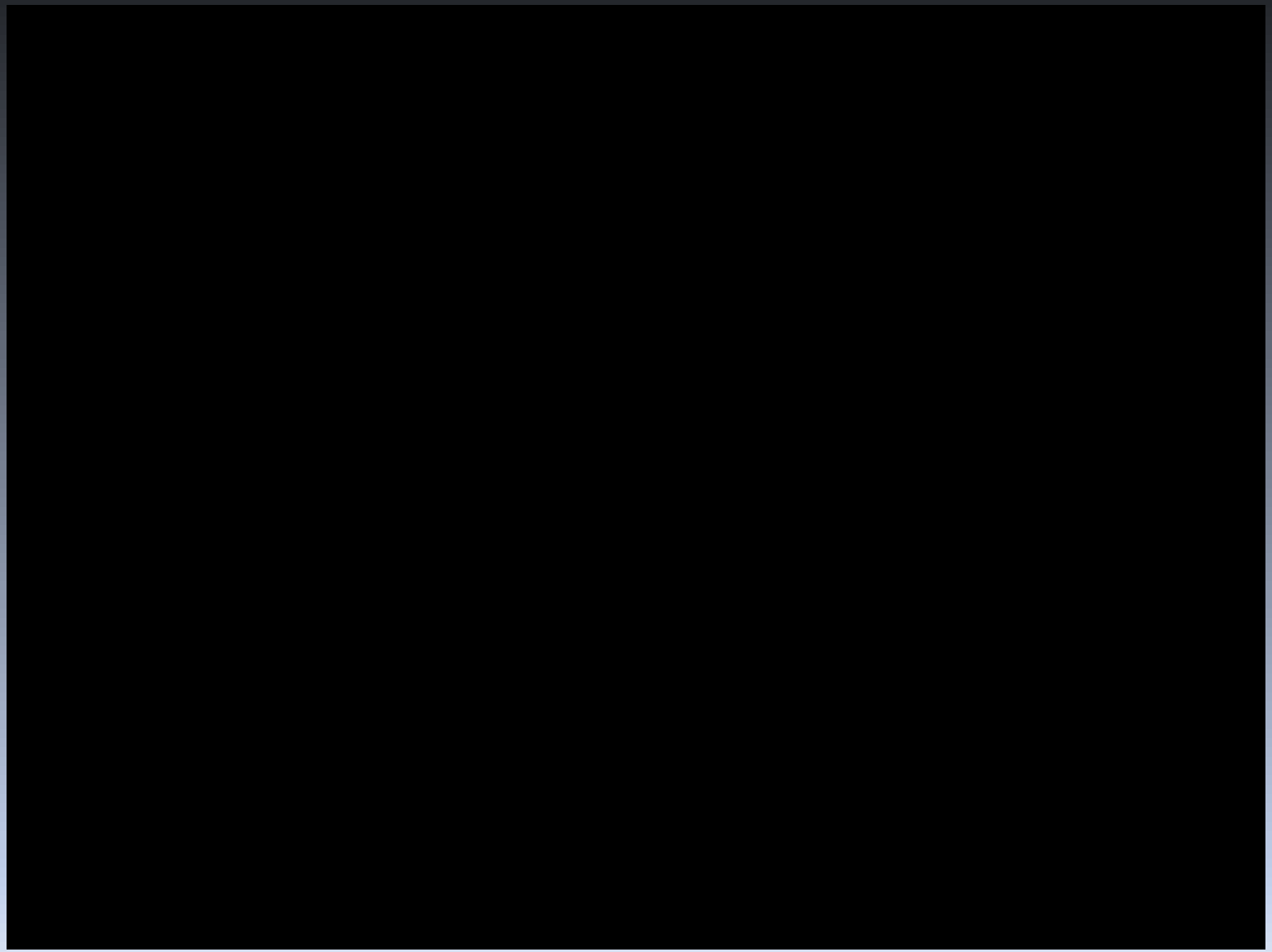
- Determined using 6 ground control points
- Points were surveyed by NCDOT Field Survey Office
- Accuracy was found to be within .03 ft. (.36 in.)

Skid comparison

Time to Map Comparison



40 mph Head-on Collision



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