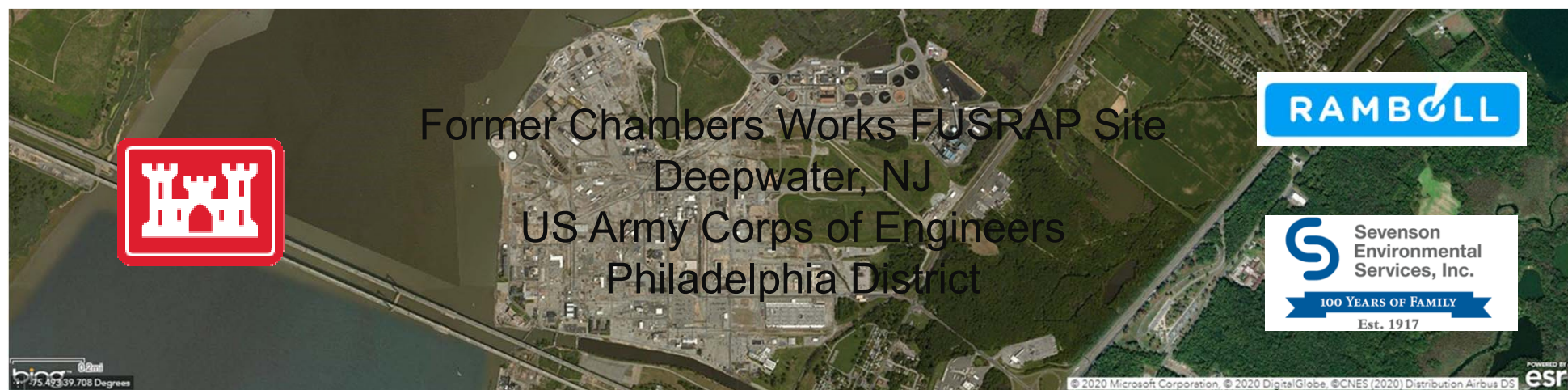


Drones, LiDAR, and 3D Models: A New Paradigm for Data Visualization and Analysis and the Project Management Benefits for Large Hazardous Waste Remediation Projects



Tim Cushman, GISP Tim.Cushman@Ramboll.com

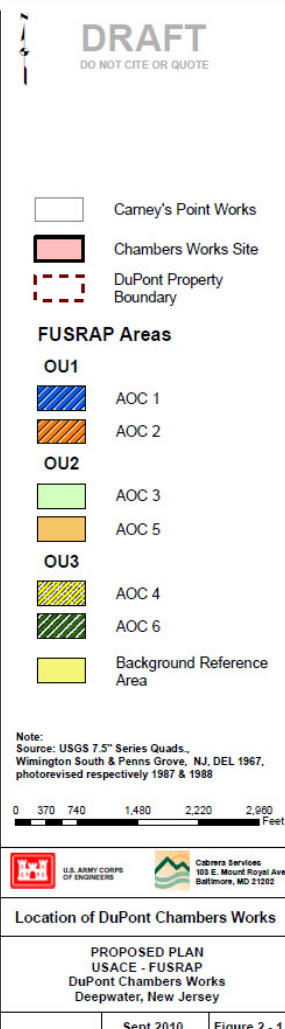
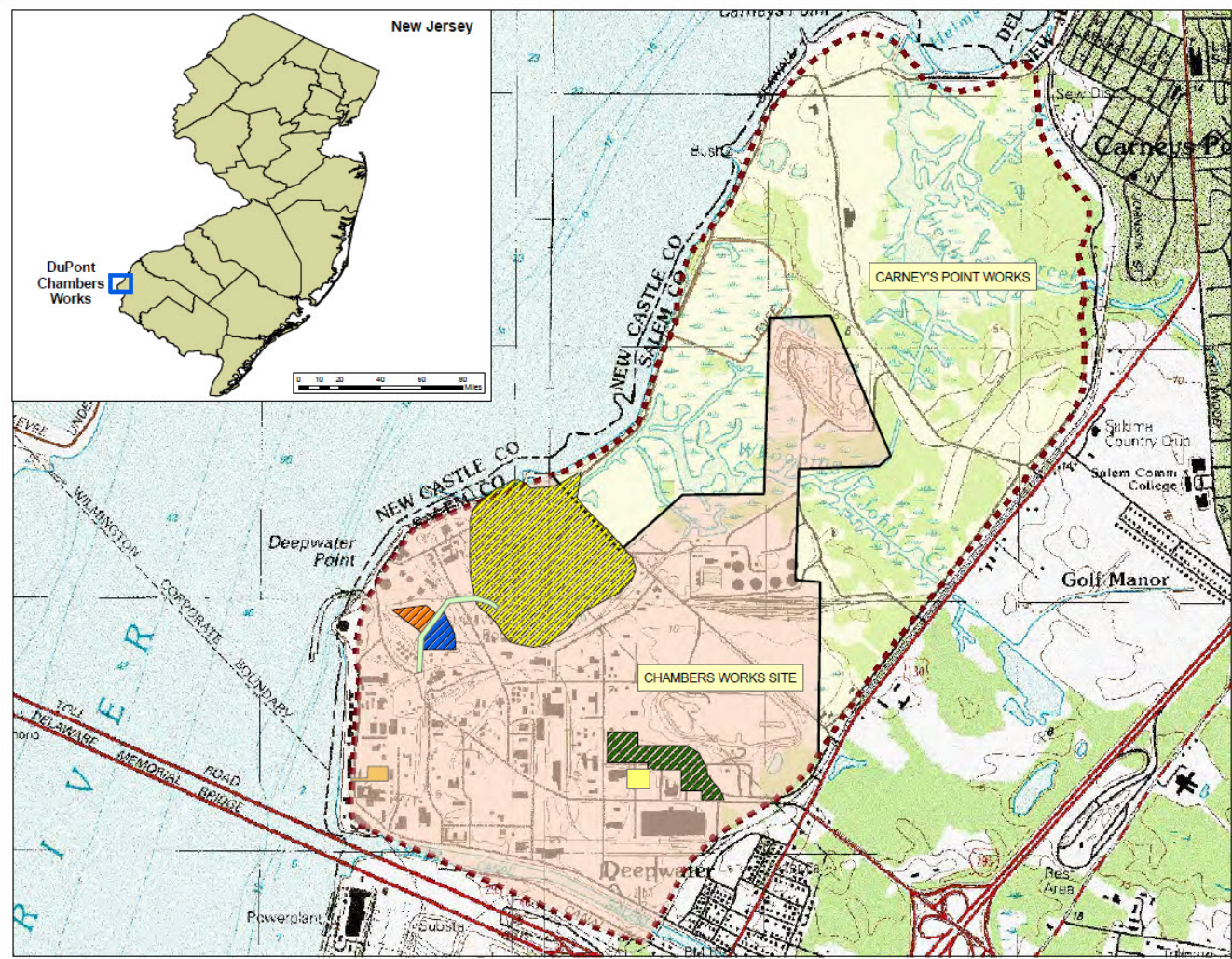
SAME

**DCHWS**
Design and Construction Issues at Hazardous Waste Sites

OCTOBER 26-28, 2020

Site Location

The DuPont Chambers Works FUSRAP Site under remediation is a 6.5-acre area located within the 680-acre Chambers Works property, in Salem County, New Jersey.



Former Chambers Works FUSRAP Site History

- In the 1940s, U.S. Army Corps of Engineers (USACE) Manhattan Engineer District (MED) and Atomic Energy Commission (AEC) contracted E. I. du Pont de Nemours and Company (DuPont) to support the nation's atomic energy program.
- In 1997, USACE was directed by Congress to conduct assessment, remedial action, and site closure activities for FUSRAP sites.
- The USACE is currently addressing residual radiological contamination in multiple Areas of Concern (AOCs) under the Formerly Utilized Sites Remedial Action Program (FUSRAP).
- As lead agency for the response action, USACE selected a remedial action, consistent with CERCLA, that includes excavation and offsite disposal of contaminated soil (beginning in 2014).

- Improve upon the conventional radiological data collection techniques and rudimentary 2D data representations.
- Find a better way to collect, process, and utilize the remedial action radiological data that would enable the project team to optimize operations, perform predictive planning and document expectations.
- Develop a more precise and robust visualization of radiological contamination, to support remediation efforts.
- Enable real-time decision-making, with real-time data. Avoid very expensive stand by time for contractors.

Legend

- Original 28' Depth Limit
- Original 48' Depth Limit
- Original 58' Depth Limit

Counts Per Minute

CPM Range	Color	Approx. Depth
0 - 100	Green	<10cpm
101 - 200	Yellow	5-10cpm
201 - 300	Orange	10-15cpm
301 - 400	Red	15-20cpm
401 - 500	Dark Red	20-30cpm
501 - 600	Black	30-40cpm
601 - 700	Dark Blue	40-50cpm
701 - 800	Light Blue	50-60cpm
801 - 900	Dark Green	60-70cpm
901 - 1000	Light Green	70-80cpm
1001 - 2500	Dark Green	80-90cpm
CPM > 2500	Dark Green	>90cpm

Scale

0 75 150 Feet

North Arrow

Site Labels:

- AOC2
- CWTP
- 3.1 Projected Future Remediation Area Est. Area = 87 sq. yds. Est. Vol. = 711 cu. yds.
- 3.2 Est. Vol. = 4 cu. yds. Under Concrete
- 3.3 & 3.4 Projected Future Remediation Area Est. Area = 1320 sq. yds. Est. Vol. = 2287 cu. yds.
- 3.3 & 3.4 Remaining Total Est. Vol. = 1037 cu. yds.
- 3.5 AOC1-SU1 Excavation Zone
- 3.6 AOC1-SU2 Excavation Zone
- 3.7 Remaining Total Est. Vol. = 2 cu. yds. Referenced to live water line.
- 3.8 Projected Future Remediation Area Est. Area = 176 sq. yds. Est. Vol. = 263 cu. yds.
- 3.9 Projected Future Remediation Area Est. Area = 200 sq. yds. Est. Vol. = 33 cu. yds.
- 3.A AOC1-SU3A Remaining Total Est. Vol. = 430 cu. yds.
- 3.B AOC1-SU3B Remaining Total Est. Vol. = 430 cu. yds.
- Original 10' Depth Limit
- Original 15' Depth Limit
- Original 20' Depth Limit
- Original 25' Depth Limit
- Original 30' Depth Limit
- Original 35' Depth Limit
- Original 40' Depth Limit
- Original 45' Depth Limit
- Original 50' Depth Limit
- Original 55' Depth Limit
- Original 60' Depth Limit
- Original 65' Depth Limit
- Original 70' Depth Limit
- Original 75' Depth Limit
- Original 80' Depth Limit
- Original 85' Depth Limit
- Original 90' Depth Limit
- Original 95' Depth Limit
- Original 100' Depth Limit
- Original 105' Depth Limit
- Original 110' Depth Limit
- Original 115' Depth Limit
- Original 120' Depth Limit
- Original 125' Depth Limit
- Original 130' Depth Limit
- Original 135' Depth Limit
- Original 140' Depth Limit
- Original 145' Depth Limit
- Original 150' Depth Limit
- Original 155' Depth Limit
- Original 160' Depth Limit
- Original 165' Depth Limit
- Original 170' Depth Limit
- Original 175' Depth Limit
- Original 180' Depth Limit
- Original 185' Depth Limit
- Original 190' Depth Limit
- Original 195' Depth Limit
- Original 200' Depth Limit
- Original 205' Depth Limit
- Original 210' Depth Limit
- Original 215' Depth Limit
- Original 220' Depth Limit
- Original 225' Depth Limit
- Original 230' Depth Limit
- Original 235' Depth Limit
- Original 240' Depth Limit
- Original 245' Depth Limit
- Original 250' Depth Limit
- Original 255' Depth Limit
- Original 260' Depth Limit
- Original 265' Depth Limit
- Original 270' Depth Limit
- Original 275' Depth Limit
- Original 280' Depth Limit
- Original 285' Depth Limit
- Original 290' Depth Limit
- Original 295' Depth Limit
- Original 300' Depth Limit
- Original 305' Depth Limit
- Original 310' Depth Limit
- Original 315' Depth Limit
- Original 320' Depth Limit
- Original 325' Depth Limit
- Original 330' Depth Limit
- Original 335' Depth Limit
- Original 340' Depth Limit
- Original 345' Depth Limit
- Original 350' Depth Limit
- Original 355' Depth Limit
- Original 360' Depth Limit
- Original 365' Depth Limit
- Original 370' Depth Limit
- Original 375' Depth Limit
- Original 380' Depth Limit
- Original 385' Depth Limit
- Original 390' Depth Limit
- Original 395' Depth Limit
- Original 400' Depth Limit
- Original 405' Depth Limit
- Original 410' Depth Limit
- Original 415' Depth Limit
- Original 420' Depth Limit
- Original 425' Depth Limit
- Original 430' Depth Limit
- Original 435' Depth Limit
- Original 440' Depth Limit
- Original 445' Depth Limit
- Original 450' Depth Limit
- Original 455' Depth Limit
- Original 460' Depth Limit
- Original 465' Depth Limit
- Original 470' Depth Limit
- Original 475' Depth Limit
- Original 480' Depth Limit
- Original 485' Depth Limit
- Original 490' Depth Limit
- Original 495' Depth Limit
- Original 500' Depth Limit
- Original 505' Depth Limit
- Original 510' Depth Limit
- Original 515' Depth Limit
- Original 520' Depth Limit
- Original 525' Depth Limit
- Original 530' Depth Limit
- Original 535' Depth Limit
- Original 540' Depth Limit
- Original 545' Depth Limit
- Original 550' Depth Limit
- Original 555' Depth Limit
- Original 560' Depth Limit
- Original 565' Depth Limit
- Original 570' Depth Limit
- Original 575' Depth Limit
- Original 580' Depth Limit
- Original 585' Depth Limit
- Original 590' Depth Limit
- Original 595' Depth Limit
- Original 600' Depth Limit
- Original 605' Depth Limit
- Original 610' Depth Limit
- Original 615' Depth Limit
- Original 620' Depth Limit
- Original 625' Depth Limit
- Original 630' Depth Limit
- Original 635' Depth Limit
- Original 640' Depth Limit
- Original 645' Depth Limit
- Original 650' Depth Limit
- Original 655' Depth Limit
- Original 660' Depth Limit
- Original 665' Depth Limit
- Original 670' Depth Limit
- Original 675' Depth Limit
- Original 680' Depth Limit
- Original 685' Depth Limit
- Original 690' Depth Limit
- Original 695' Depth Limit
- Original 700' Depth Limit
- Original 705' Depth Limit
- Original 710' Depth Limit
- Original 715' Depth Limit
- Original 720' Depth Limit
- Original 725' Depth Limit
- Original 730' Depth Limit
- Original 735' Depth Limit
- Original 740' Depth Limit
- Original 745' Depth Limit
- Original 750' Depth Limit
- Original 755' Depth Limit
- Original 760' Depth Limit
- Original 765' Depth Limit
- Original 770' Depth Limit
- Original 775' Depth Limit
- Original 780' Depth Limit
- Original 785' Depth Limit
- Original 790' Depth Limit
- Original 795' Depth Limit
- Original 800' Depth Limit
- Original 805' Depth Limit
- Original 810' Depth Limit
- Original 815' Depth Limit
- Original 820' Depth Limit
- Original 825' Depth Limit
- Original 830' Depth Limit
- Original 835' Depth Limit
- Original 840' Depth Limit
- Original 845' Depth Limit
- Original 850' Depth Limit
- Original 855' Depth Limit
- Original 860' Depth Limit
- Original 865' Depth Limit
- Original 870' Depth Limit
- Original 875' Depth Limit
- Original 880' Depth Limit
- Original 885' Depth Limit
- Original 890' Depth Limit
- Original 895' Depth Limit
- Original 900' Depth Limit
- Original 905' Depth Limit
- Original 910' Depth Limit
- Original 915' Depth Limit
- Original 920' Depth Limit
- Original 925' Depth Limit
- Original 930' Depth Limit
- Original 935' Depth Limit
- Original 940' Depth Limit
- Original 945' Depth Limit
- Original 950' Depth Limit
- Original 955' Depth Limit
- Original 960' Depth Limit
- Original 965' Depth Limit
- Original 970' Depth Limit
- Original 975' Depth Limit
- Original 980' Depth Limit
- Original 985' Depth Limit
- Original 990' Depth Limit
- Original 995' Depth Limit
- Original 1000' Depth Limit
- Original 1005' Depth Limit
- Original 1010' Depth Limit
- Original 1015' Depth Limit
- Original 1020' Depth Limit
- Original 1025' Depth Limit
- Original 1030' Depth Limit
- Original 1035' Depth Limit
- Original 1040'

Solution 1: Geographic Information Systems

REMEDY MOSAIC BASEMAP

SPATIAL ANALYSIS RESULTS

DEPTH OF CONTAMINATION

ANALYTICAL INTERPOLATIONS

AVERAGE CONCENTRATION

REMEDIAL DESIGN (CAD DATA)

EXCLUSION ZONES

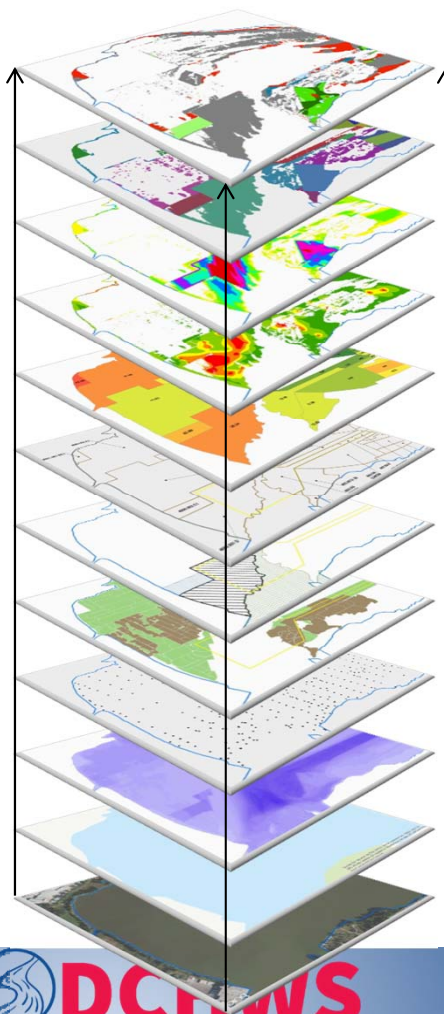
EXCAVATION AREAS

BORING LOCATIONS (GPS)

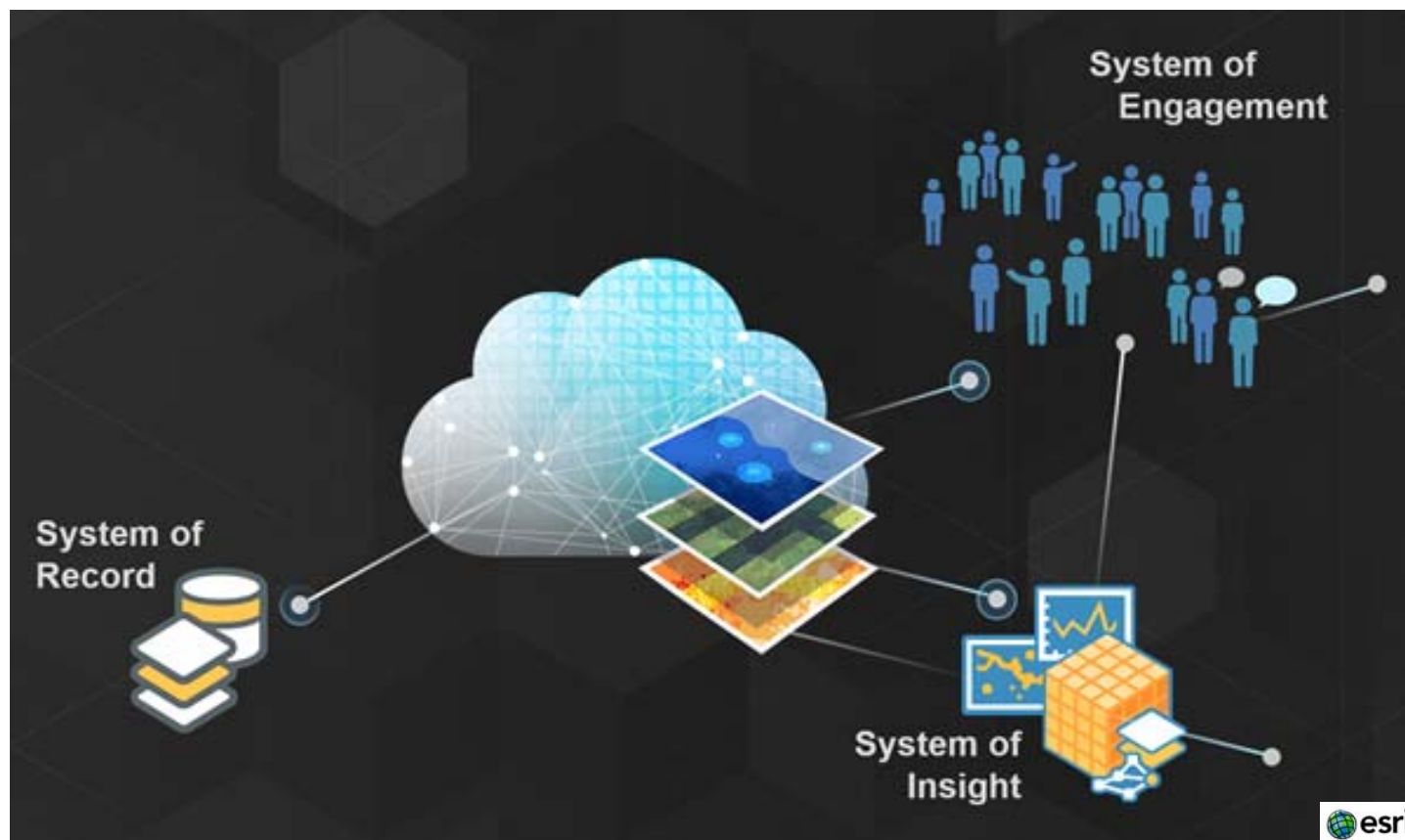
LIDAR-DERIVED DIGITAL ELEVATION MODEL

PLANIMETRIC DATA

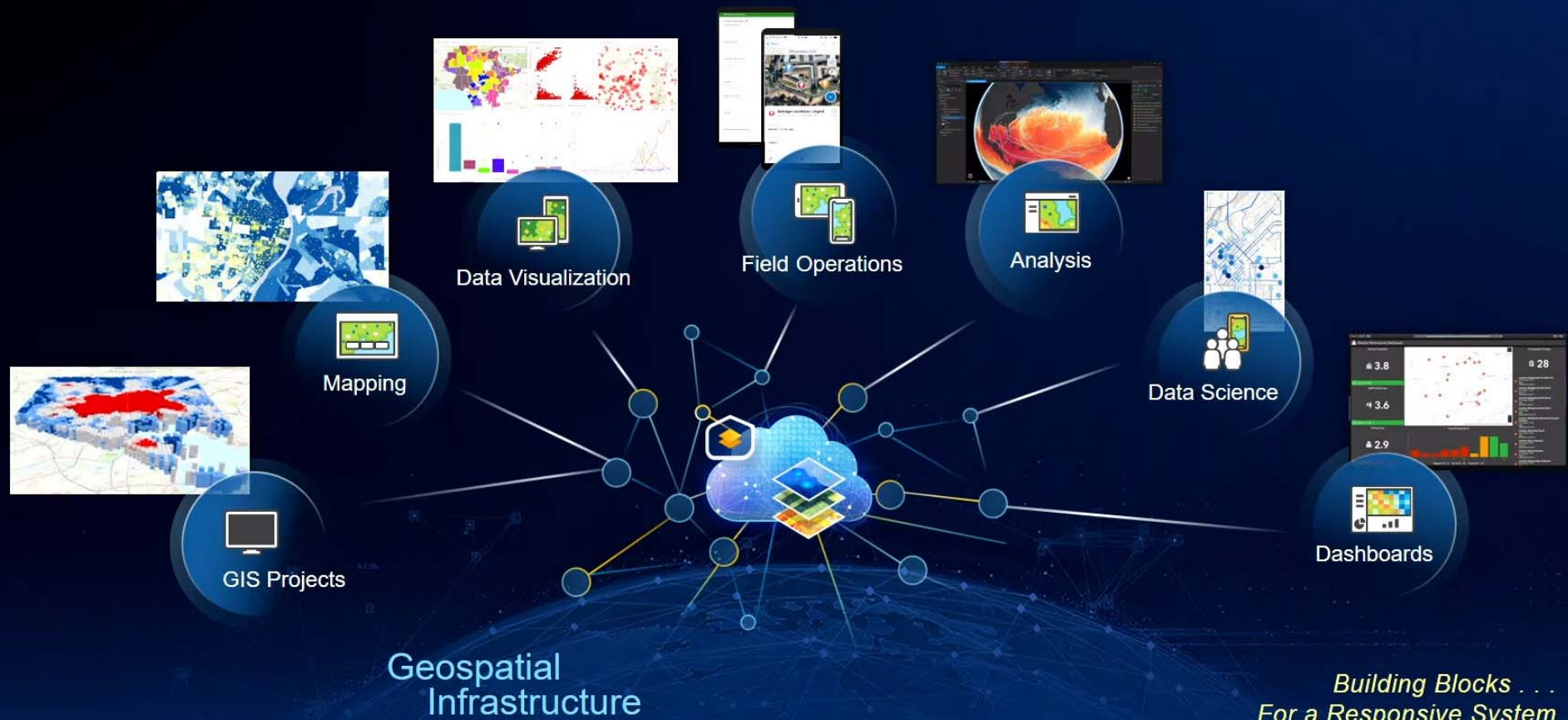
DRONE ORTHOIMAGERY



Solution 1: Geographic Information Systems



Delivering Powerful Capabilities Across Organizations



Credits: Esri, 2019 User Conference Plenary

SAME

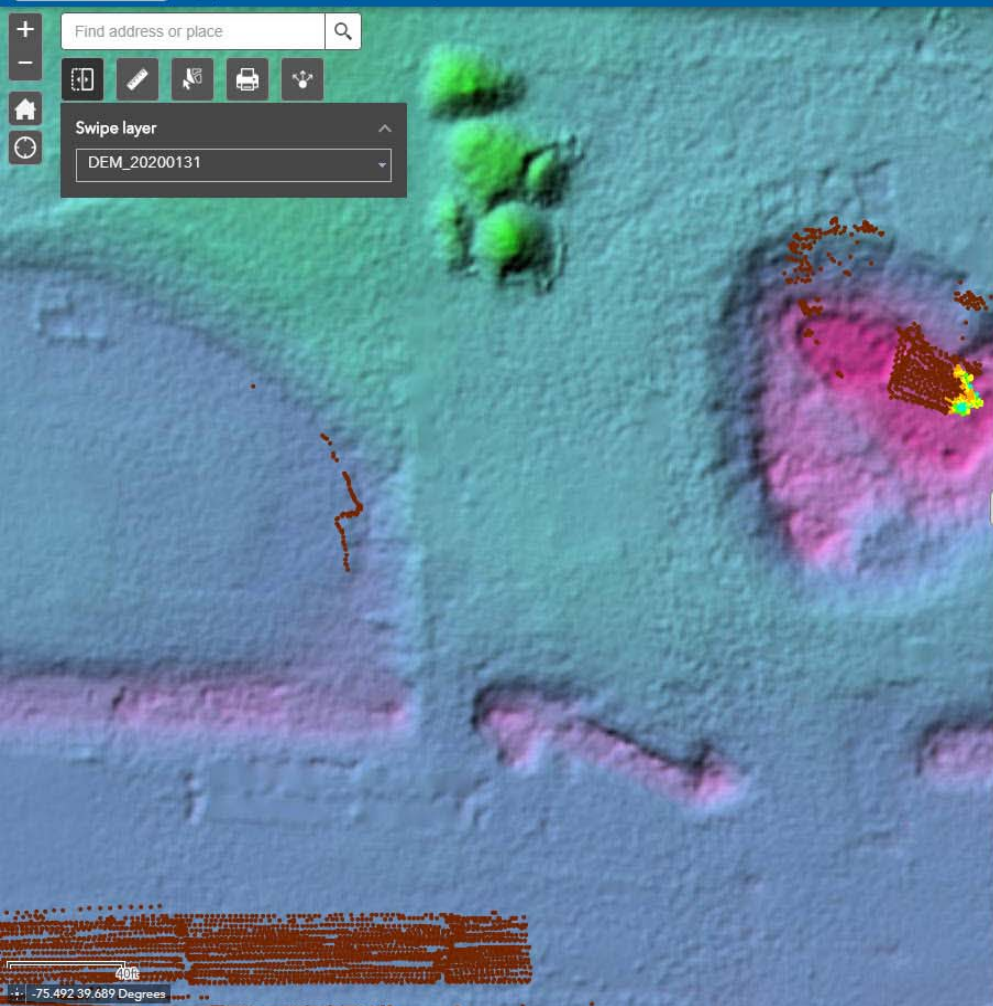
DCHWS
Design and Construction Issues at Hazardous Waste Sites

OCTOBER 26-28, 2020

esri

Key Highlights of ArcGIS Online

- Features real-time data access, querying, and visualization capabilities
- Incorporates all available data sources (orthoimagery, LiDAR, 3D field data, GIS, CAD, GPS, etc.)
- Provides a common operating picture to all team members in a secure, online platform
- Allows mobile access and enables adaptable electronic field data collection
- This is the hub for GIS data, maps, and apps for the Chambers Works project. This site is dynamically updated and can be customized tailored to meet ever-changing project needs.



Layer List	
Layers	
<input type="checkbox"/> Map Notes	...
<input type="checkbox"/> AOC4_Boundary	...
<input checked="" type="checkbox"/> AOC6_and_AOC4_Land_Survey_200203; Greater than 13,000 CPM	...
Gamma CPM	
<input type="checkbox"/> ≤100000	...
<input type="checkbox"/> ≤50000	...
<input type="checkbox"/> ≤30000	...
<input type="checkbox"/> ≤25000	...
<input type="checkbox"/> ≤23000	...
<input type="checkbox"/> ≤20000	...
<input type="checkbox"/> ≤18000	...
<input type="checkbox"/> AOC6_and_AOC4_Land_Survey_200203; All Results	...
<input checked="" type="checkbox"/> DEM_20200131	...
<input checked="" type="checkbox"/> Ortho_20200131	...
<input type="checkbox"/> DEM_20200124	...
<input type="checkbox"/> Ortho_20200124_pit	...
<input type="checkbox"/> DEM_20200117	...
<input type="checkbox"/> Ortho_20200117	...

Solution 2: Electronic Field Data Collection

Recent improvements include:

- Wireless communications with radiation detection equipment
- Real Time Kinematic GNSS GPS equipment for cm-grade accuracy
- Mobile data logger
- Improved field software for data processing



In the Field

Live Data Streams



OCTOBER 26-28, 2020

Solution 2: Electronic Field Data Collection



Collector
for ArcGIS

Accurate data collection made easy



Survey123
for ArcGIS

Smarter forms, smarter data collection



Tracker for ArcGIS

Know what happens in the field



Workforce
for ArcGIS

Smarter field workforce coordination at your fingertips.



Navigator for ArcGIS

Advanced navigation and routing for your workforce



Explorer for ArcGIS

Maps at your fingertips



Operations Dashboard
for ArcGIS

Make decisions at a glance

<https://www.esri.com/en-us/arcgis/products/collector-for-arcgis/overview>
<https://www.esri.com/en-us/arcgis/products/explorer-for-arcgis/overview>
<https://www.esri.com/en-us/arcgis/products/navigator-for-arcgis/overview>
<https://www.esri.com/en-us/arcgis/products/operations-dashboard/overview>

<https://www.esri.com/en-us/arcgis/products/survey123/overview>
<https://www.esri.com/en-us/arcgis/products/tracker-for-arcgis/overview>
<https://www.esri.com/en-us/arcgis/products/workforce/overview>
https://www.esri.com/en-us/arcgis/products/field-operations/overview?rmedium=esri_com_redirects01&rsource=/en-us/arcgis/field-mobility/overview

SAME

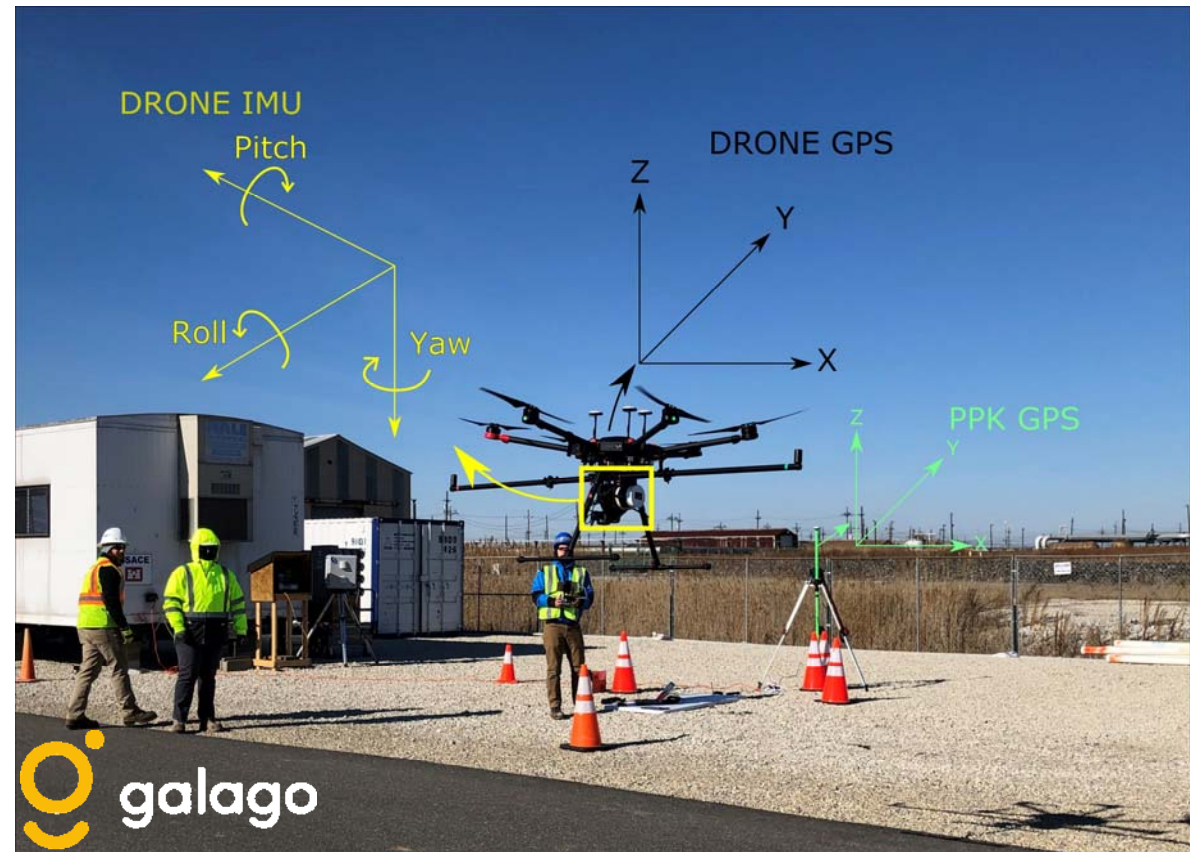
 **DCHWS**
Design and Construction Issues at Hazardous Waste Sites

OCTOBER 26-28, 2020

Solution 3: Drones for LiDAR and Imagery

New Technology Platform includes:

- 8-rotor UAV (octocopter) with gimbal and sensor array mount
- Velodyne-32MR LiDAR sensor
 - Light Detection and Ranging (LiDAR)
 - 1.2 million points per second; 100 meters +/-10 cm accuracy
- Sony A6000 24MP Digital camera
 - RGB image collection for orthophotos
 - Tied to IMU/GPS for precise image location and seamless image matching



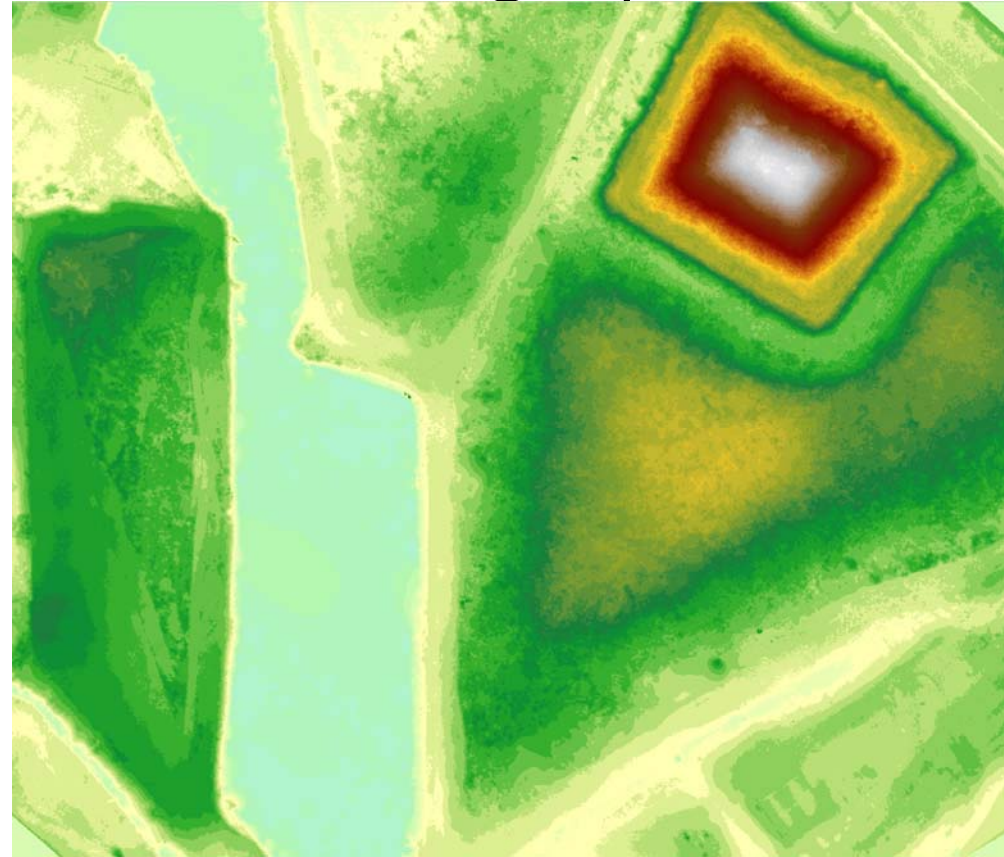
Solution 3: Drones for LiDAR and Imagery

High-resolution aerial imagery (Orthomosaic)

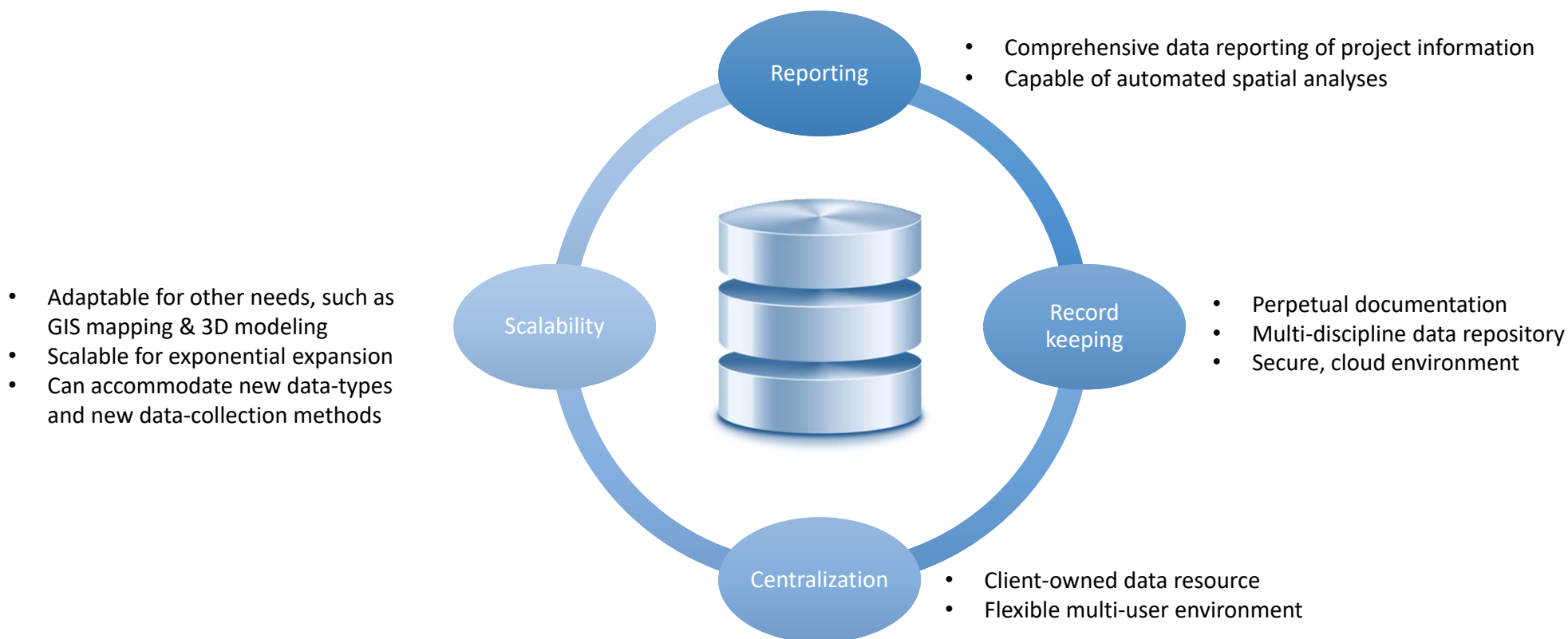
- Low altitude imagery collection from a highly adaptable platform. Very quick turn-around-time.
- < 0.5-in per pixel, best available imagery today!
- No comparison to modern satellite imagery or other commonly available basemaps.

LiDAR point-cloud and Digital Elevation Models (DEMs)

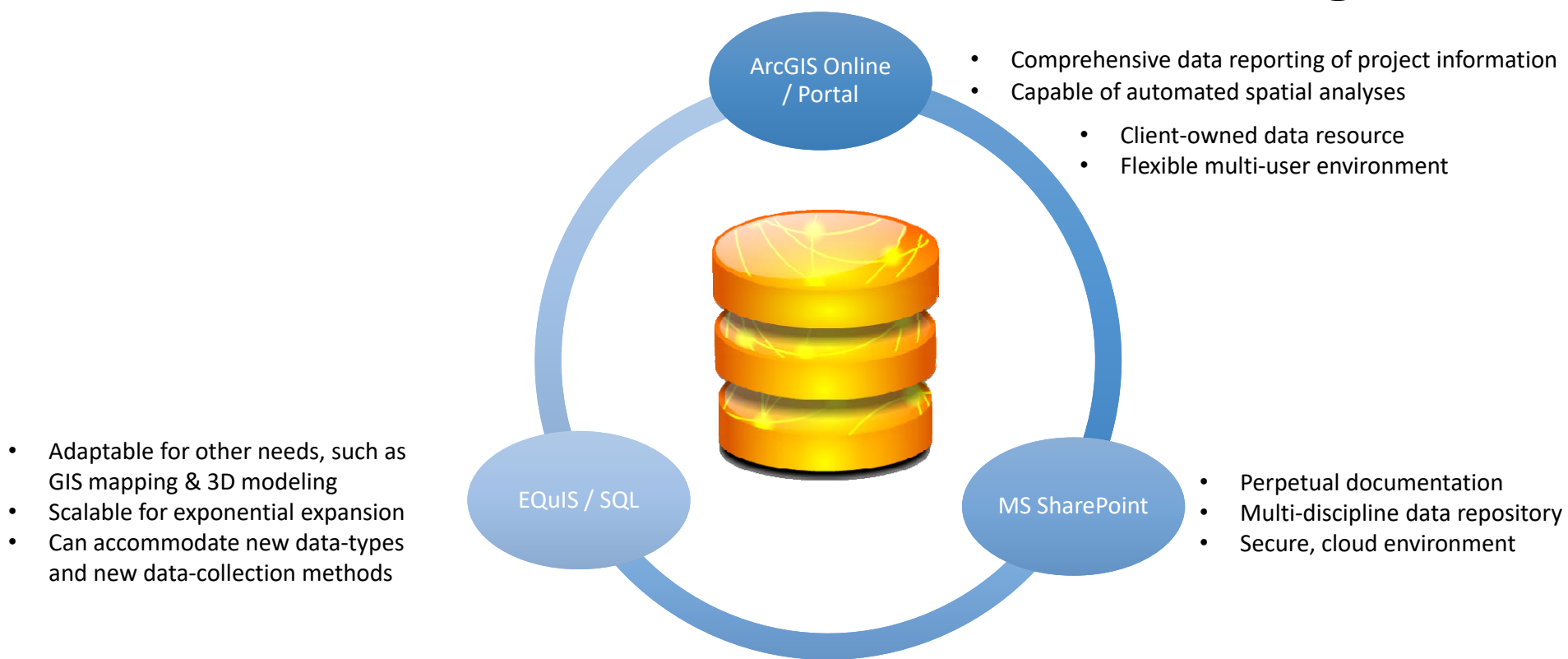
- High sample density for increased accuracy and precision
- Point-cloud classification and enhanced post-processing
- Near-real-time volumetric analysis and interpretation
- Allows easy access and full coverage in inaccessible places



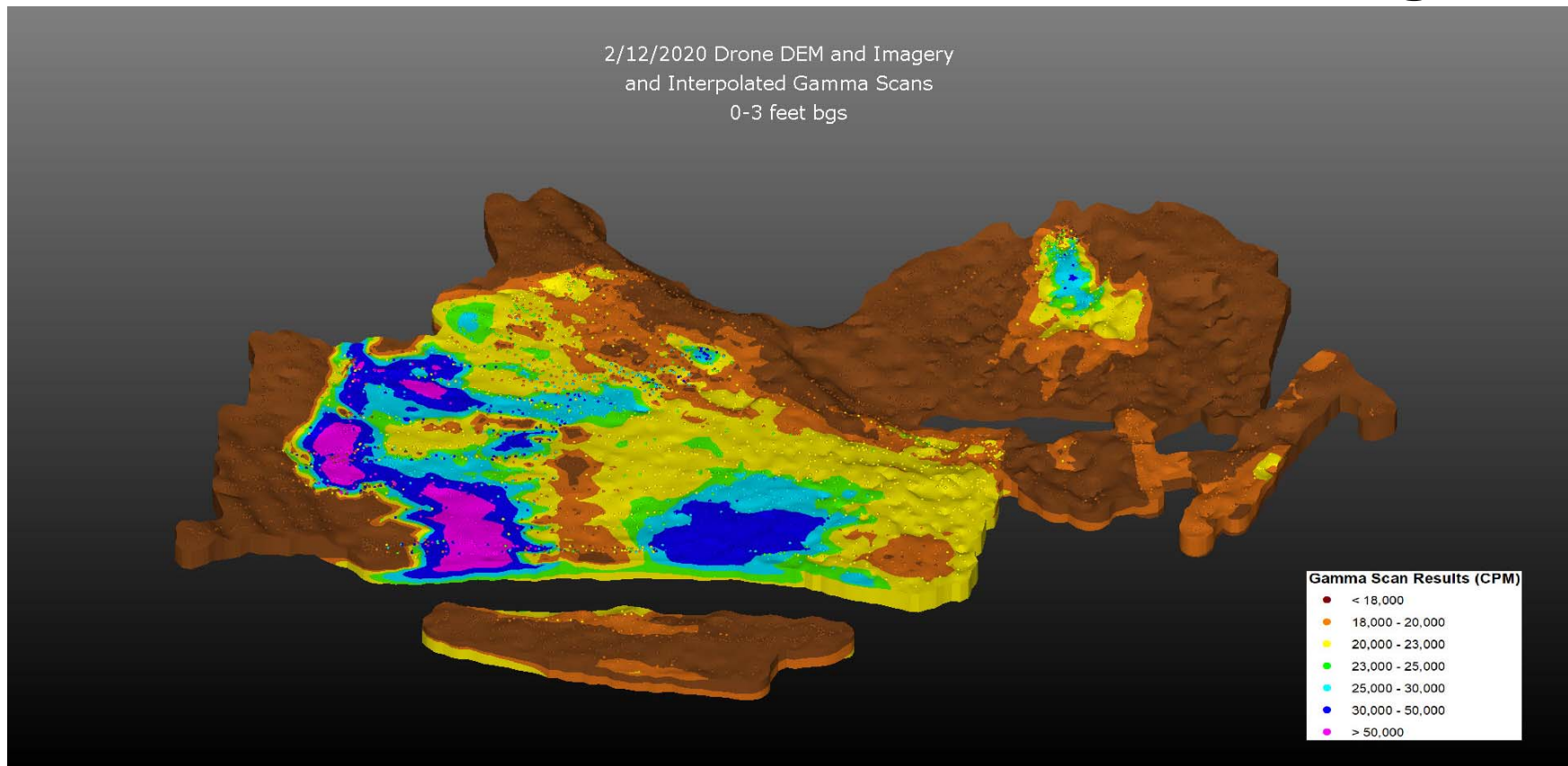
Solution 4: Centralized Database Management



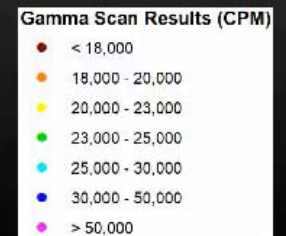
Solution 4: Centralized Database Management



Solution 5: 3D Visualization and Modeling



2/12/2020 Drone DEM and Imagery
and Interpolated Gamma Scans



Former Chambers Works FUSRAP Site Team

- USACE

- Daniel M. Sirkis, PG - US Army Corps of Engineers Philadelphia
- George Bock - US Army Corps of Engineers Philadelphia
- Dave Watters, CHP - US Army Corps of Engineers Baltimore



- Ramboll

- Thomas Cornuet, PG
- Tim Cushman, GISP
- Christopher Bowles (Founder and Director of Galago)
- Kyle Kohler (FAA certified UAV pilot)



- Severson

- Don Wadsworth, MSHP
- Daniel Caputo, CHP



OCTOBER 26-28, 2020