

NGS Lidar Data in support of Chesapeake Bay needs

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Remote Sensing Division

NOAA's National Geodetic Survey

Scientific, Technical Assessment & Reporting Team Meeting

Topic: Land-use Data, Forecasting, and Lidar



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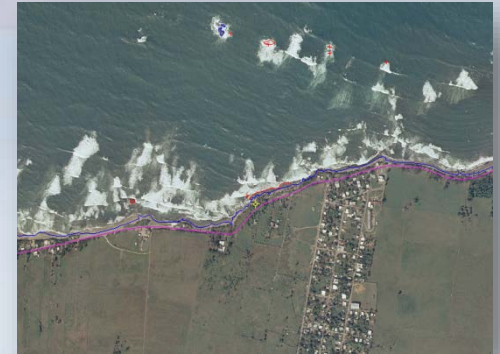
Outline

- **Background**
- **Data collection**
- **FY18 & 19 - planning**
- **Gather requirements**



Background

- **U.S. Department of Commerce**
 - **National Oceanic Atmospheric Administration (NOAA)**
 - **National Ocean Service**
 - **National Geodetic Survey**
 - **Remote Sensing Division**
- **Primary programs**
 - **Coastal Mapping Program**
 - **Aeronautical Survey Program**
 - **Emergency Response**



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NOAA's Coastal Mapping Program

- Define the National Shoreline and nearshore elevation data
- NOAA nautical charts
- Other important applications:
 - Used in defining the United States' territorial limits
 - Coastal resource management
 - Storm surge and coastal flooding modeling
 - GIS analysis
 - Benthic habitat mapping
- Coastal Intelligence and Resiliency...



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How do we do it?

- **King Air 350ER Aircraft**
 - Extended Range: 8 hour endurance
 - 180kt survey & 250kt transit speed
- **DHC-6 Twin Otter**
 - Slow stable, low flying
 - 80-160kt survey speed
- **Trimble DSS580 Dual Cam & DSS500 Dual Oblique Cam**
 - RGB & NIR cameras (NIR in DSS580 only)
 - 35cm GSD at 10,500' flying height
 - In-flight image processing
- **RIEGL LIDARs**
 - Topographic LIDAR (LMS-Q680i)
 - Topobathymetric System (VQ-880G)
- **Satellite Imagery**
- **Private sector contracts**



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RSD Lidar Sensor Upgrade and Operations: VQ-880-G

Topo-Hydrographic Airborne Laser Scanning System
with Online Waveform Processing and Full Waveform Recording

RIEGL VQ-880-G

- designed for combined topographic and hydrographic airborne survey
- high accuracy ranging based on echo digitization and online waveform processing with multiple-target capability
- multiple-time-around processing for straightforward mission planning and operation
- concurrent full waveform output for all measurements for subsequent full waveform analysis
- high spatial resolution due to measurement rate of up to 550 kHz and high scanning speed of up to 160 scans/sec
- integrated inertial navigation system
- integrated digital cameras
- compact and robust housing compliant with typical hatches in aircrafts and with stabilized platforms

The new RIEGL VQ-880-G is a fully integrated airborne laser scanning system for combined hydrographic and topographic surveying. The system is offered with integrated and factory-calibrated high-end GNSS/IMU system and camera. The design allows flexible adaptation of these components to specific application requirements. Complemented by a RIEGL data recorder, the RIEGL VQ-880-G is a complete LIDAR system to be installed on various platforms in a straightforward way.

The RIEGL VQ-880-G carries out laser range measurements for high-resolution surveying of underwater topography with a narrow, visible green laser beam, emitted from a powerful pulsed laser source. Subject to clarity, of this particular wavelength the laser beam penetrates water enabling measurement of submerged targets.

The distance measurement is based on the time-of-flight measurement with very short laser pulses and subsequent echo digitization and online waveform processing. To handle target situations with most complex multiple echo signals, beside the online waveform processing the digitized echo waveforms can be stored on the RIEGL solid state data recorder for subsequent offline waveform analysis.

The laser beam is deflected in a circular scan pattern and hits the water surface at a nominally constant incidence angle.

The VQ-880-G comprises a high-precision inertial measurement sensor for subsequent precise estimation of the instrument's exact location and orientation. A high-resolution digital camera and optionally an infrared camera are integrated to supplement the data gained by laser scanning.

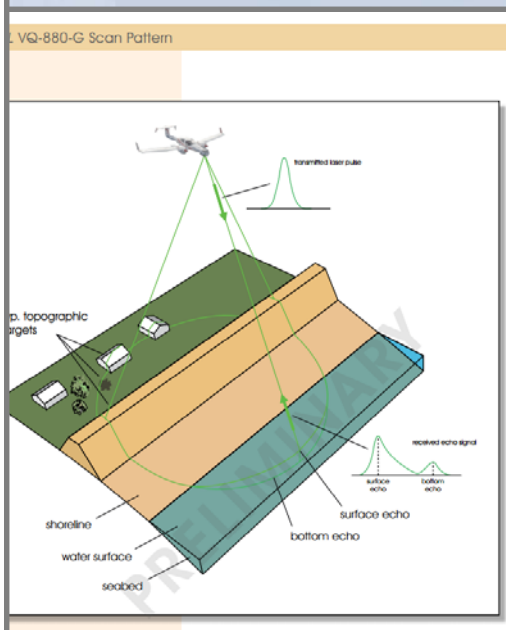
The rugged internal mechanical structure together with the dust- and splash-water proof housing enables long-term operation on airborne platforms.

Typical applications include:

- coastline and shallow water mapping
- acquiring base data for flood prevention
- measurement for aggradation zones
- habitat mapping
- surveying for hydraulic engineering
- hydro-archaeological surveying

visit our website
www.riegl.com

RIEGL
LASER MEASUREMENT SYSTEMS



- **AGL: 1300 feet**
- **PRF: 145 kHz**
- **Nominal Point Density: 9 pt/m²**
- **Swath Width: 287 meters**
- **Generic Operational Parameters:**

Hydrography

Typ. Measurement Range ¹⁾
Typ. Operating Flight Altitude ²⁾
Above Ground Level (AGL)

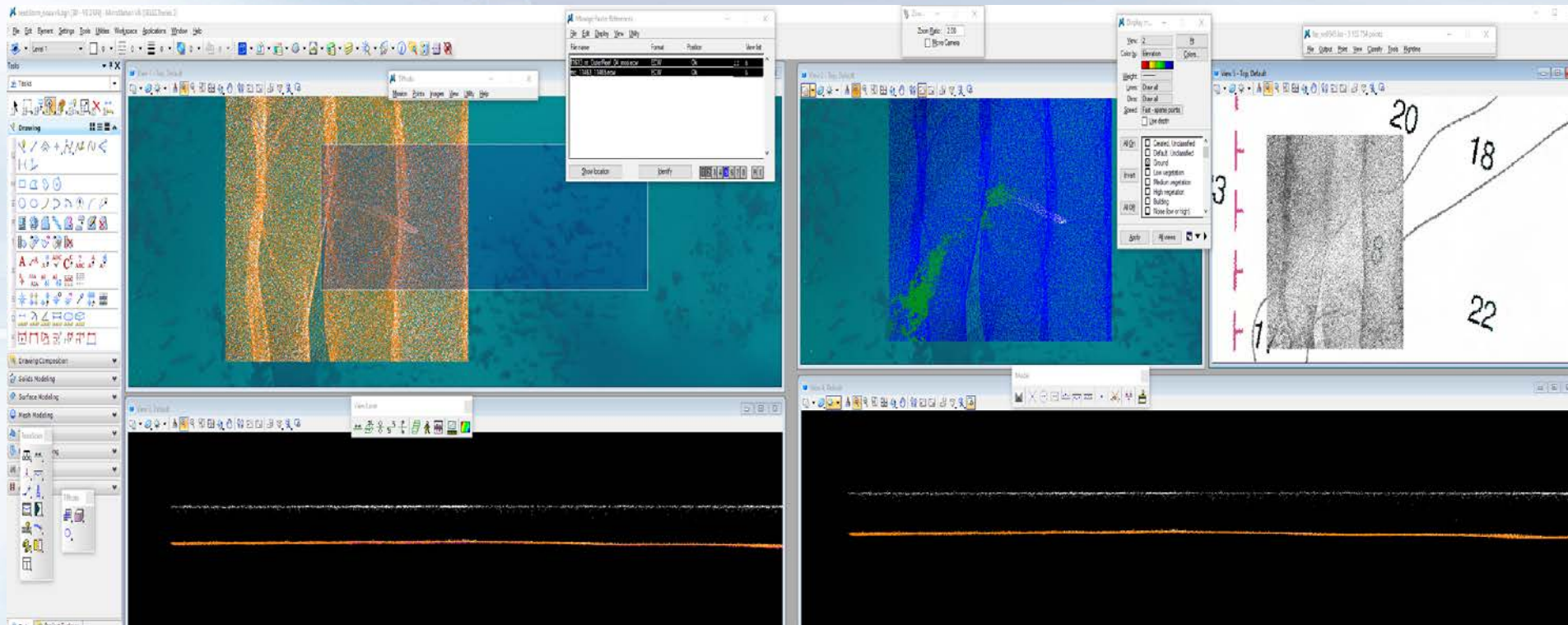
1.5 Secchi depth for bright ground ($\rho \geq 80\%$) ²⁾
600 m (1970 ft.)

- 50% sidelap of swaths
- 40° Field of View



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Point Cloud



Format: .las (.laz is compressed las) – open source binary file format



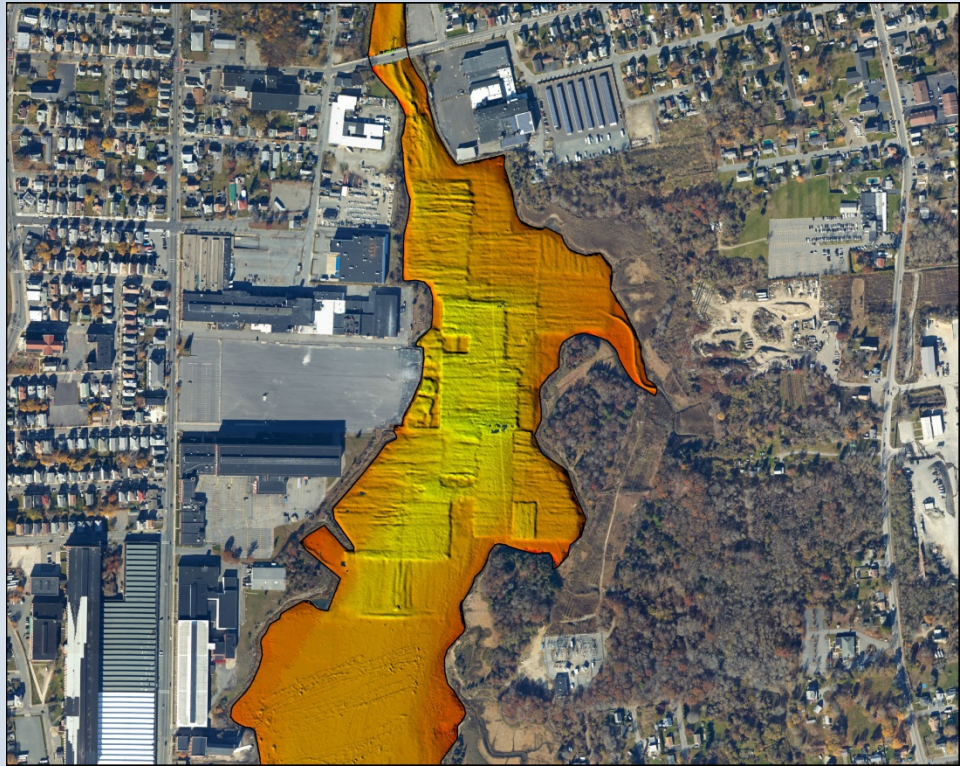
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Buzzards Bay: New Bedford Harbor

VQ-820



VQ-880



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Total Propagated Uncertainty

General Approach

ANALYTICAL
UNCERTAINTY
PROPAGATION

$$\Sigma_{ws} = \begin{bmatrix} \sigma_X^2 & \sigma_{XY} & \sigma_{XZ} \\ \sigma_{XY} & \sigma_Y^2 & \sigma_{YZ} \\ \sigma_{XZ} & \sigma_{YZ} & \sigma_Z^2 \end{bmatrix} = [\Sigma_m]^T$$

SUBAERIAL VECTOR

WATER SURFACE

UNCERTAINTY ELLIPSOID:
WATER SURFACE COORDINATES

RANDOM SAMPLES
OF POSSIBLE LAER
BEAM PATHS

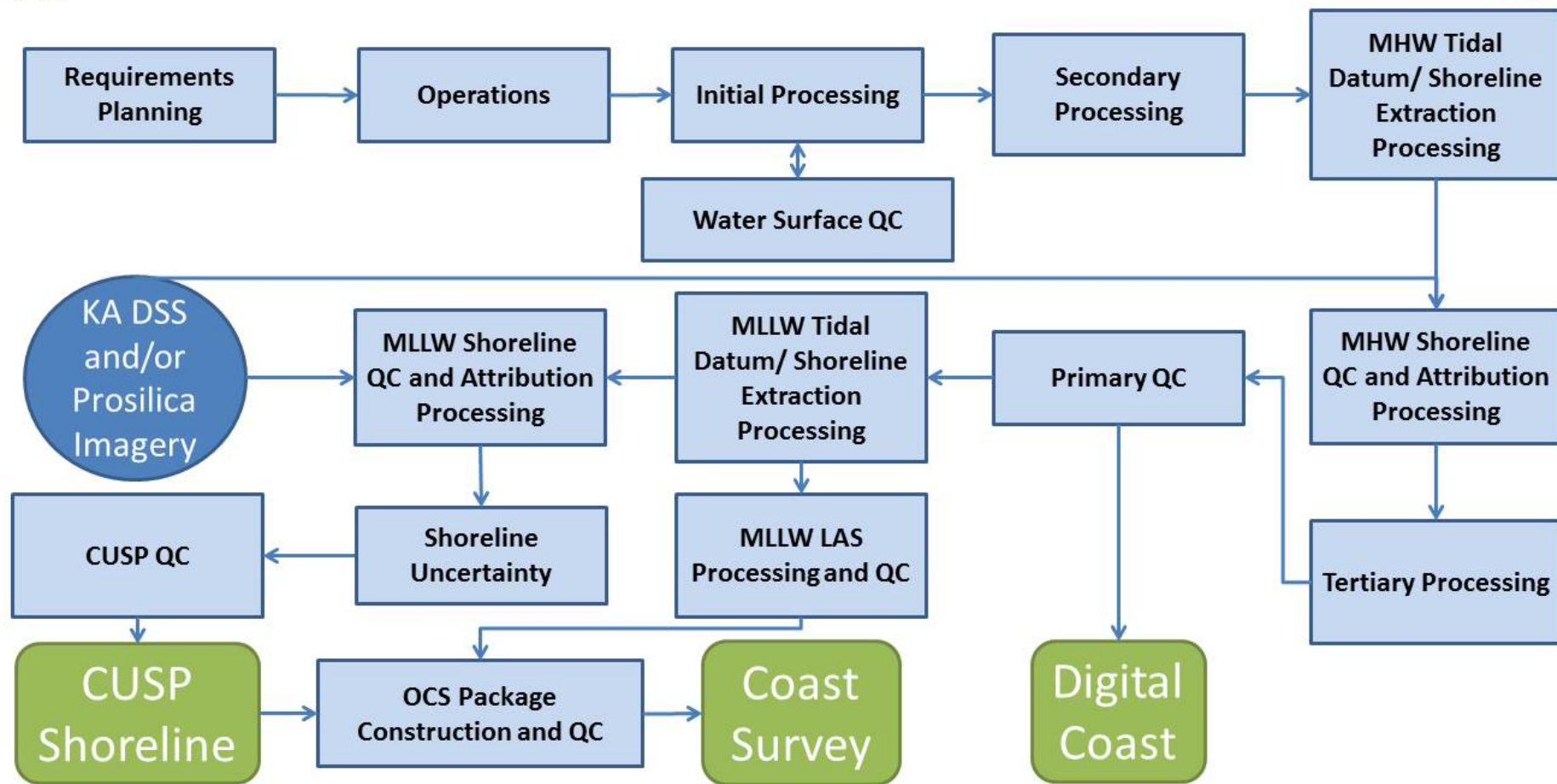
MONTE CARLO
RAY TRACING

SUBMERGED VECTOR

UNCERTAINTY ELLIPSOID:
SEAFLOOR COORDINATES



TopoBathy Program



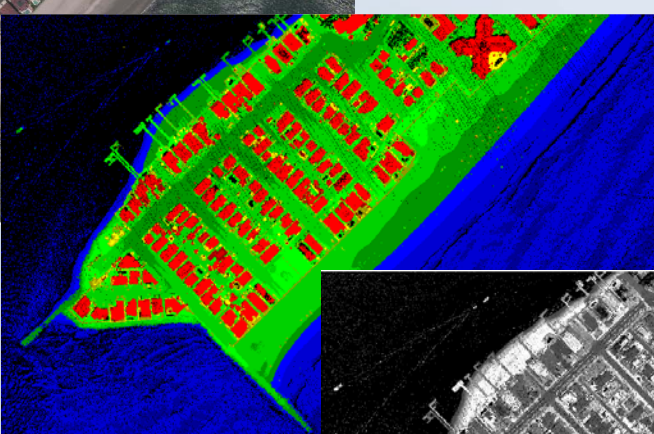
Products NGS delivers and derivatives




Shoreline



Ortho Mosaic Imagery



Lidar Point Cloud and DEMs
(elevation)



Lidar Point
Cloud
(intensity)

Map once use many times!



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RGB
Colorized Lidar
Point Cloud

Digital Coast



DATA ACCESS VIEWER

Discover, customize, and download authoritative data.

Choose a Data Type to Explore

Imagery

Land Cover

Elevation

- Can get the full point cloud and then use other tools to pick out classes.
- Or have the DAV do it for them – allows you to pick exactly which classes you want to keep and they can pick all the return, just the first returns, or just the last returns.
- Intensity will be in the LAS file with each point and you can also request a tif version of the intensity. You can also change things like the projection, datum, units etc.



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DATA COLLECTION 2017



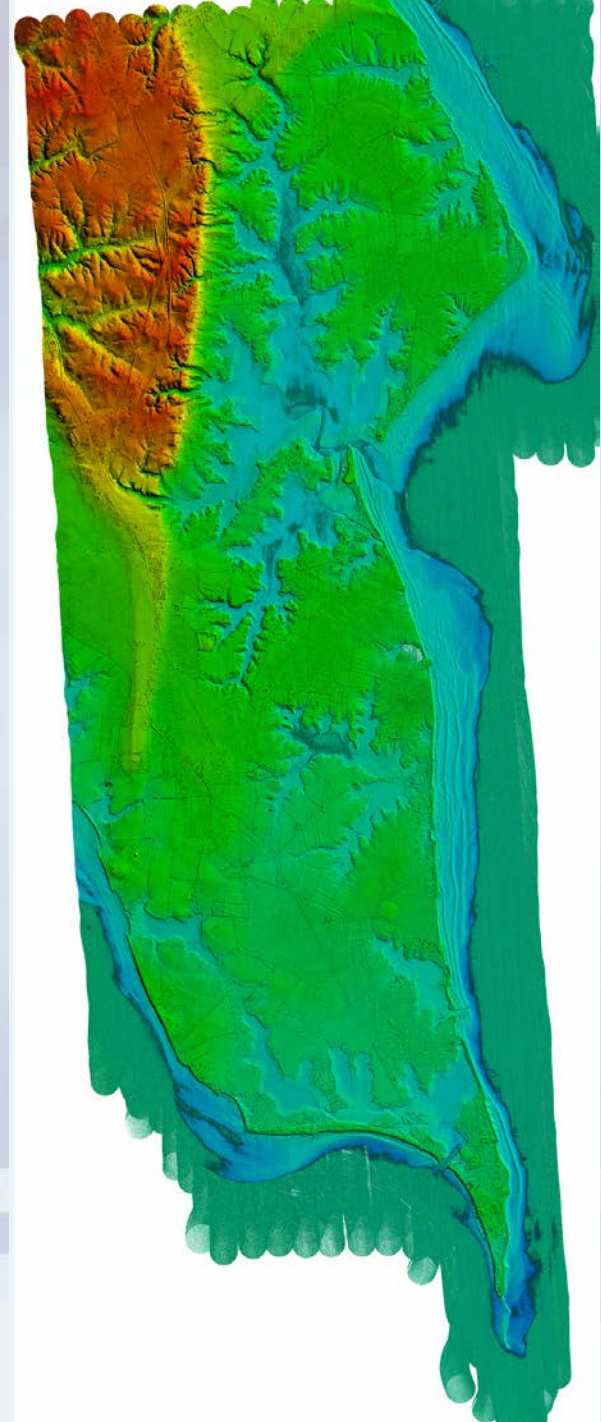
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Quick DEMS



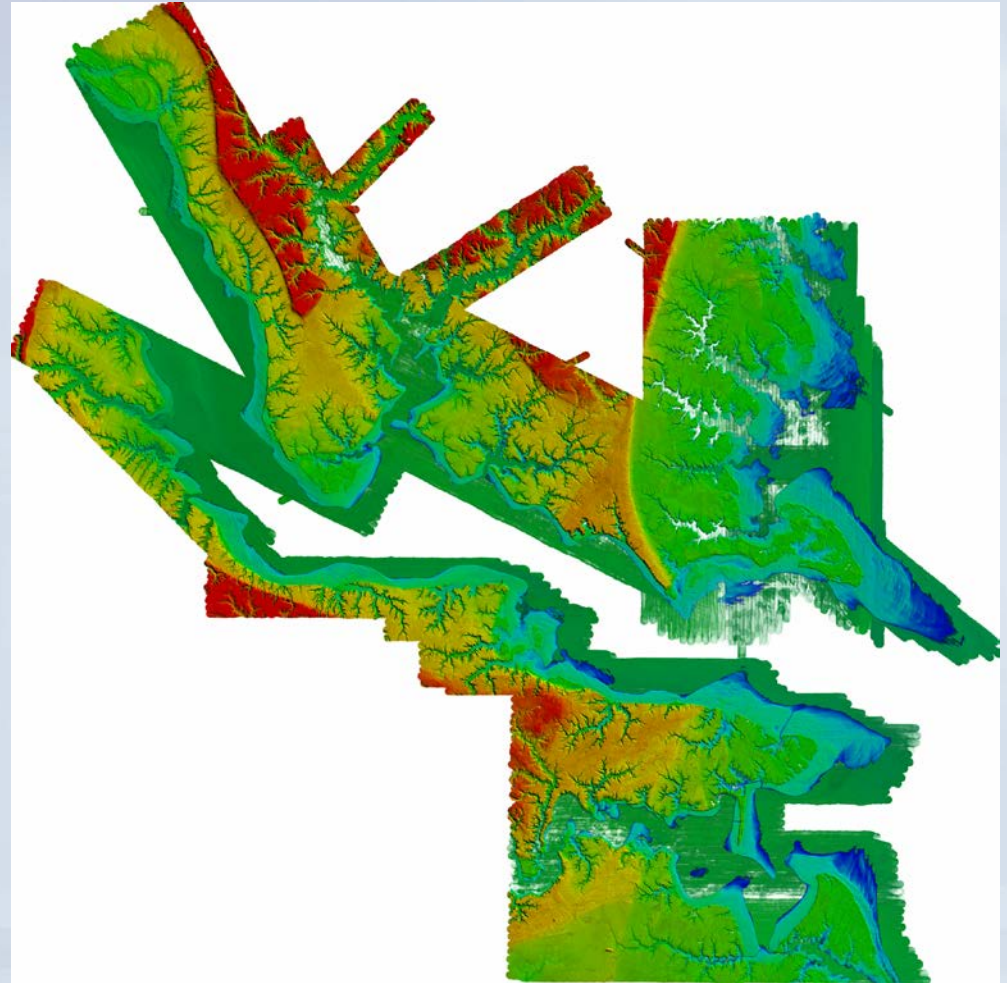
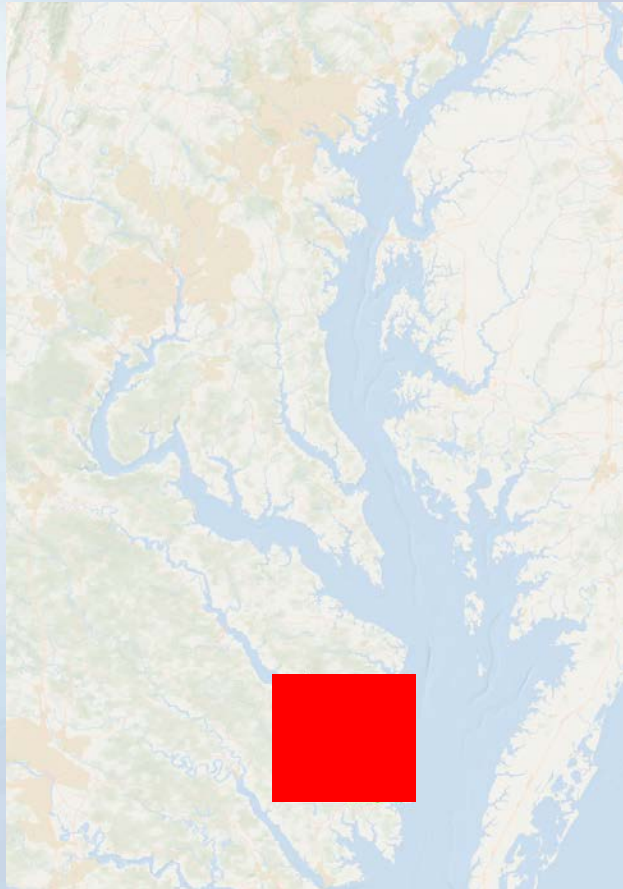
Saint Jerome Creek, MD

* Lidar collected with Twin Otter and Imagery collected with King Air



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Quick DEMS



Tabbs Creek, VA



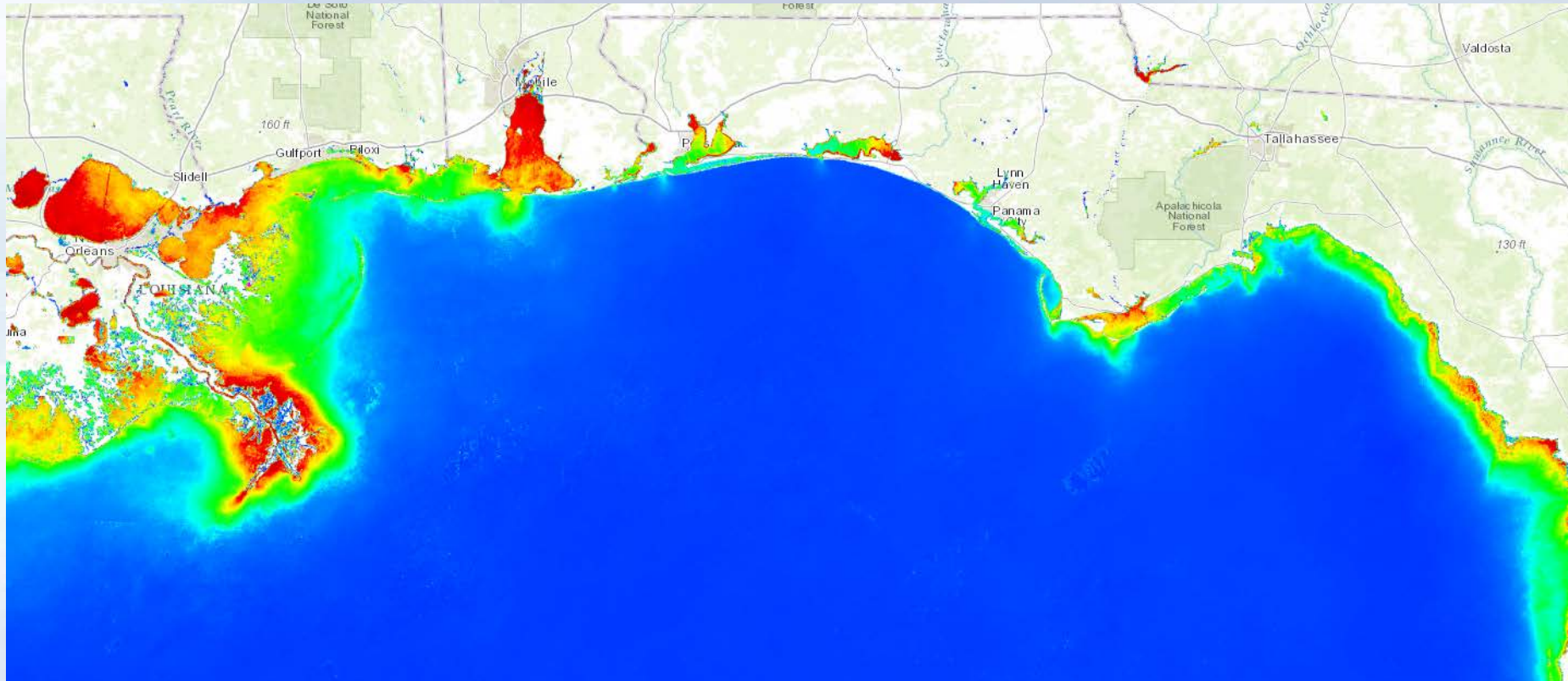
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FY18 & 19



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NGS/NCCOS Water Clarity viewer



Kd Viewer: East and Gulf Coast

Requirements Discussion



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NGS's Requirements and Goal

- RSD has a requirement for safety of navigation to support Nautical Charting (first priority).
- If there are other requirements that blend in with ours requirements so we can maximize the use of our data we will try to accommodate those requests (but it is not a guarantee if additional funding is not available)
- **Goal:** to build a coalition of both requirements and funding
- NGS intends to use internal and contract resources to perform work



Additional Requirements

- Identify data gaps - where do you need data?
 - is there a consensus on areas that multiple partners need?
- Products: will Quick DEMs, 1m/5m DEMs and/or .las files suffice?
- Frequency?



Questions

- Constraints?
- Cost sharing/additional funding possible?
- Beneficiaries – direct/indirect?
- Data Timeline variability flexibility ?
(acquisition and processing and deliverables)



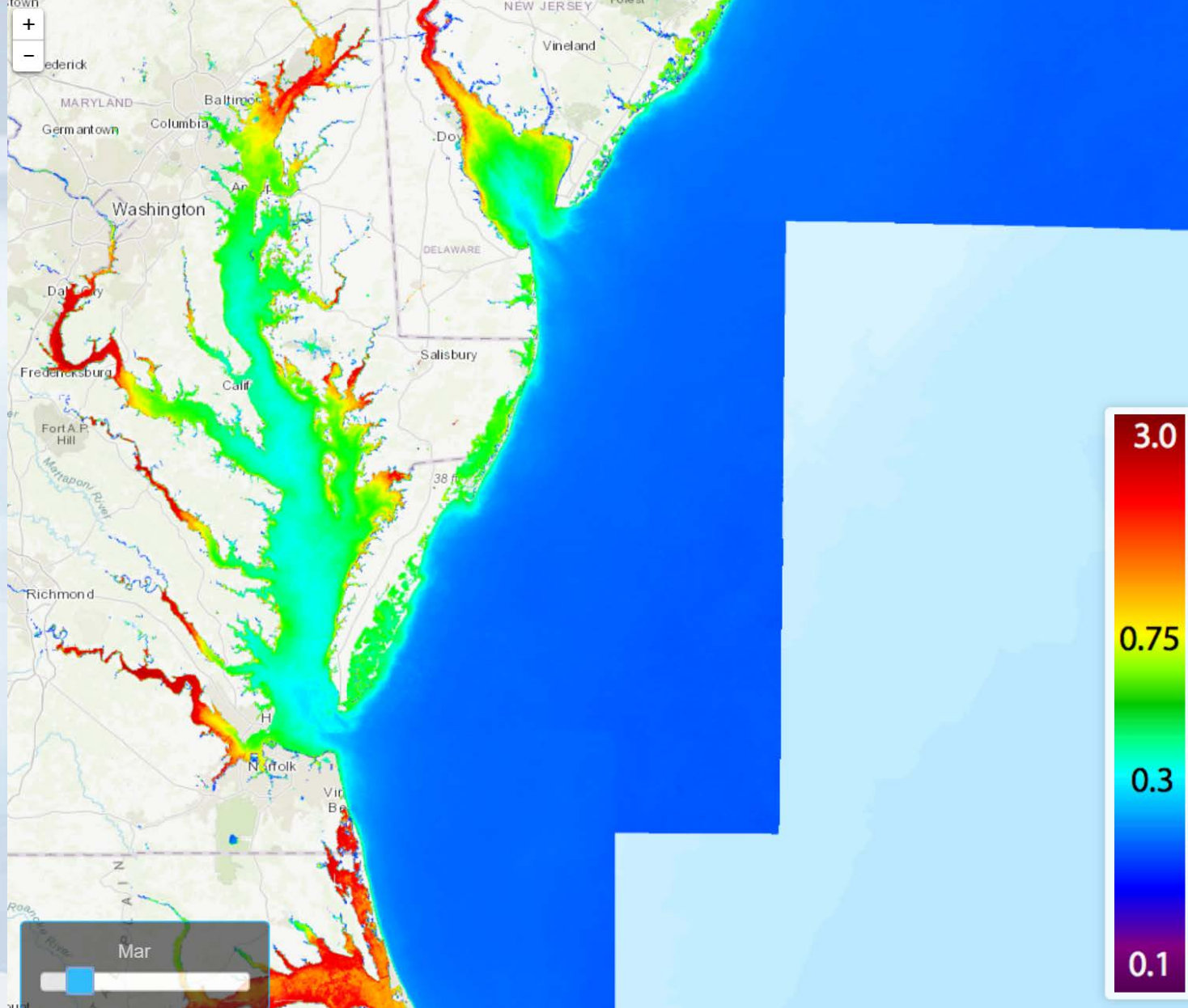
Thank you



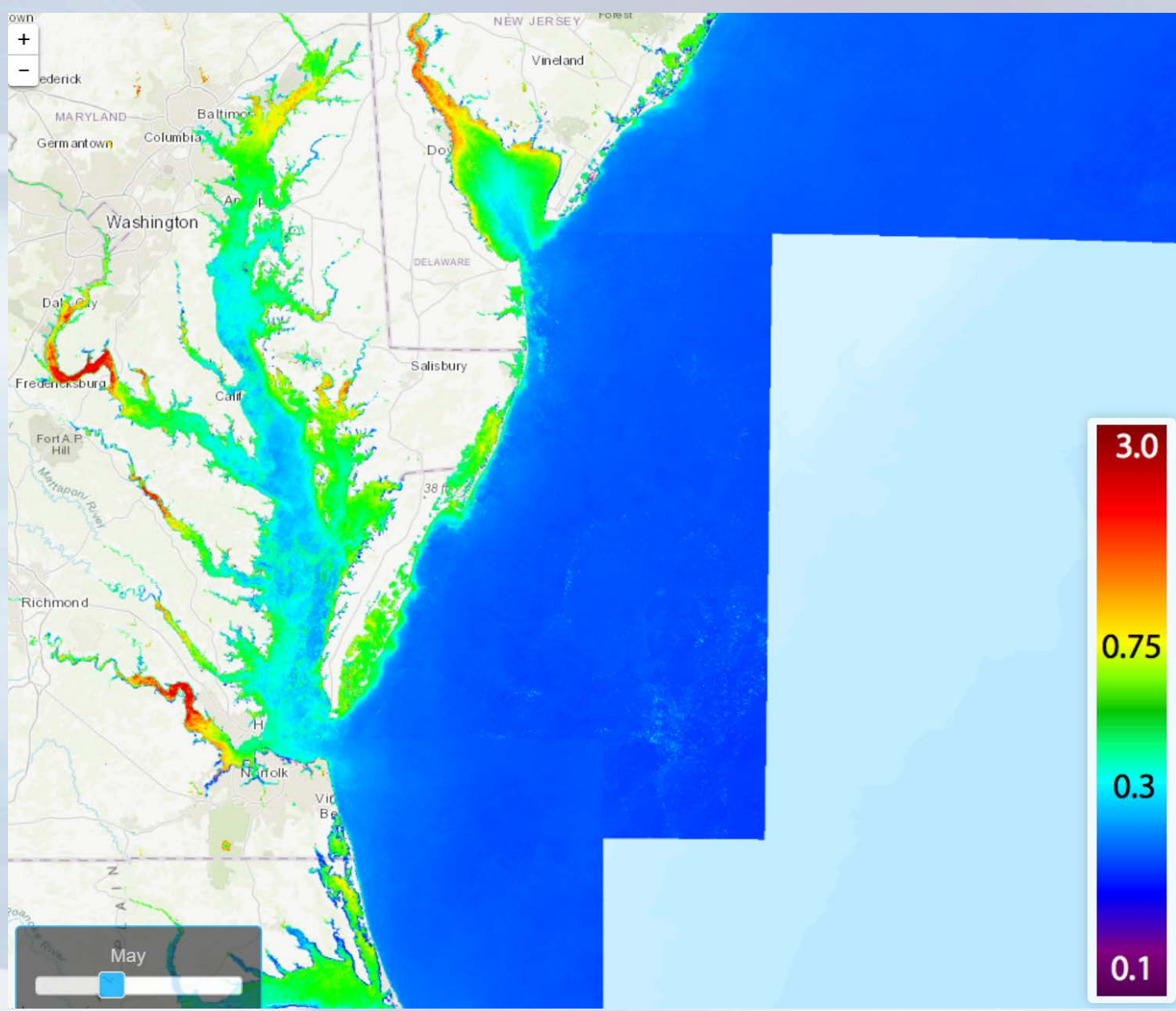
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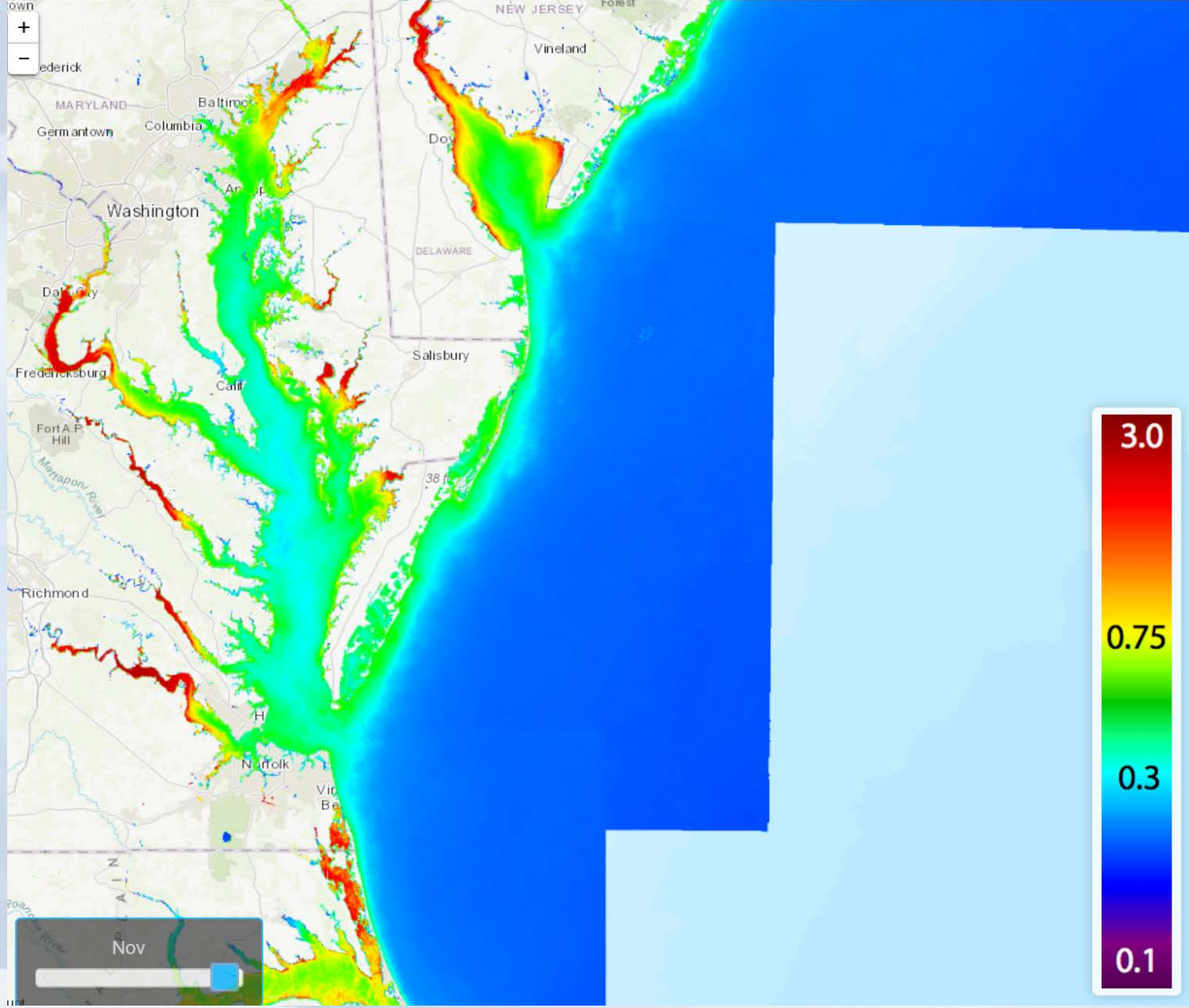
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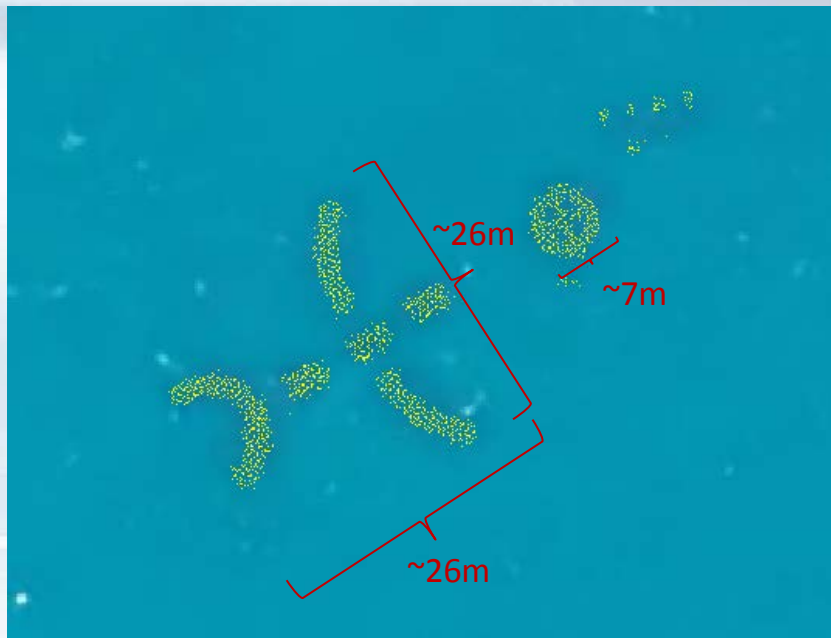


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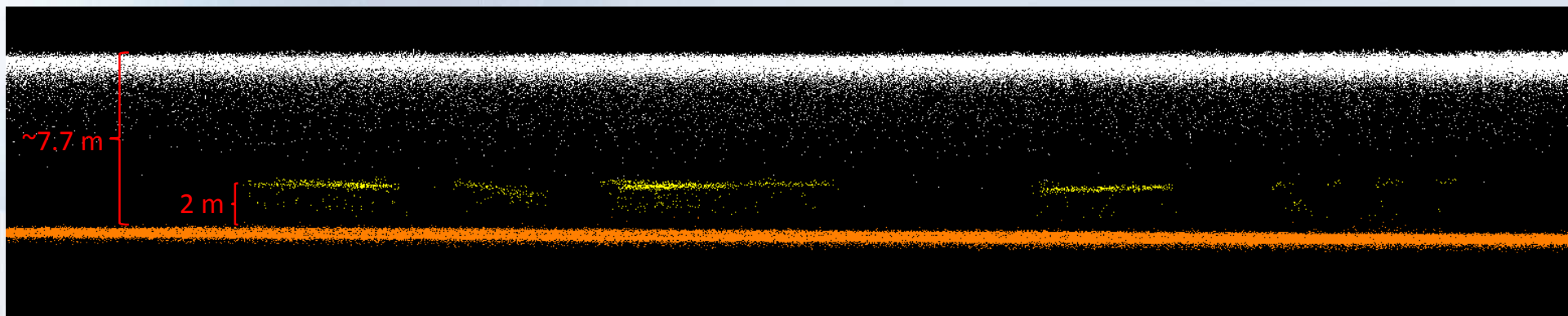
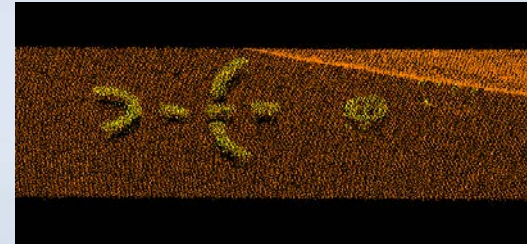


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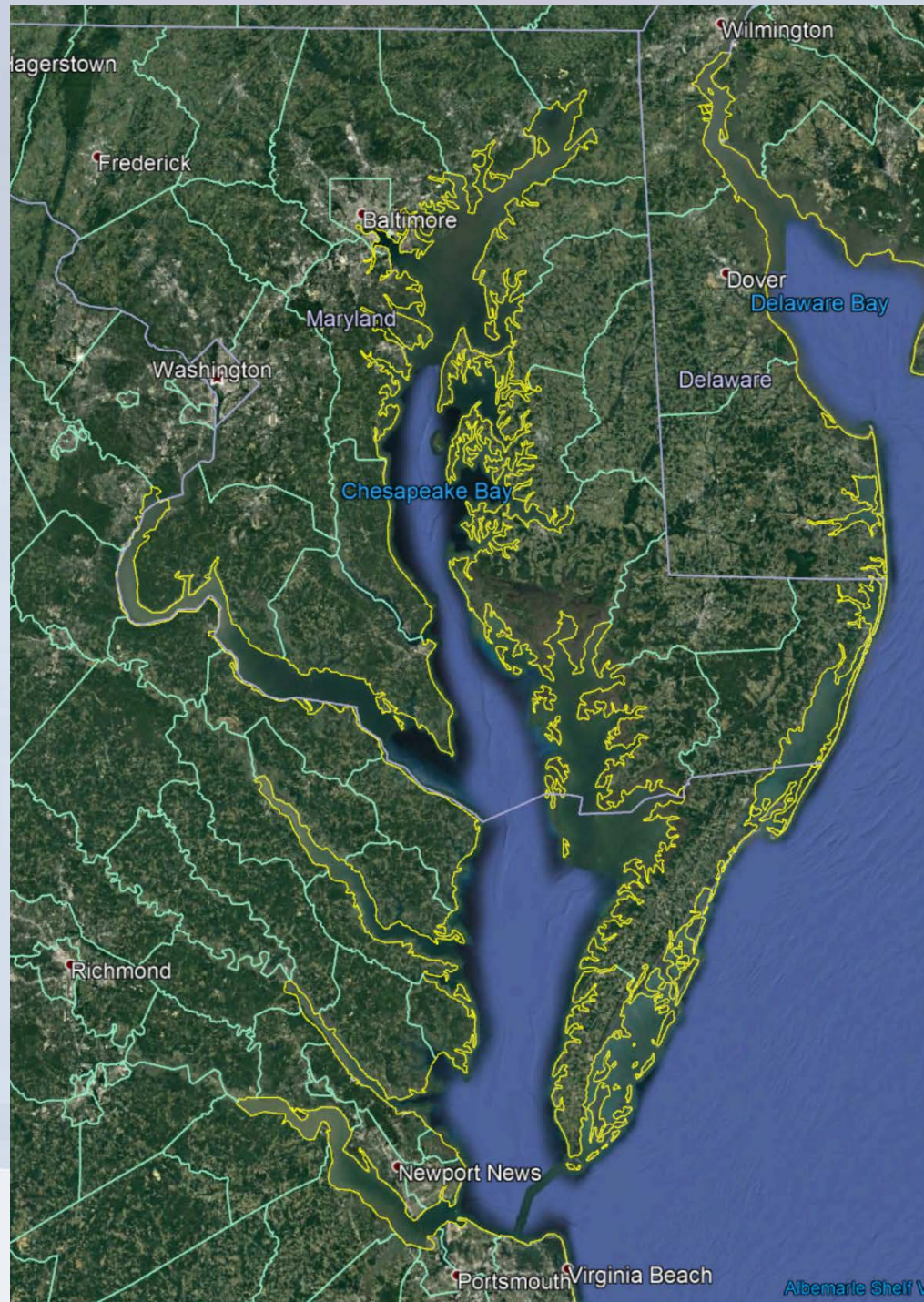
Feature found with lidar



- Point density of the object ranged from ~12.5 to 13.5 pts per m²
- Water depth: ~7.7m
- Object height: 2m



For Requirements Discussion



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