Conservation Innovation Center

AI-Powered Wetland Mapping

Dr. Michael Evans
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Chesapeake Conservancy

12/16/2025

Photo by Nicholas A. Tonelli

Chesapeake Conservancy

U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

EPA

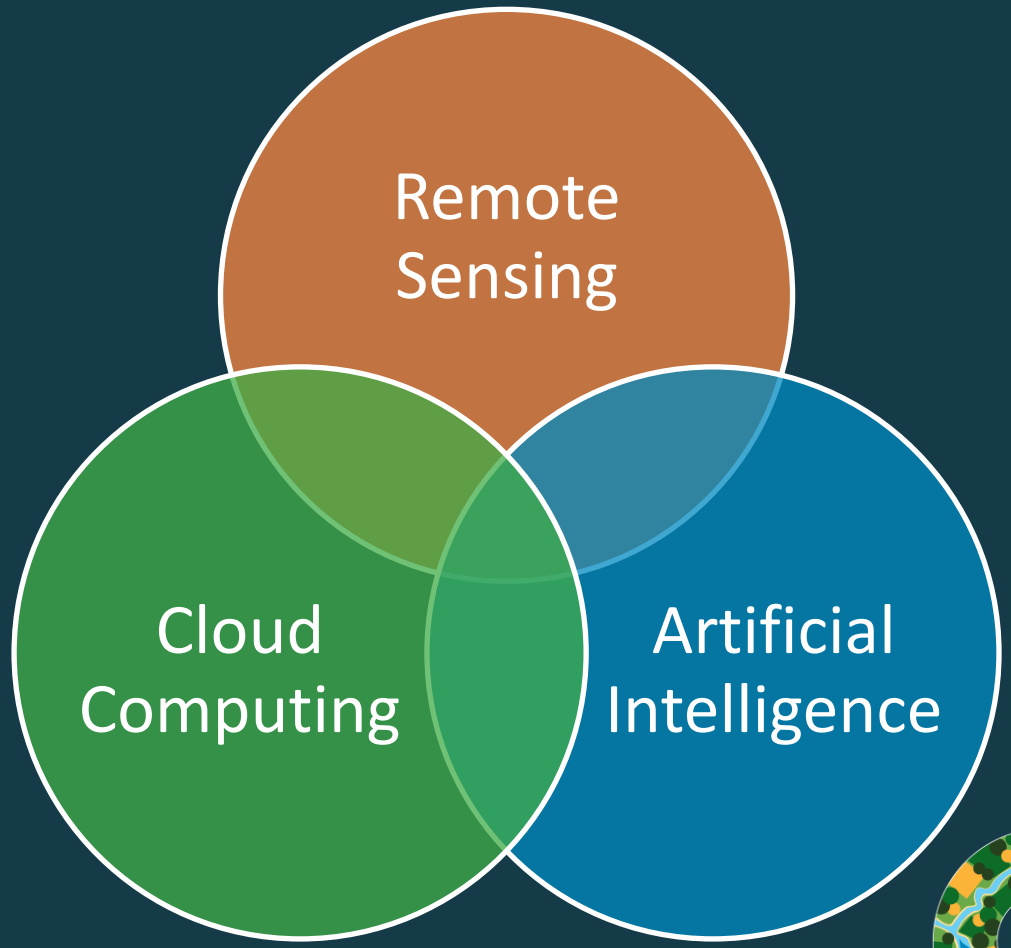
USGS

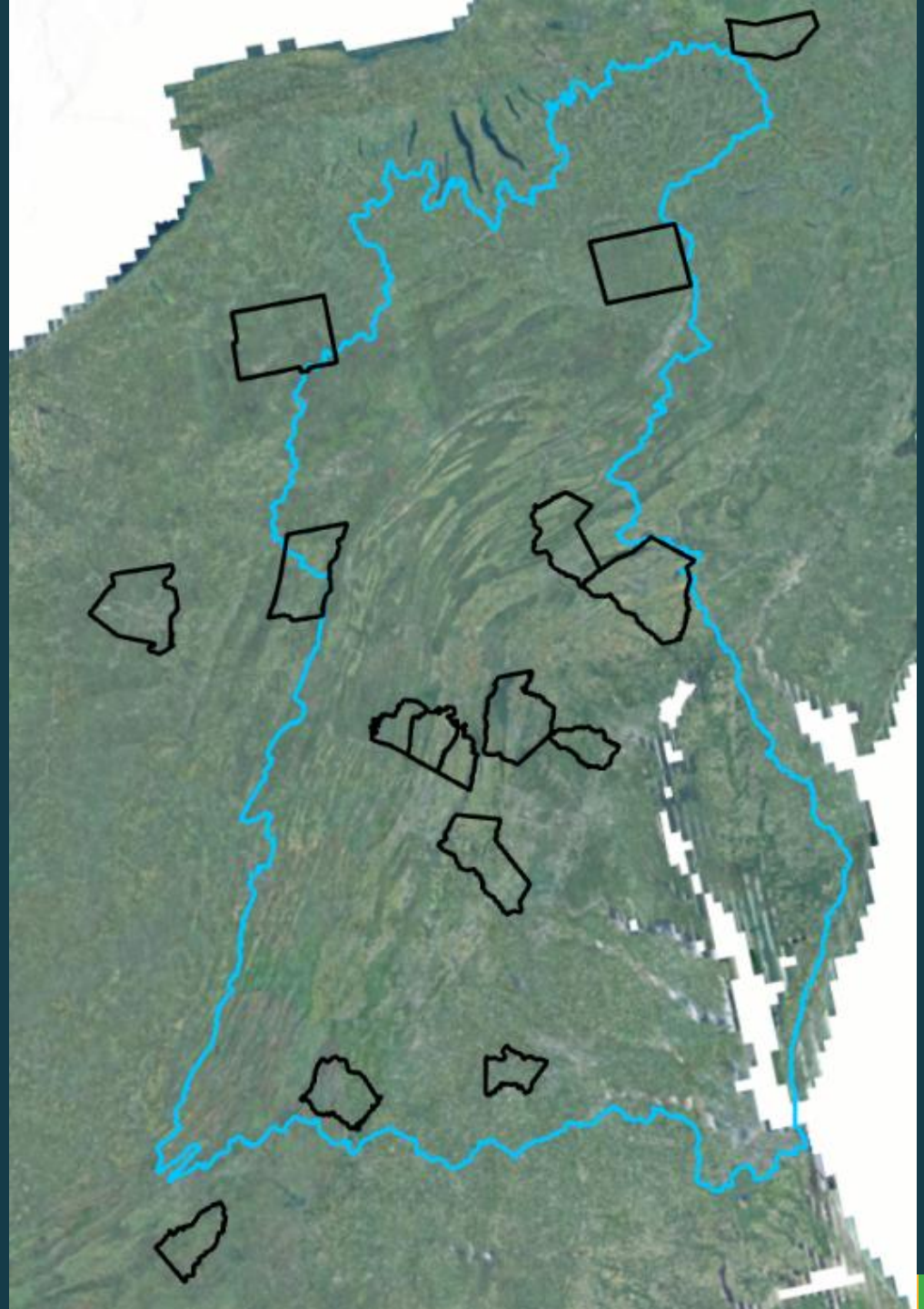
To conserve and restore the natural and cultural resources of the Chesapeake Bay watershed for the enjoyment, education and inspiration of this and future generations.

The Challenge

1. Accurate wetland maps needed for compliance and modeling
2. Existing wetland data has gaps
3. Wetlands are hard to map

The Opportunity





Goal

Make water quality modeling and regulation more effective with accurate, up-to-date wetland data.

Objectives

- Automated and repeatable
- Precise (e.g., high resolution)
- Use consistent, publicly available data
- Create data in 12 test counties

Remote Sensing Data: NAIP

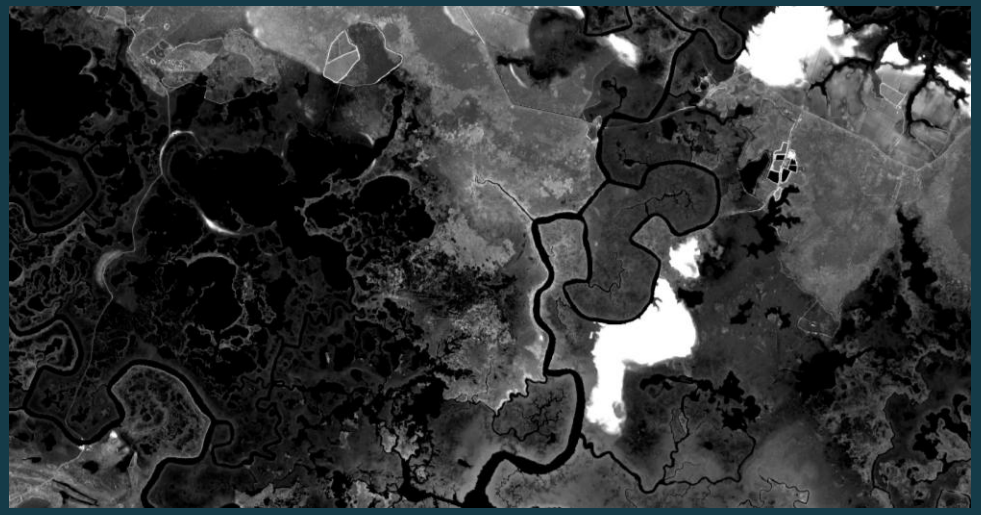
Variables: Red, Green, Blue, Near Infrared

Resolution: 0.6 - 1 m

Frequency: ~ 2 – 3 years

Time: 2013 - 2022

Remote Sensing Data: Elevation



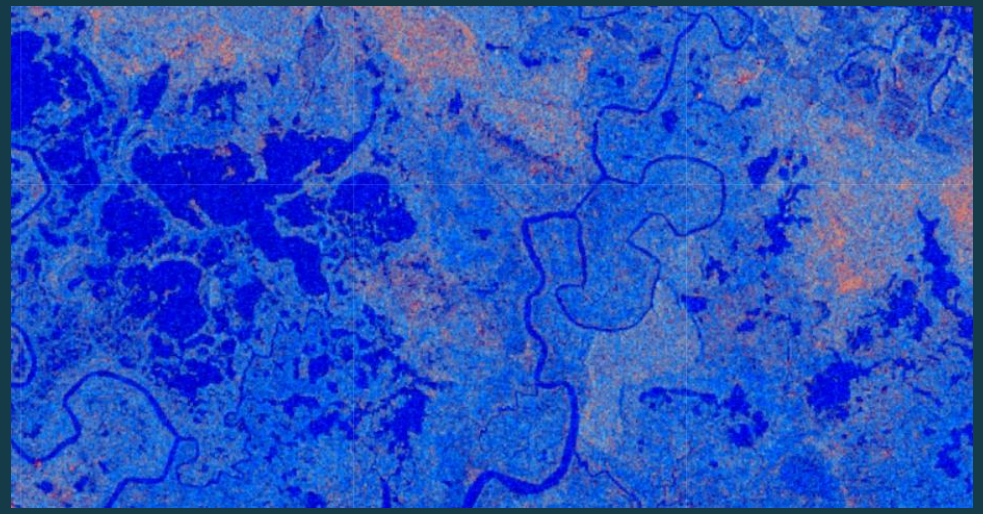
Variables: Elevation (m)

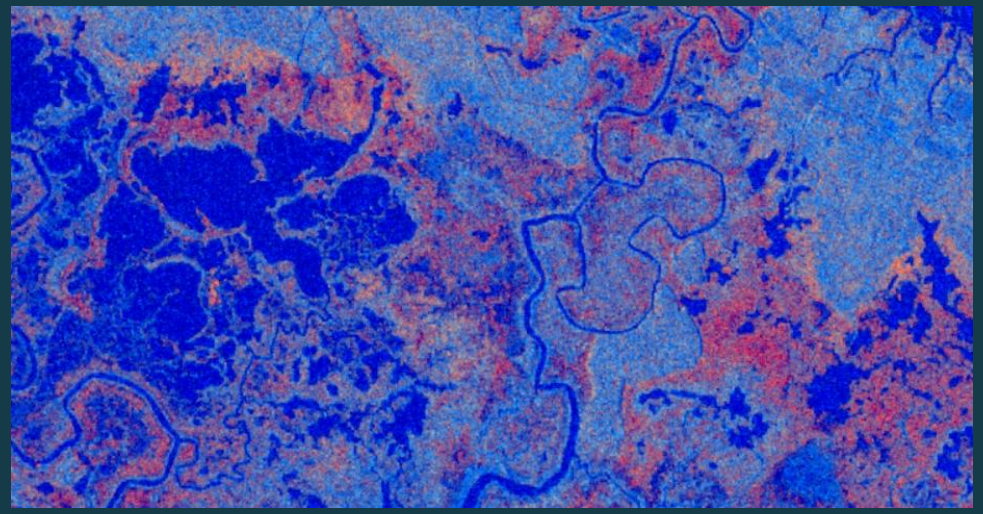
Resolution: 1 m

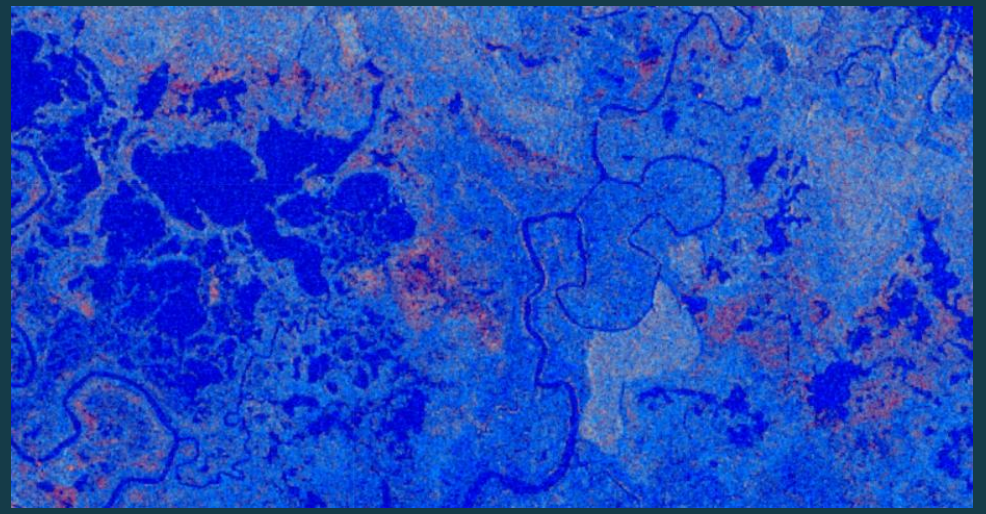
Frequency: ~2 -3 years

Time: 2016 - 2022

Remote Sensing Data: Sentinel-1







Variables: VV, VH C-band radar returns

Resolution: 10 m

Frequency: ~ every 5 days

Time: 2014 - present

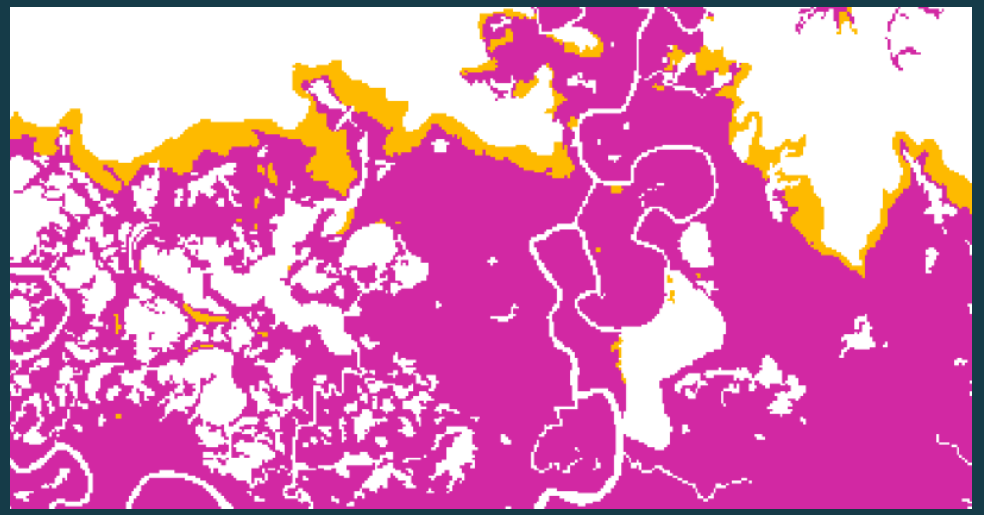
Input data – SSURGO soil characteristics

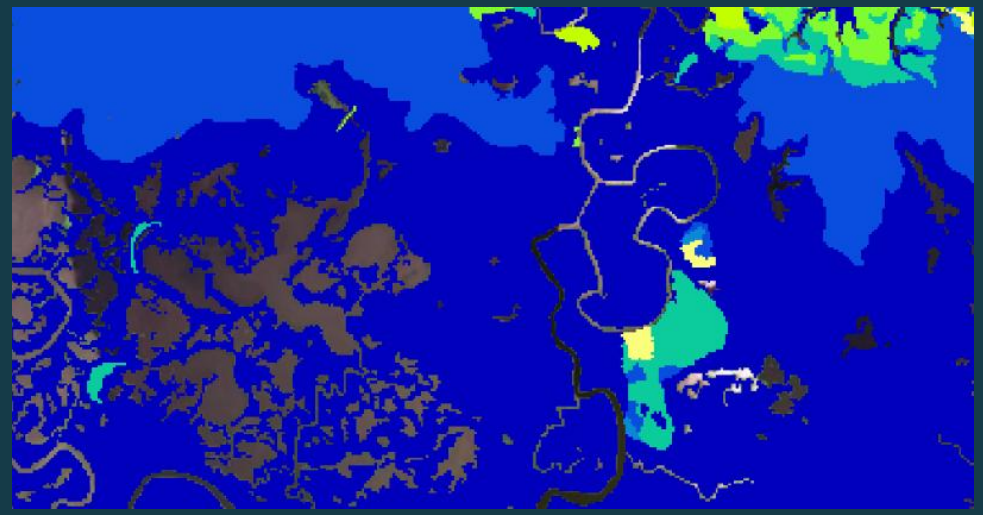
Variables: Wetness depth, Drainage class, Flood frequency, Hydric class

Resolution: 10 m

Frequency: Static

Time: Static

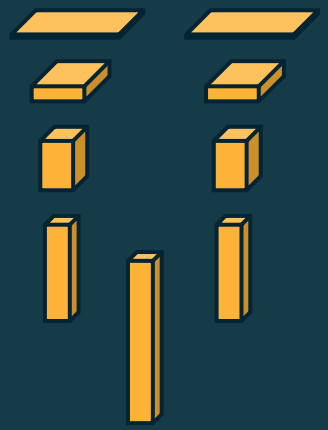


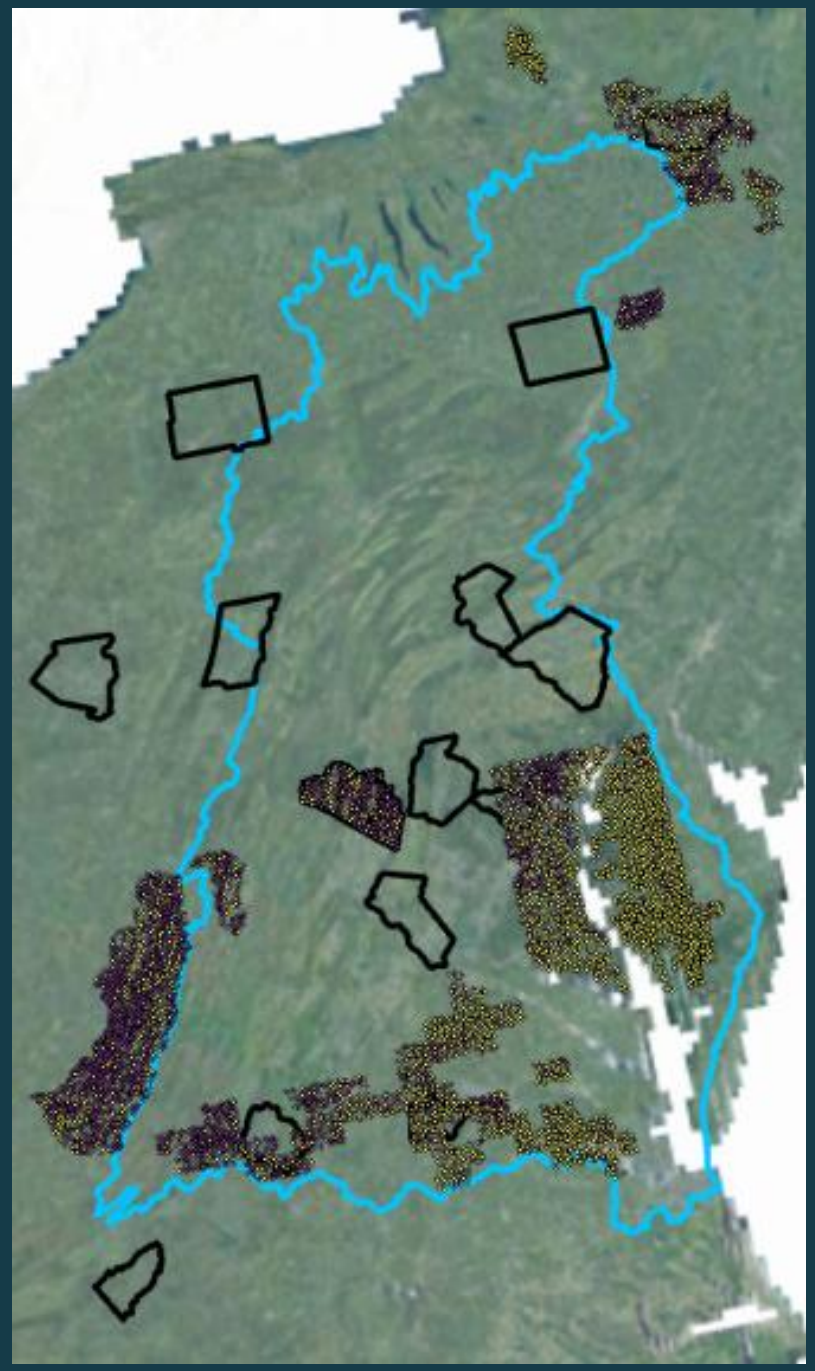


Model Training: Data

25,000 sample points

600 x 600 pixel ‘chips’

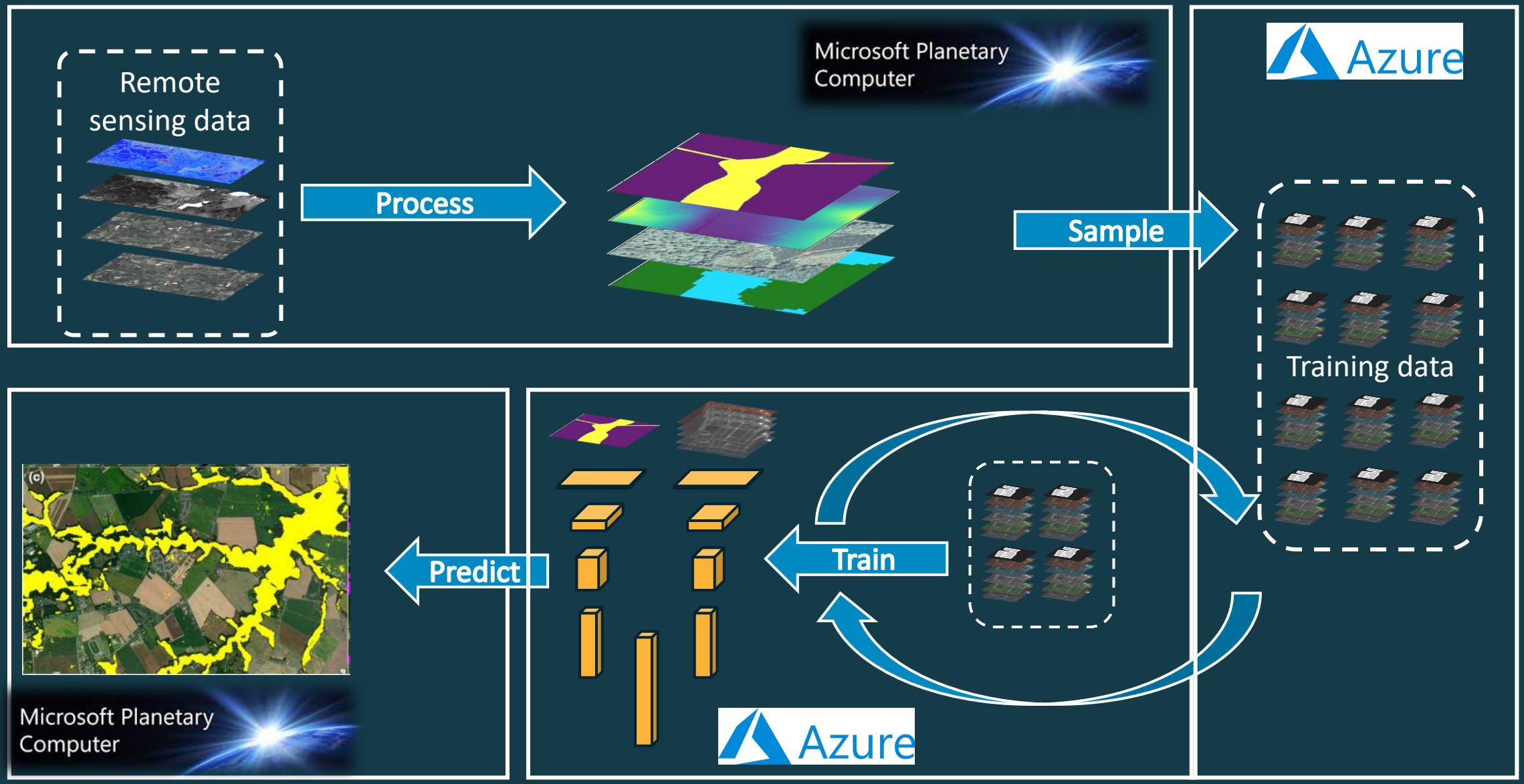




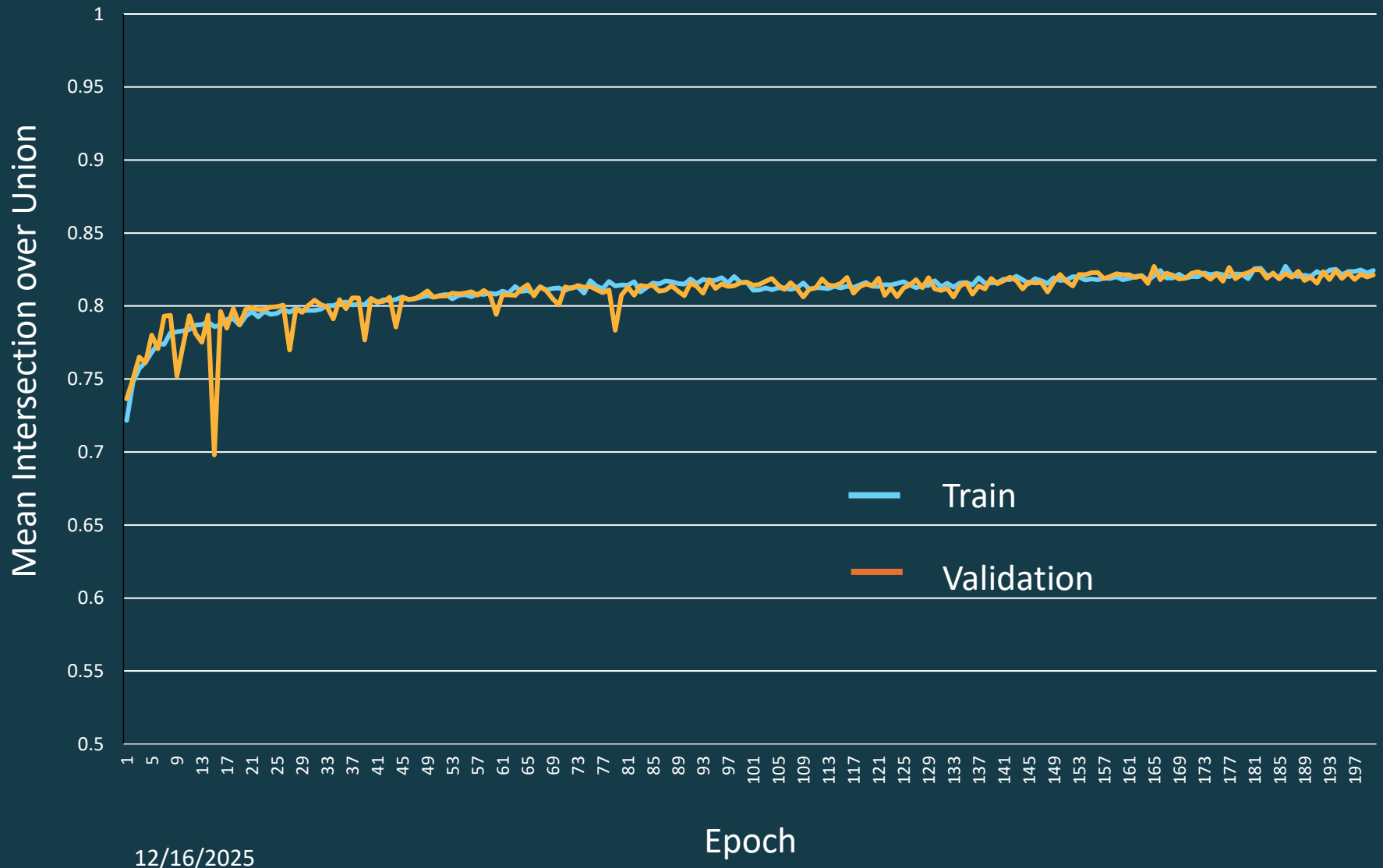
> 2016 NWI Polygons

- Inside wetlands
- Outside wetlands

Model Training: Workflow

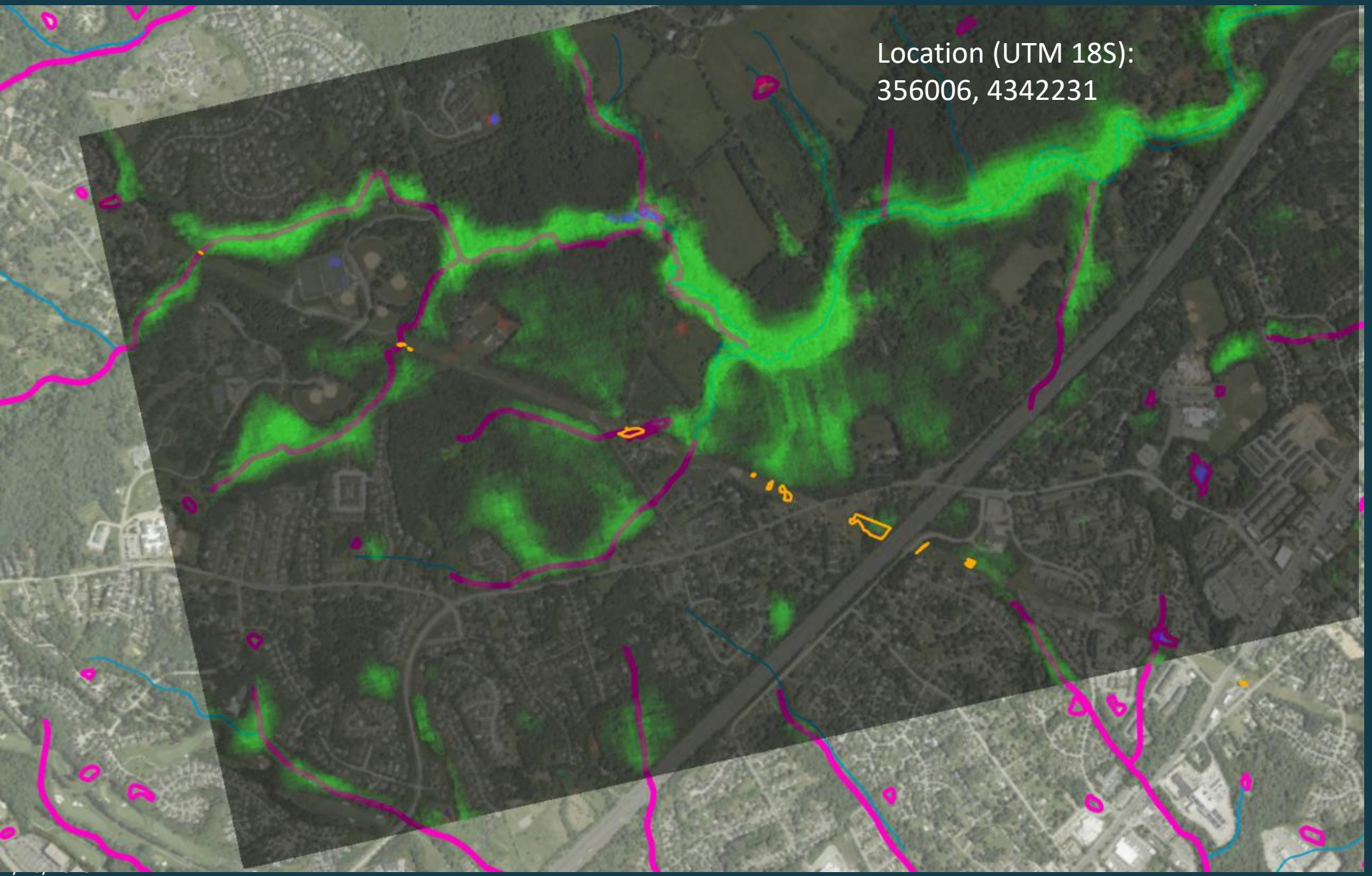


Model Training: Performance



Metric	Model	
	Basic	Full
IoU	83.3%	87.3%
Accuracy	91.6%	94.0%
Precision	90.5%	96.5%
Recall	91.3%	90.2%

Precise, Current Wetland Maps



Delineated Wetlands

BGE

NWI

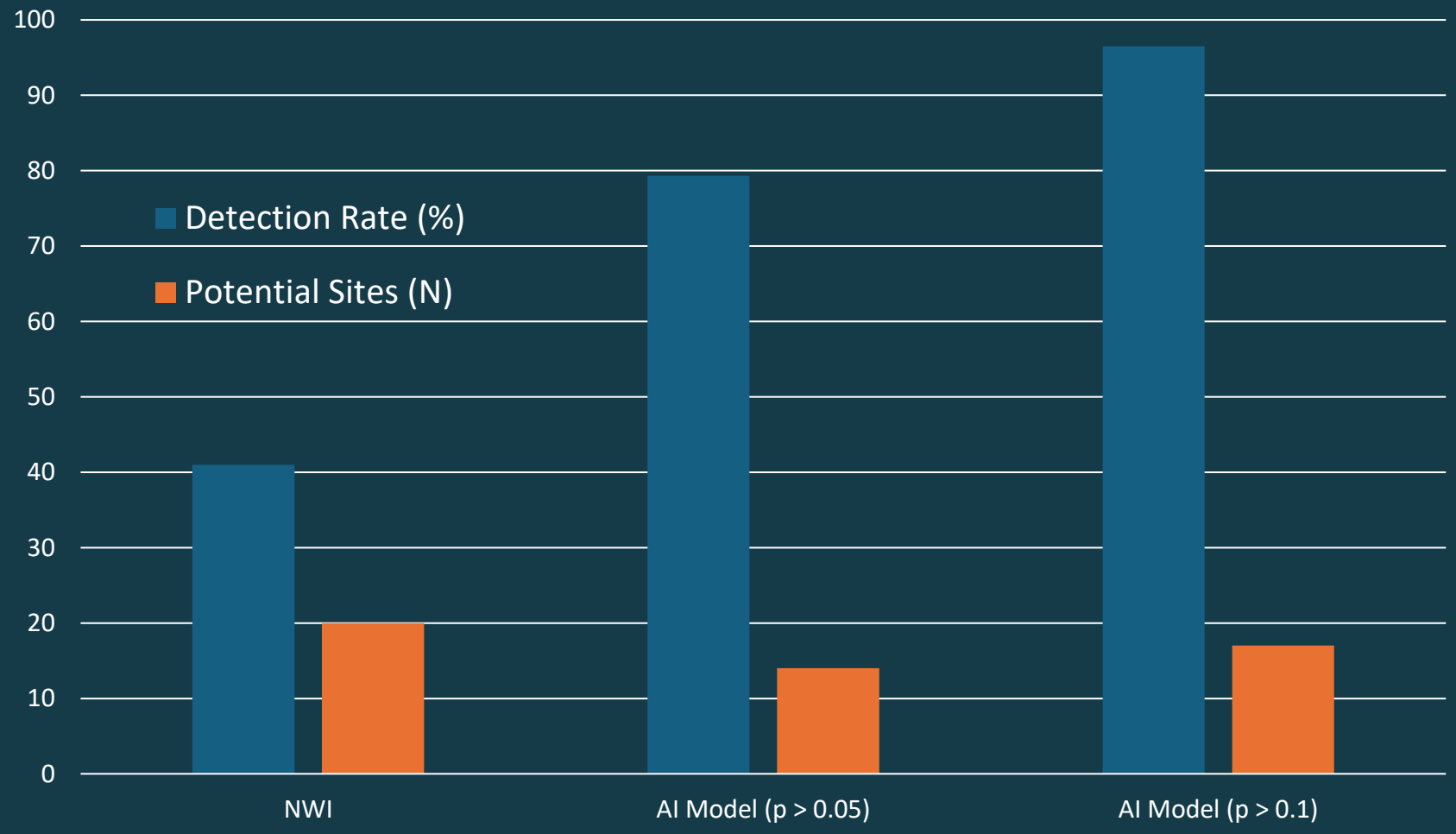
Wetland Probability

Emergent

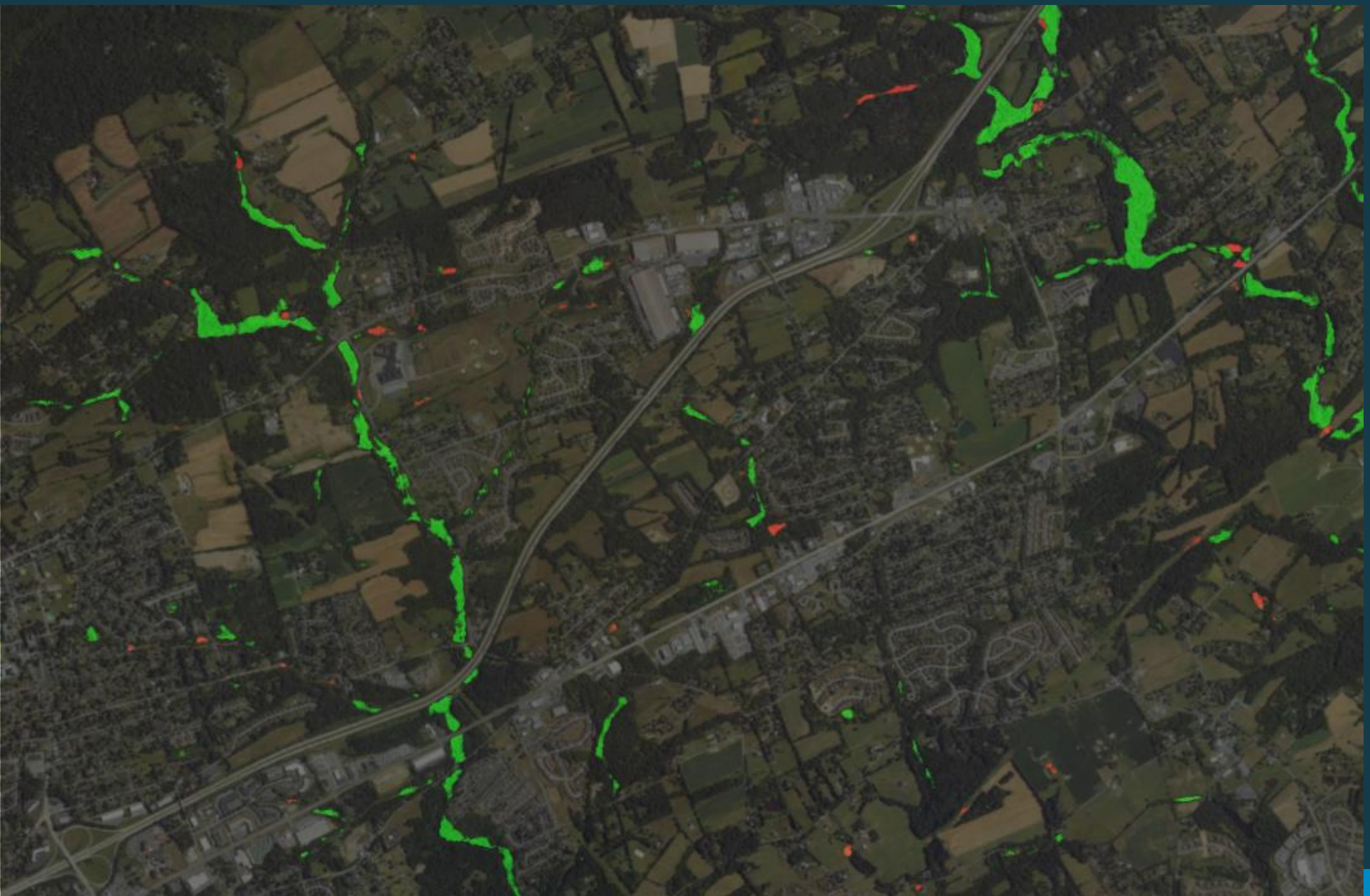
Wooded

0.0 0.5

AI Model & NWI Wetland Detection Accuracy



Precise, Current Wetland Maps



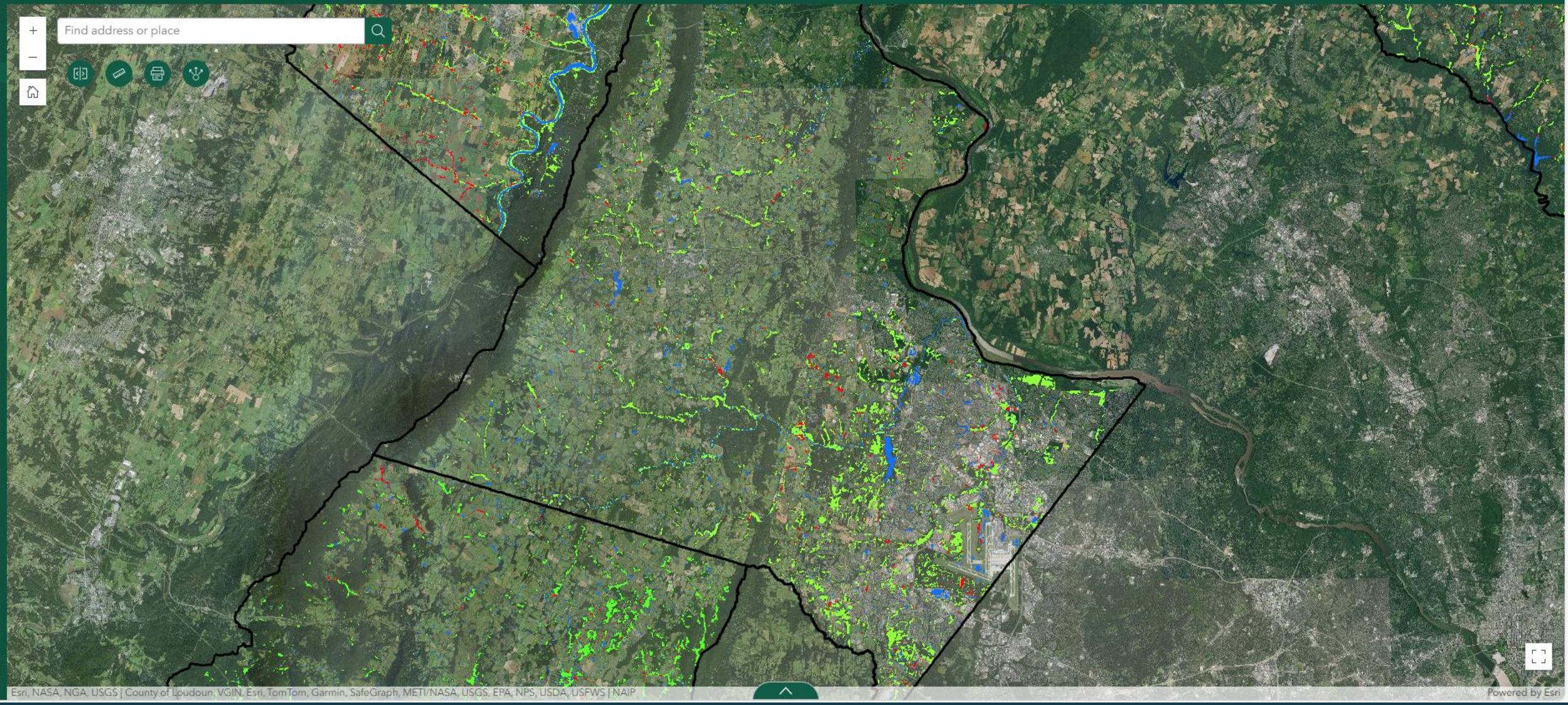
Recall

AI Wetland: 80 - 90%
NWI: 41%

Precision

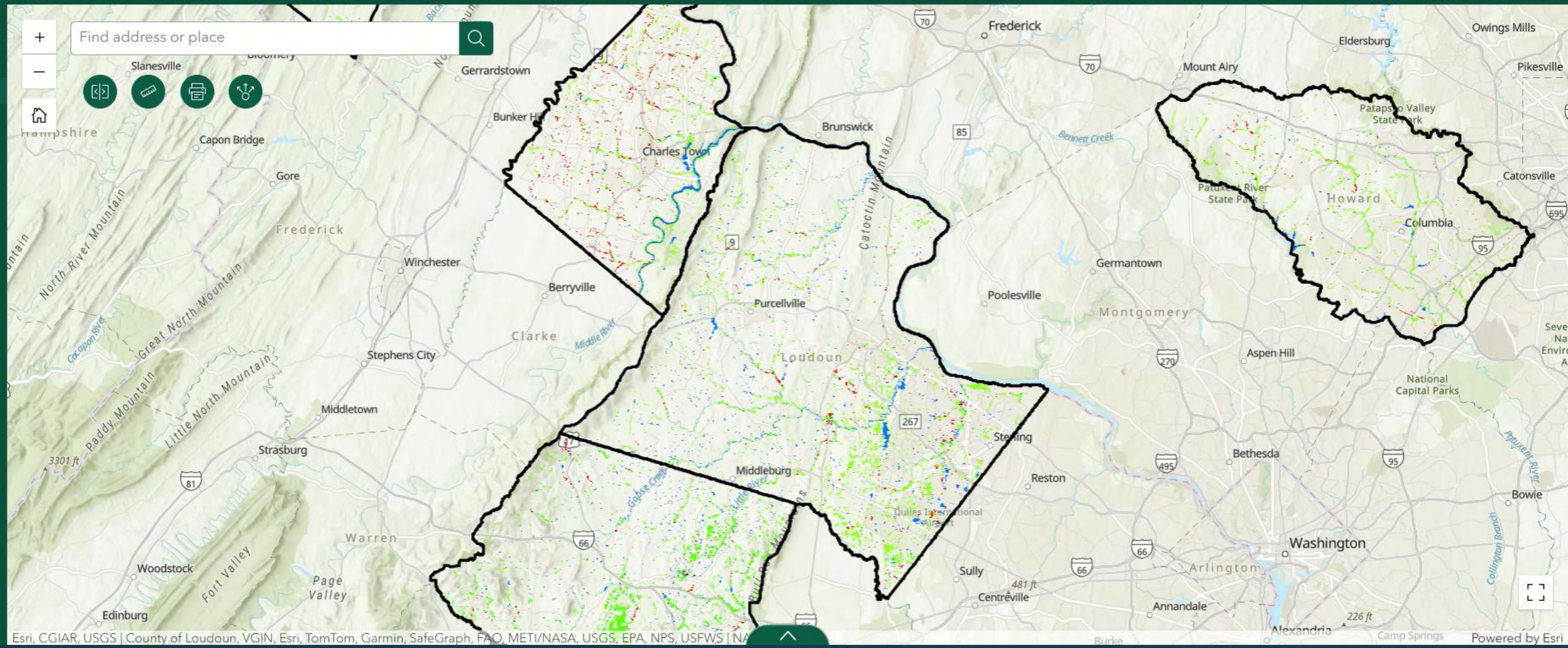
AI Wetland: 93%
NWI: 72%

Chesapeake Conservancy AI Wetlands Web App

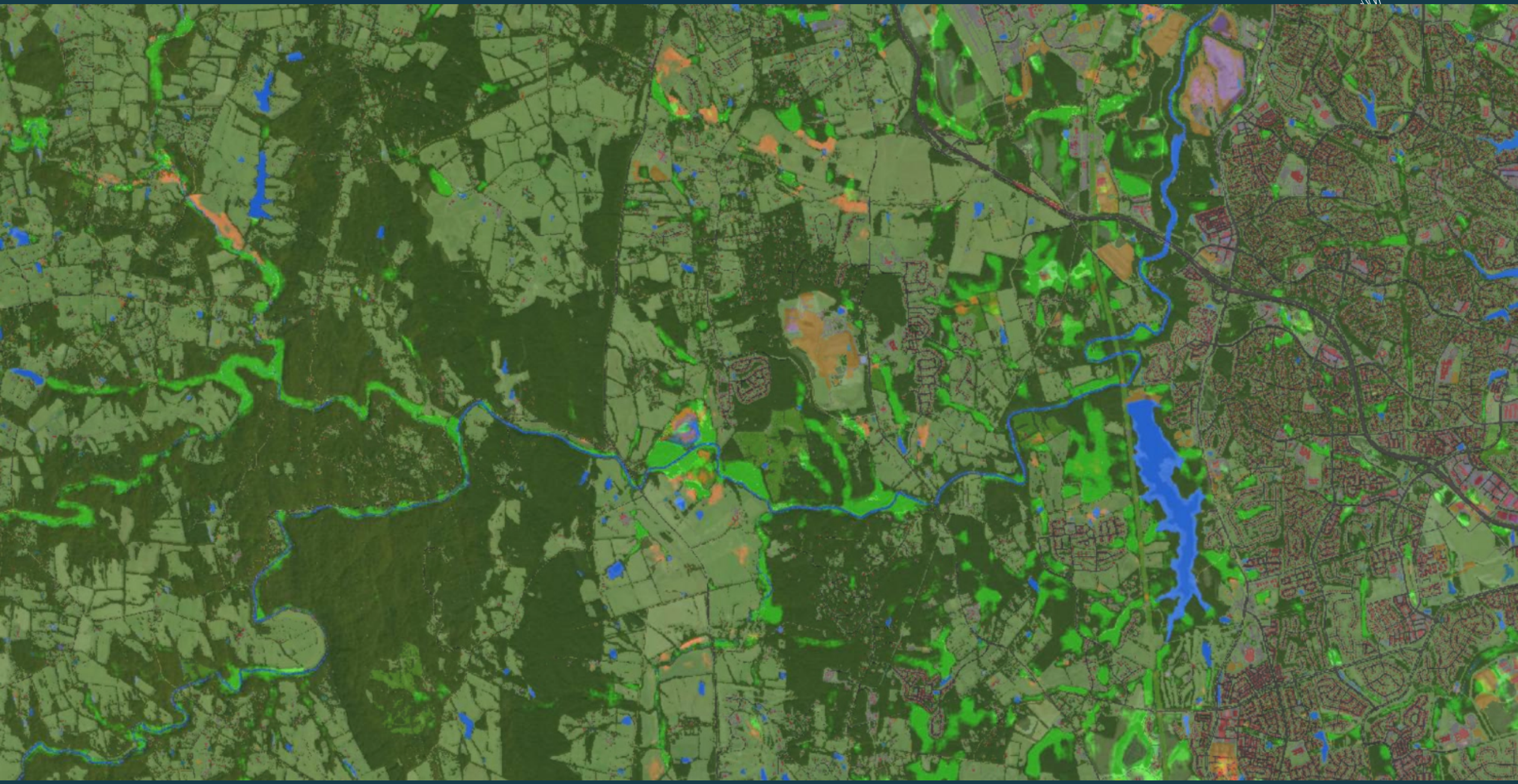


https://experience.arcgis.com/experience/4c220be8365b47d19f3effbdc98f005b

Chesapeake Conservancy AI Wetlands Web App



https://experience.arcgis.com/experience/4c220be8365b47d19f3effbdc98f005b



Restoration Opportunities

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EPRI

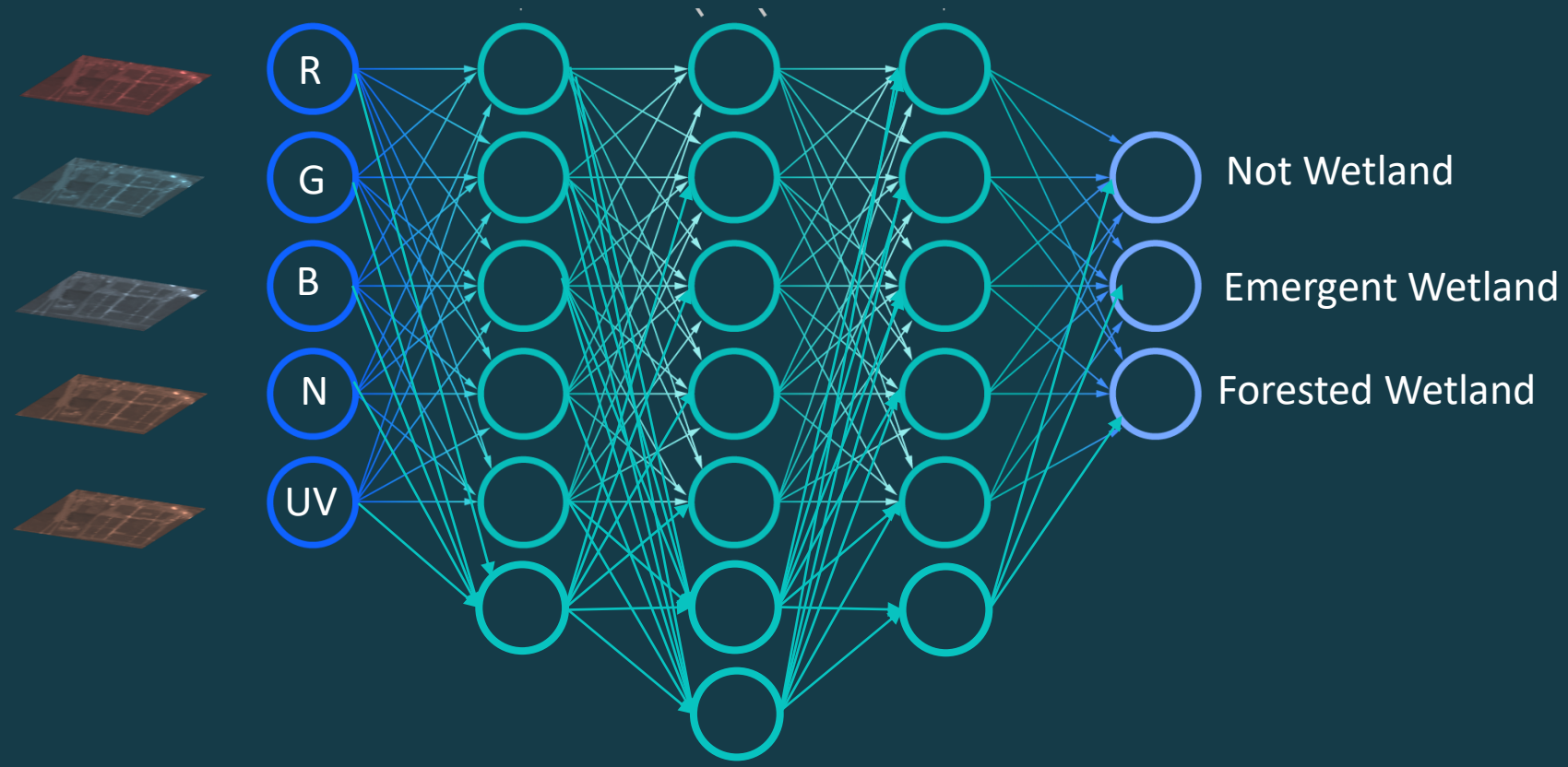
Chesapeake Bay Program
Science. Restoration. Partnership.

Thank You!

Michael Evans, PhD
mevans@chesapeakeconservancy.org

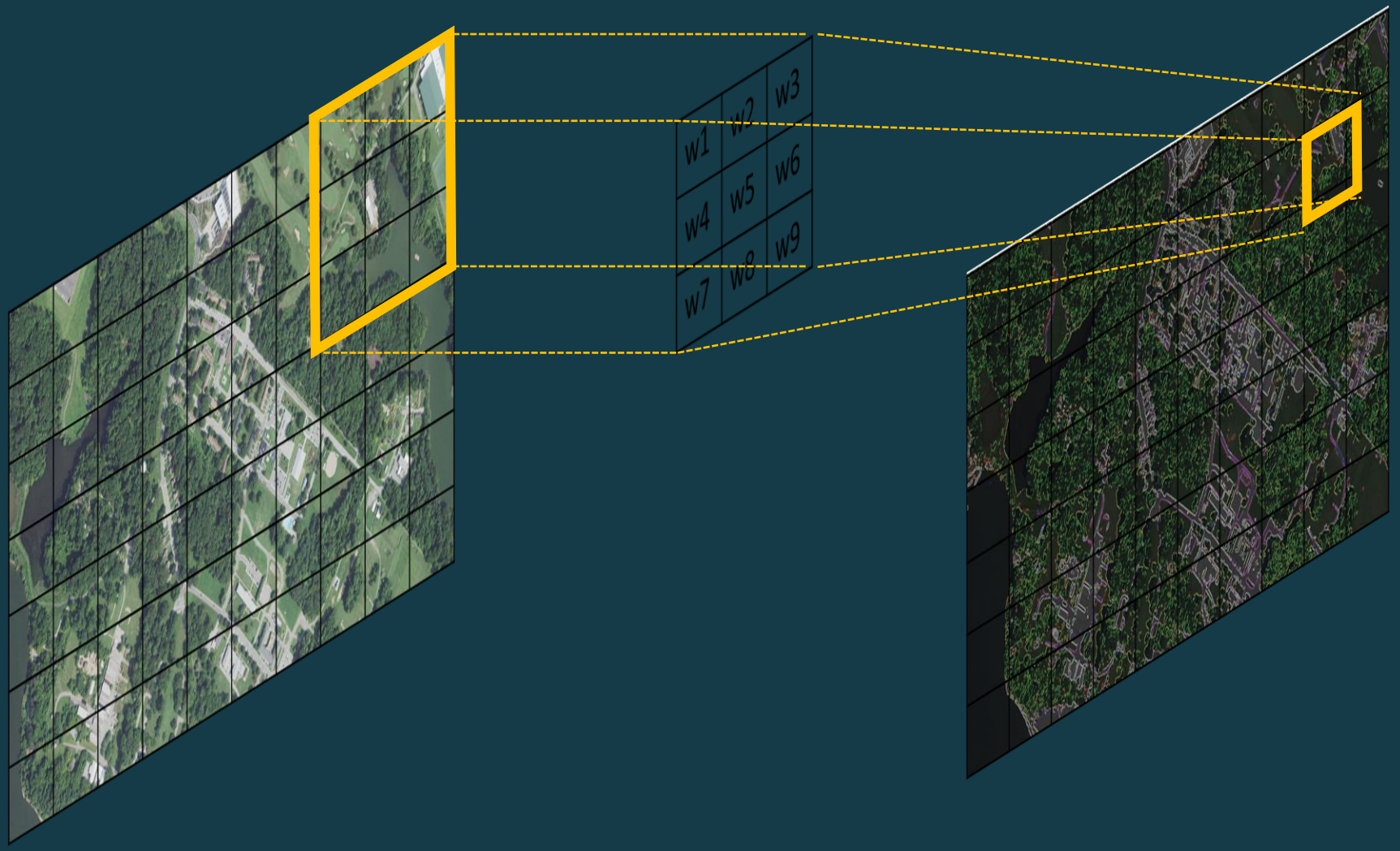
Deep Learning (AI)

Neural network – learn non-linearities, conditionalities, & interactions

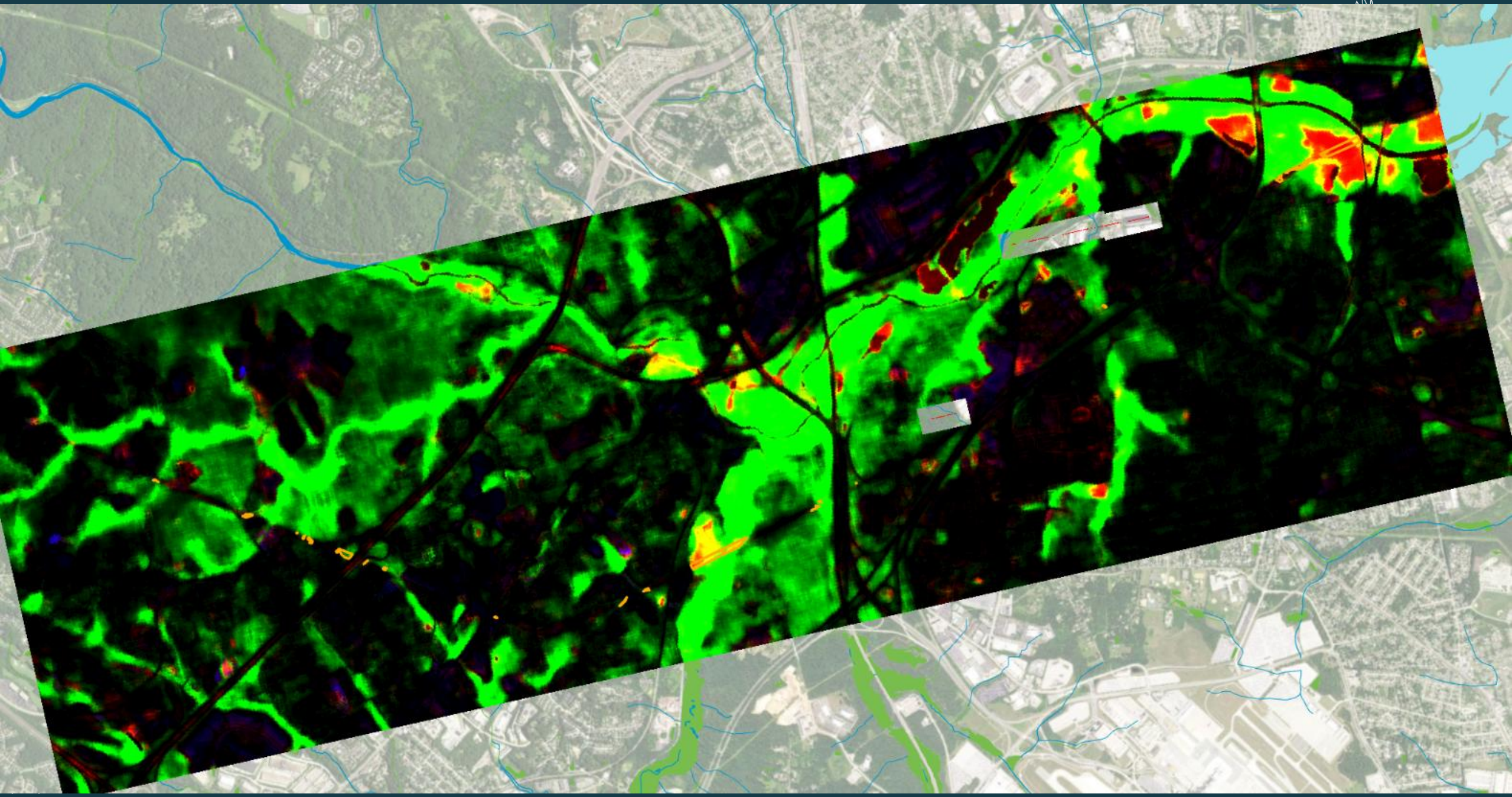


Deep Learning: Convolution

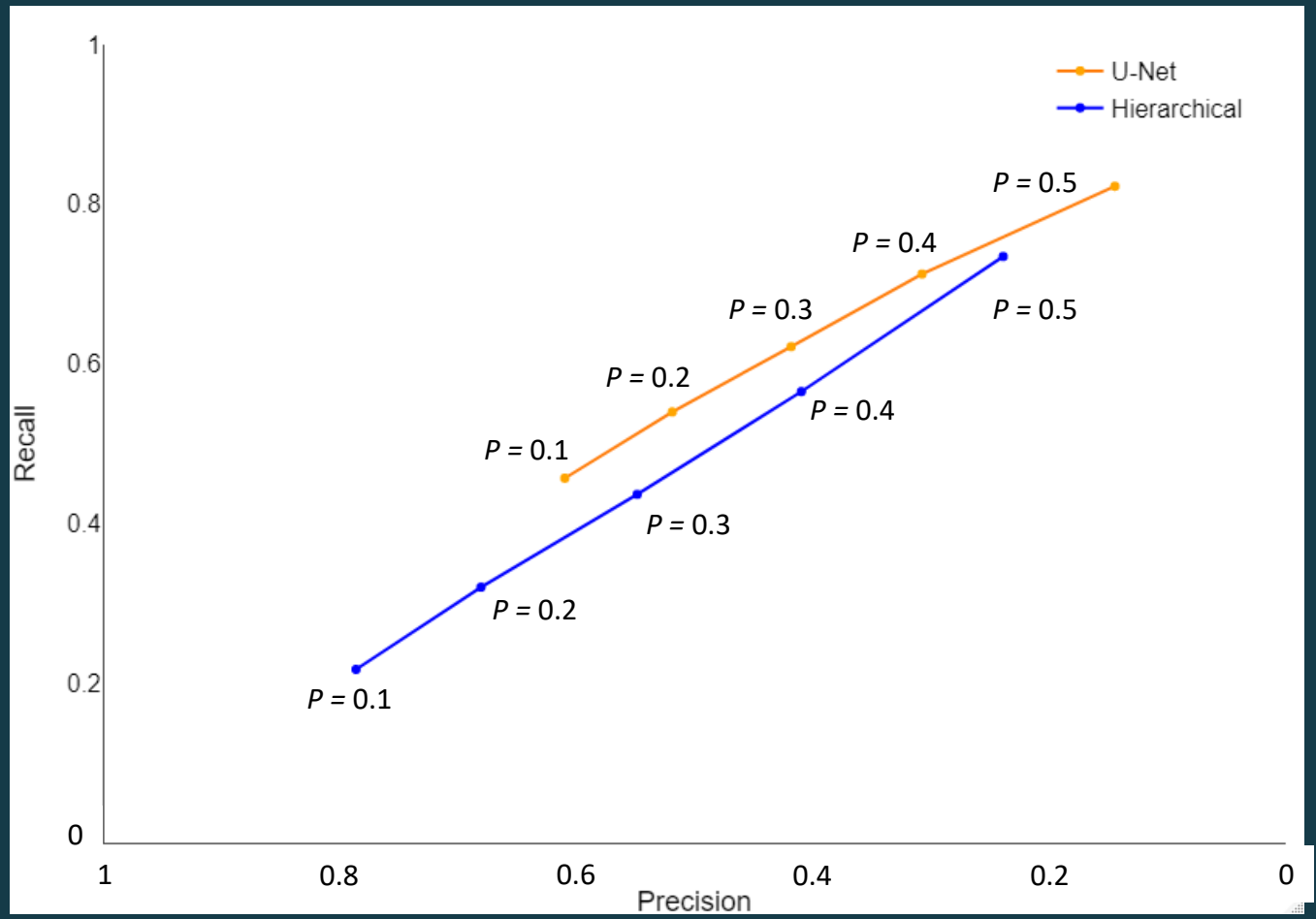
learn the shape and context of objects in images



Greenbury Point, MD. Sep, 2022

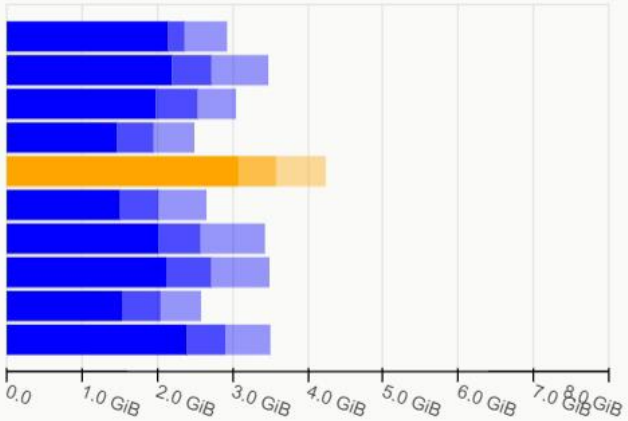


GEOMARVEL


U-Net
Hierarchical
Recall
Precision
1
0.8
0.6
0.4
0.2
0
P = 0.5
P = 0.4
P = 0.3
P = 0.2
P = 0.1
P = 0.5
P = 0.4
P = 0.3
P = 0.2
P = 0.1

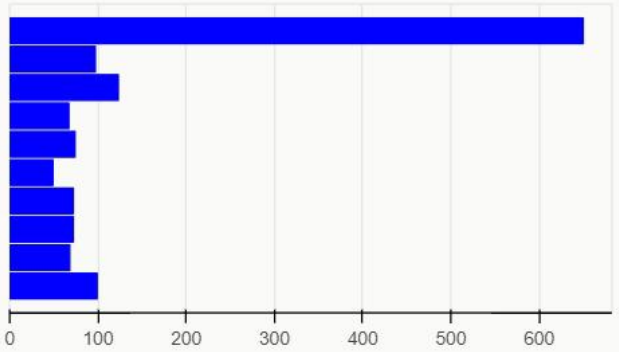
Bytes stored: 31.92 GiB

Bytes stored per worker

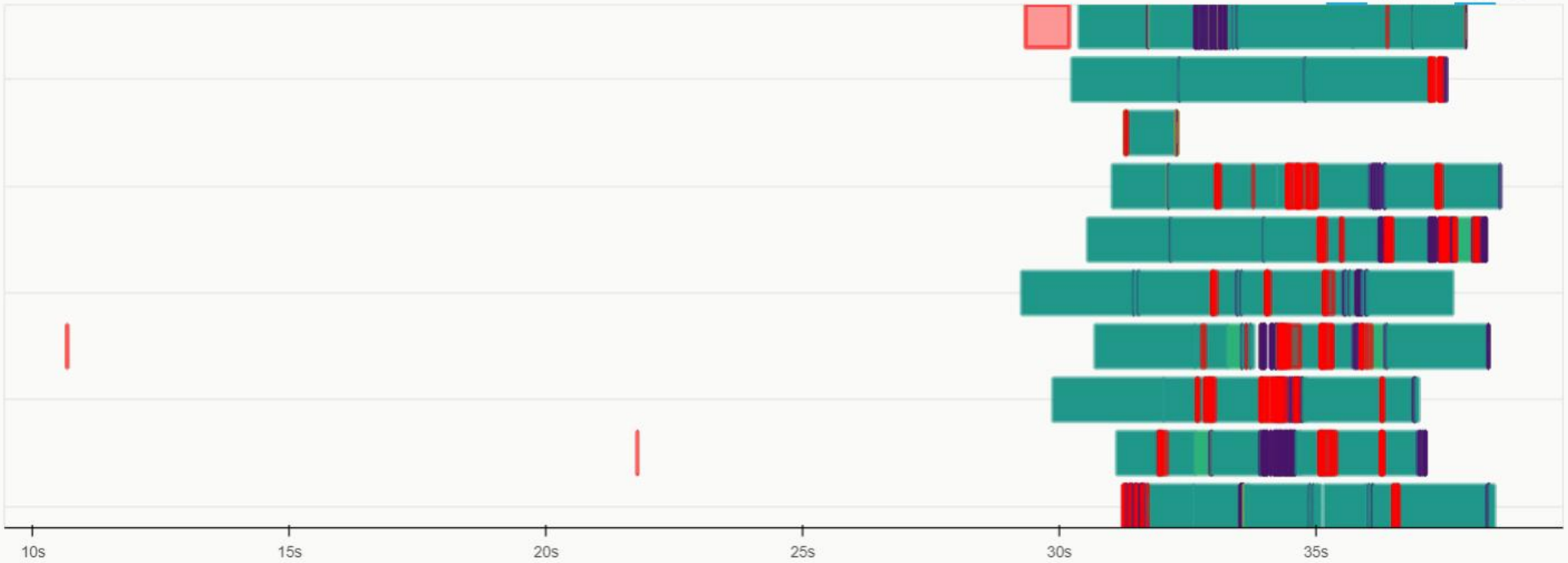


Processing CPU Occupancy

Tasks Processing



Task Stream



Progress -- total: 19324, in-memory: 1122, processing: 1371, waiting: 15266, erred: 0

rechunk-split	1524 / 6254	rechunk-merg...	30 / 624	moment_combi...	8 / 208
getitem	107 / 4606	mean_chunk	29 / 624	mean_combine...	8 / 208
where	324 / 792	concatenate	48 / 428	asset_table	132 / 132
rechunk-merge	130 / 676	_trim	0 / 350	asset-table	132 / 132
truediv-getitem	24 / 624	block-info	32 / 350	add	4 / 104
moment_chunk	30 / 624	predict_chunk	0 / 350	rechunk-spli...	30 / 104
where-getitem	30 / 624	getitem-overlap	0 / 350	mean_agg-agg...	4 / 104
nanmedian	30 / 624	rechunk-merg...	4 / 259	rechunk-merg...	2 / 91

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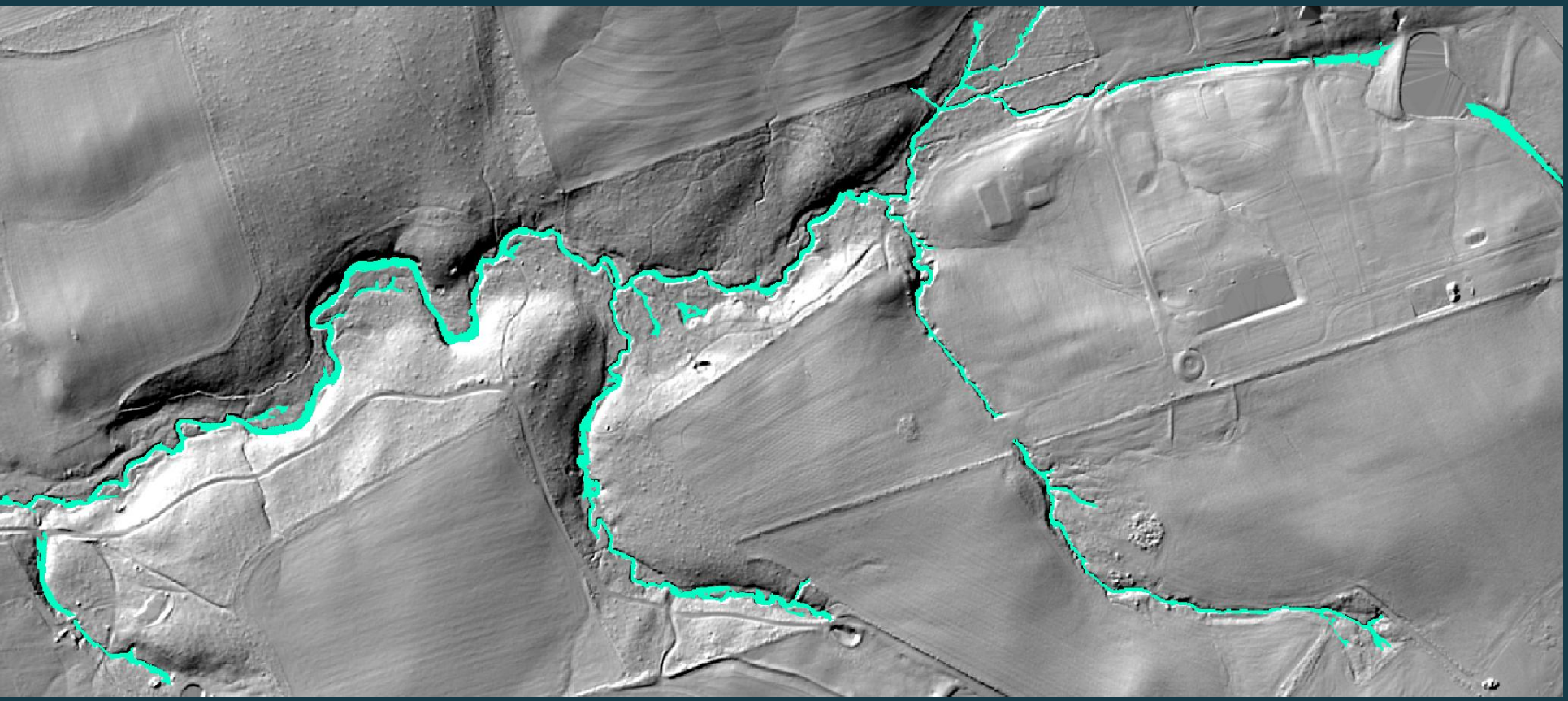
Remote Sensing Data

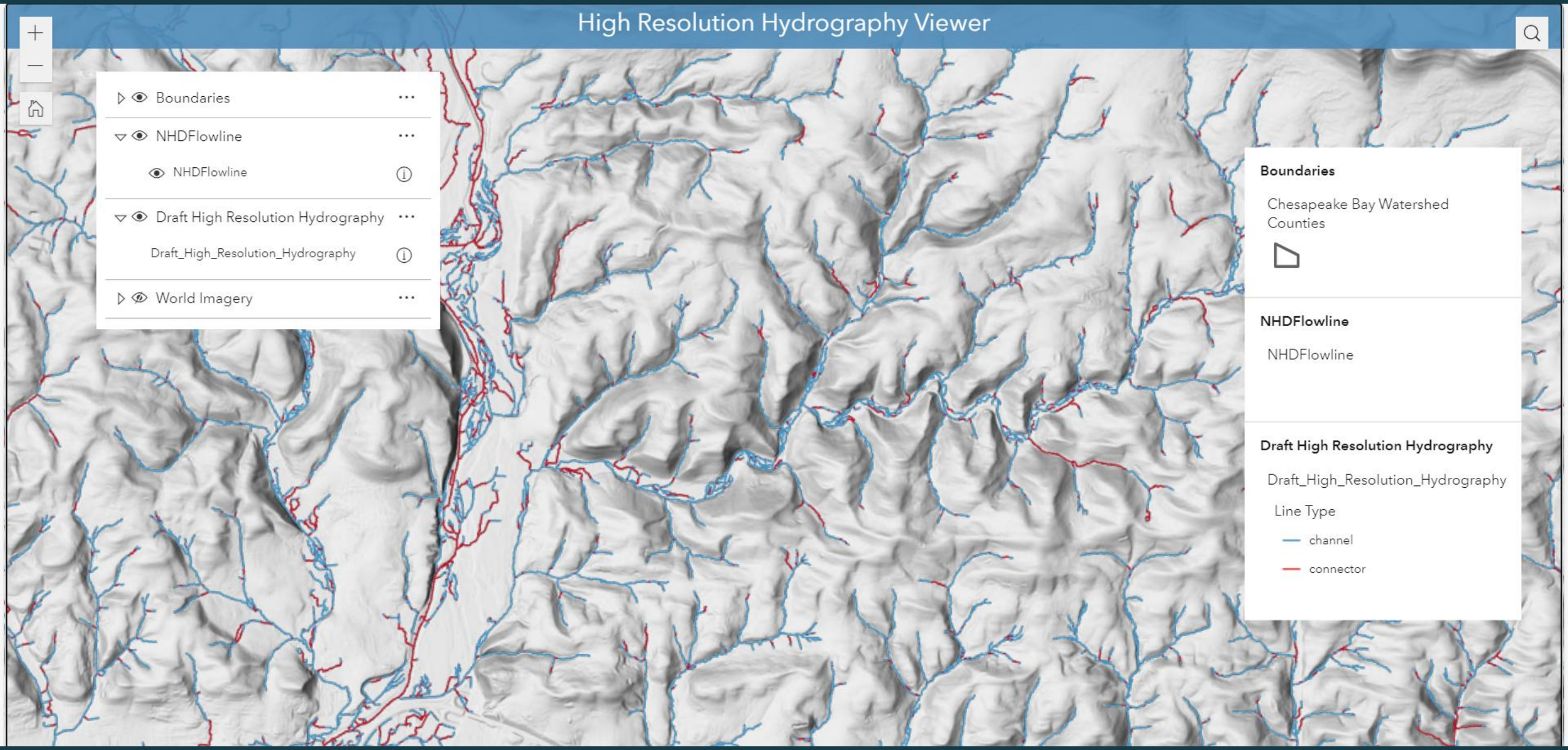
1. Data about Earth's surface
2. Collected by satellite or plane
3. Can have multiple 'bands'
4. Many types of data (radar, lidar, etc.)

Hyper-resolution hydrography

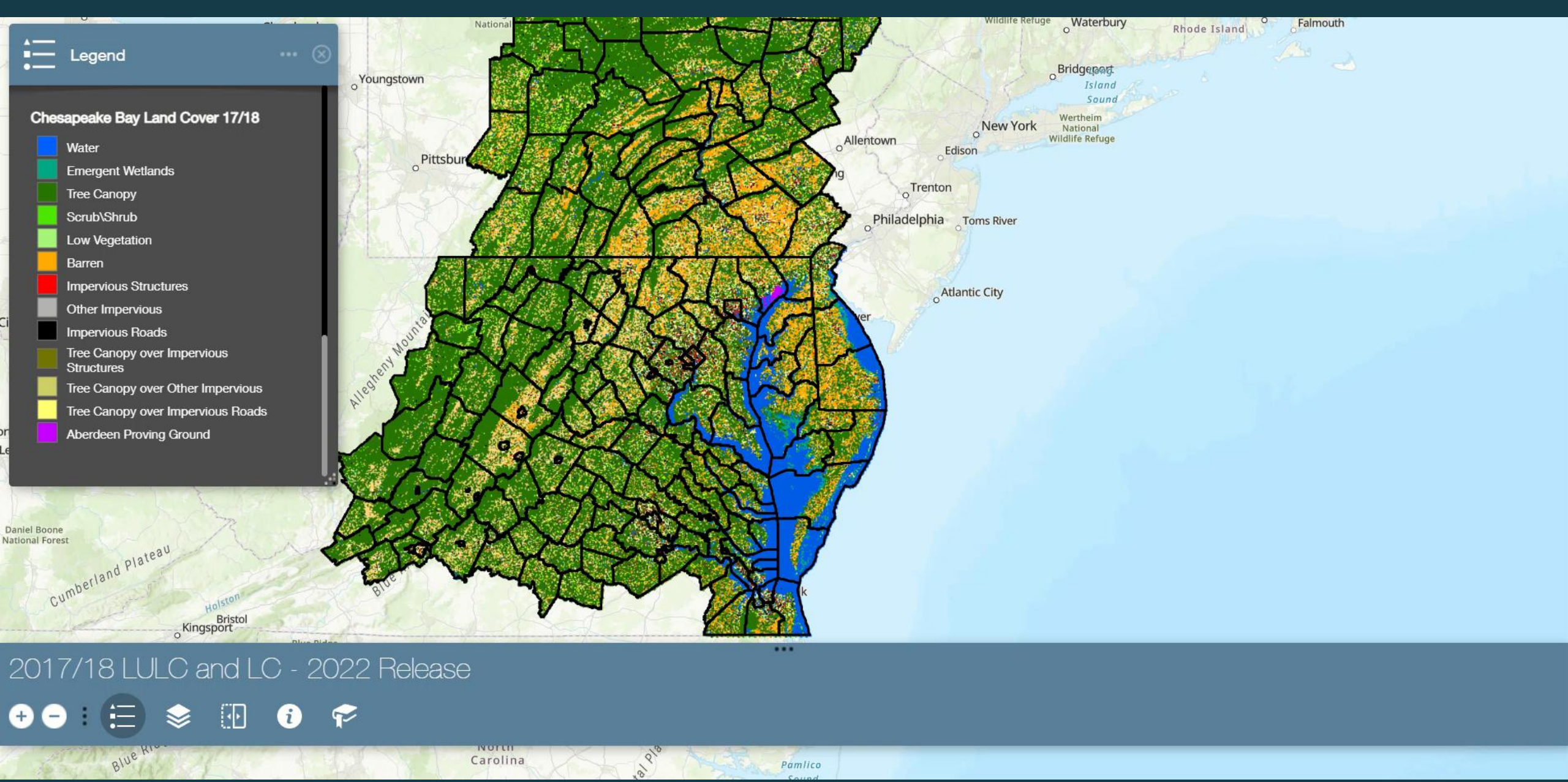


Partnership between CC, UMBC, and EPA's Chesapeake Bay Program

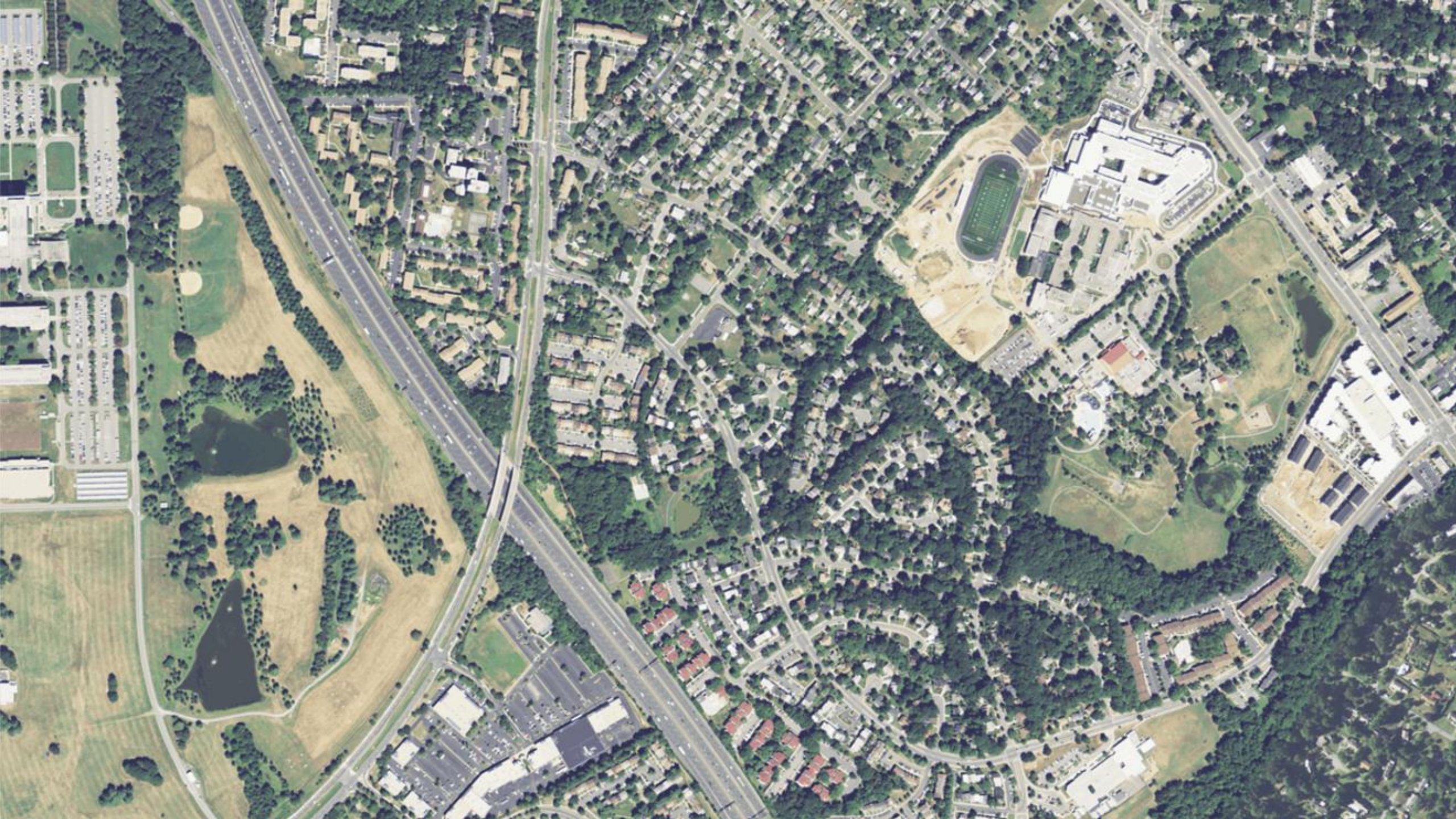
Maps headwaters and lateral positioning of stream channels more precisely than NHD



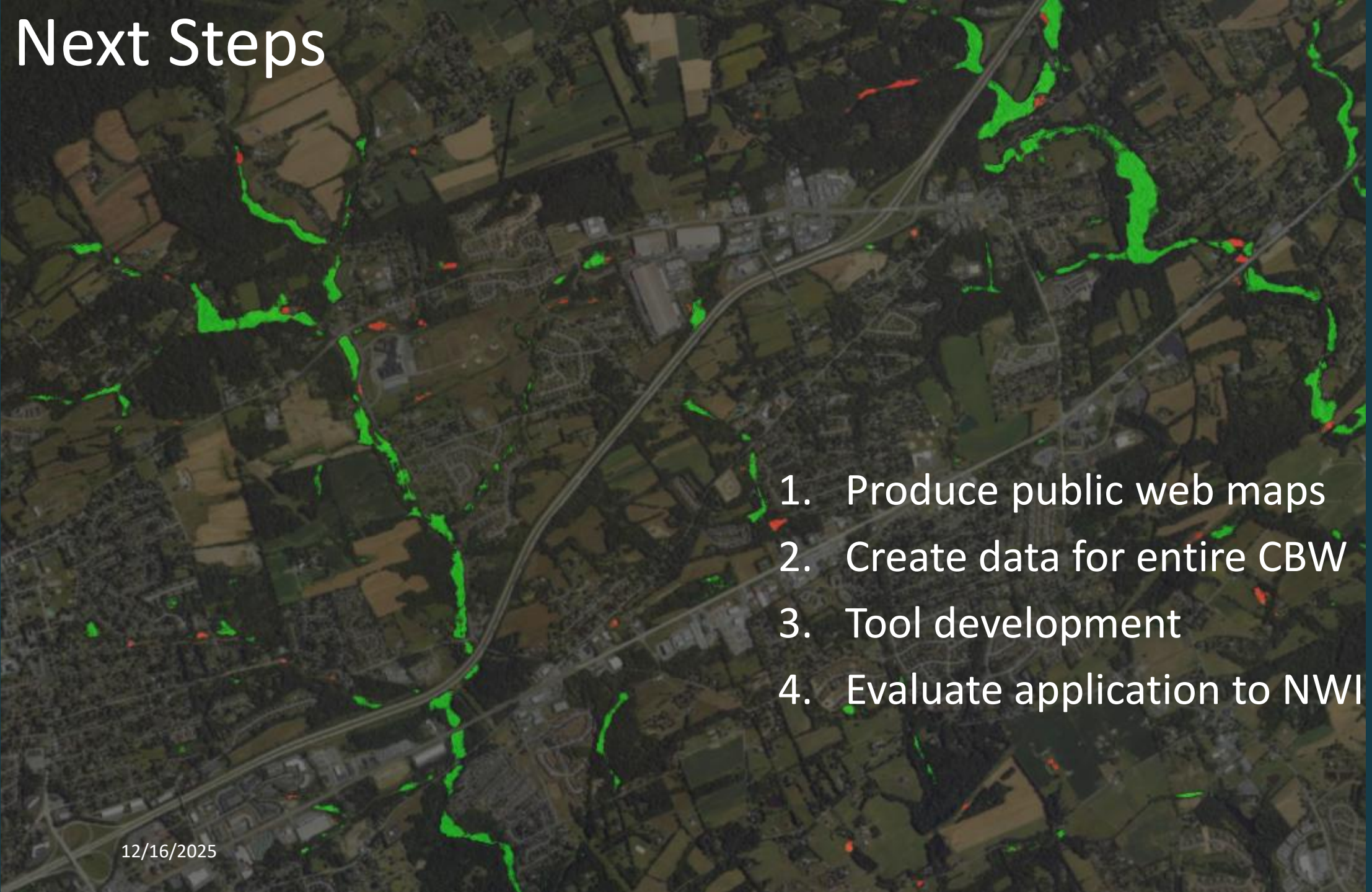
https://cicgis.org/portal/apps/experiencebuilder/experience/?id=8b64a2aa6a8544b88e3dd599ca132210



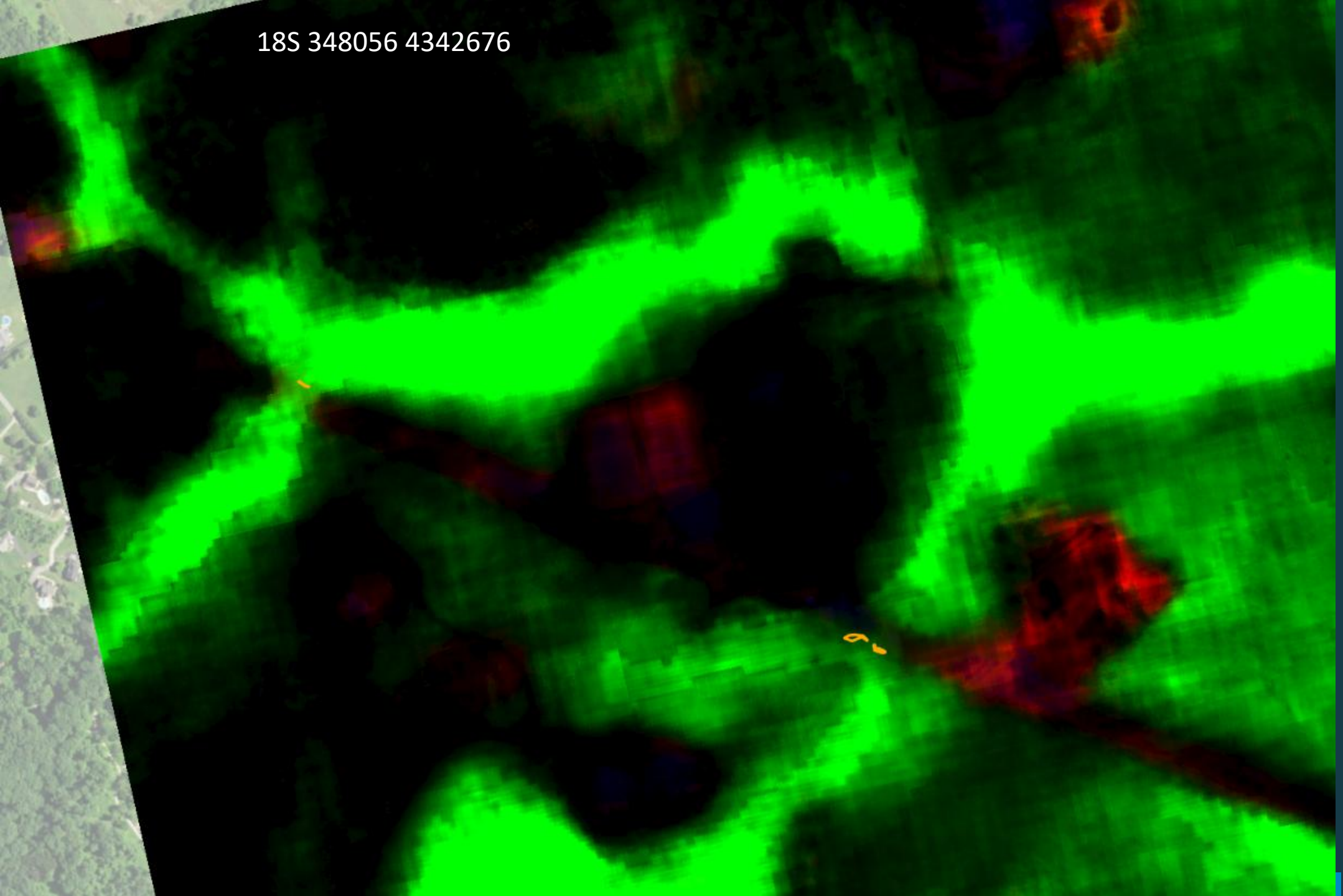
https://cicgis.org/portal/apps/webappviewer/index.html?id=bdf7ca3e249a40fd9a9d83d6e16100ea



Next Steps



1. Produce public web maps
2. Create data for entire CBW
3. Tool development
4. Evaluate application to NWI



NWI

Wetland

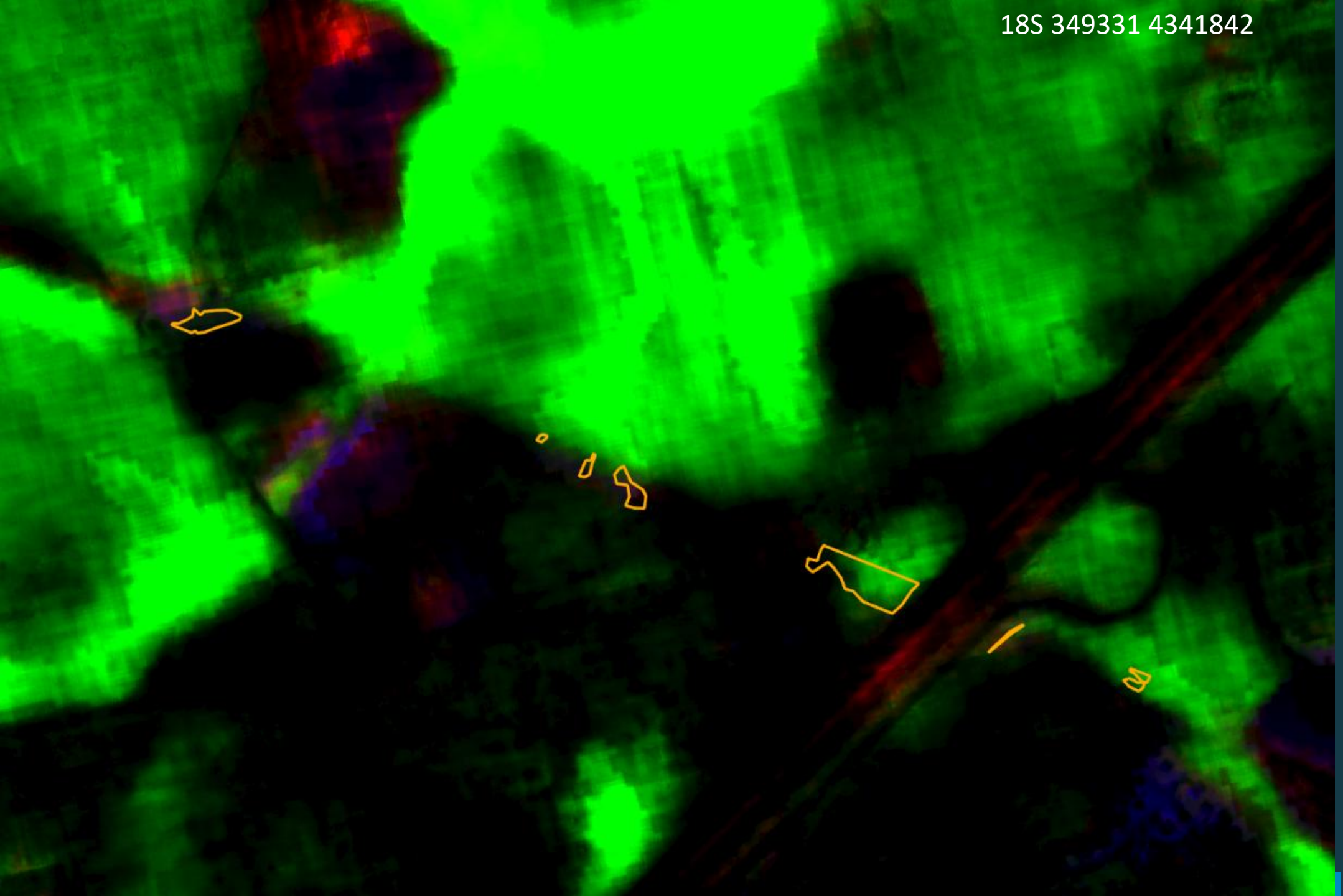
Water

AI Wetland Probability

Emergent

Wooded

Farmed



Wetland

Water

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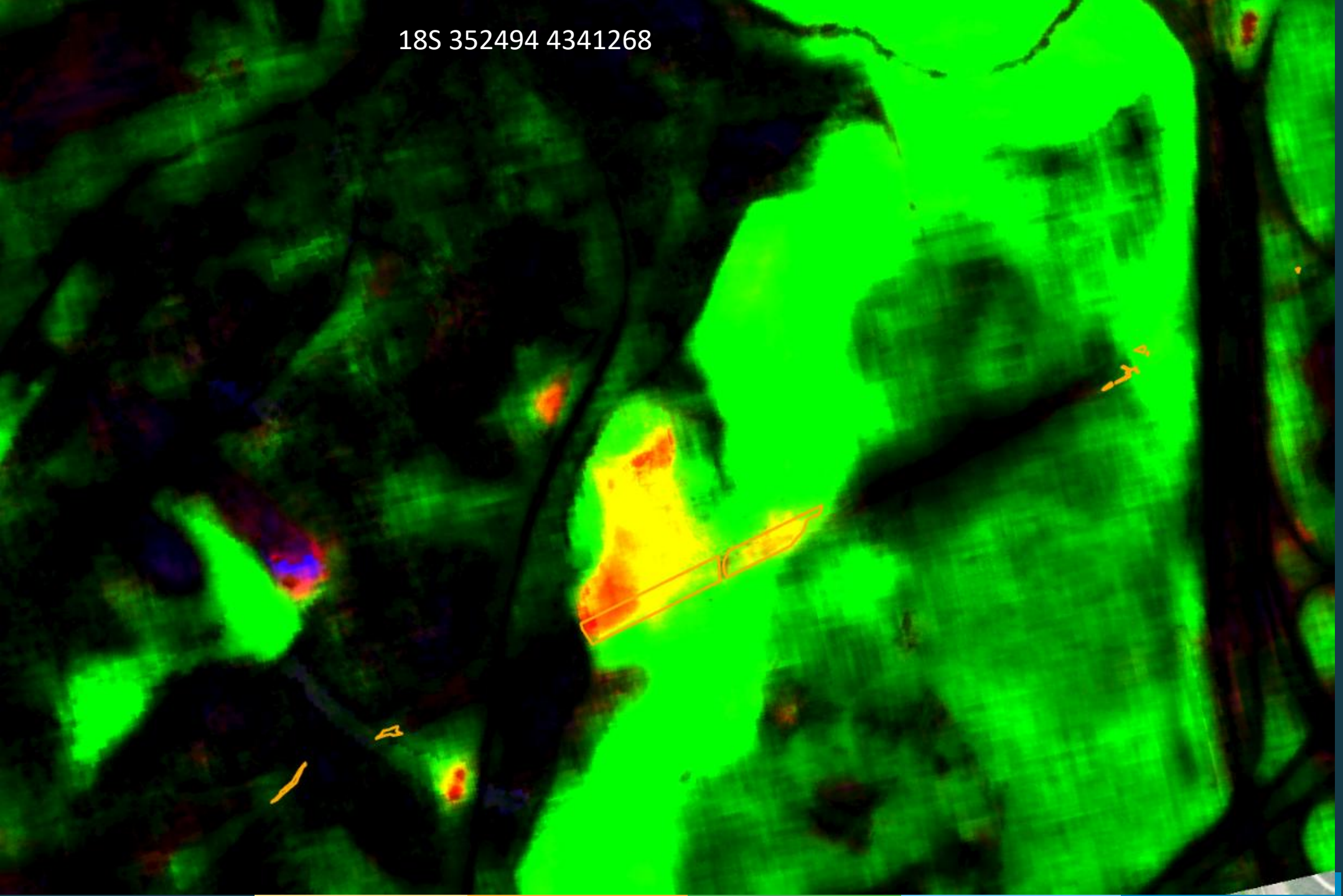

Wetland

Water

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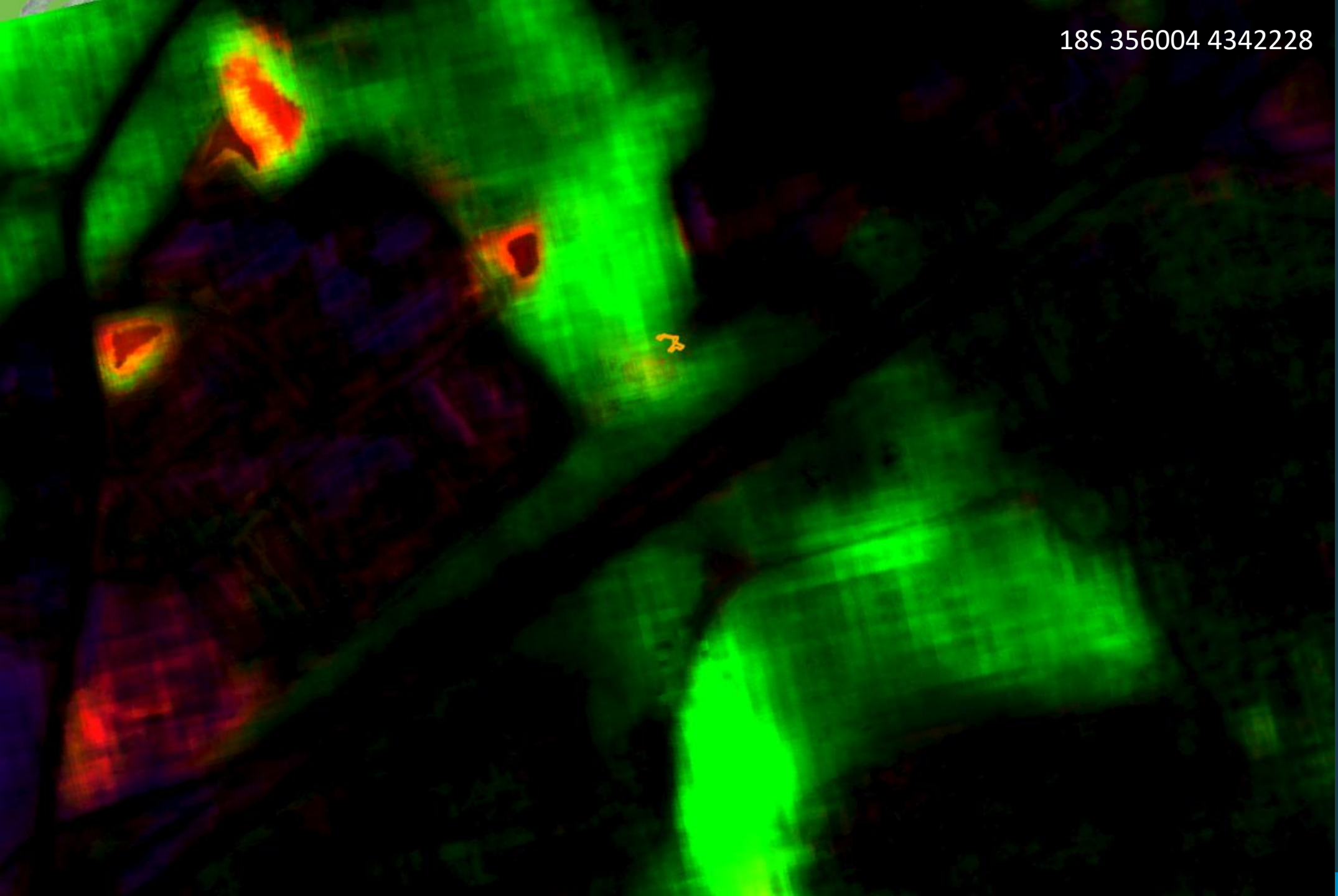
Emergent

Wooded

Farmed



Wetland

Water

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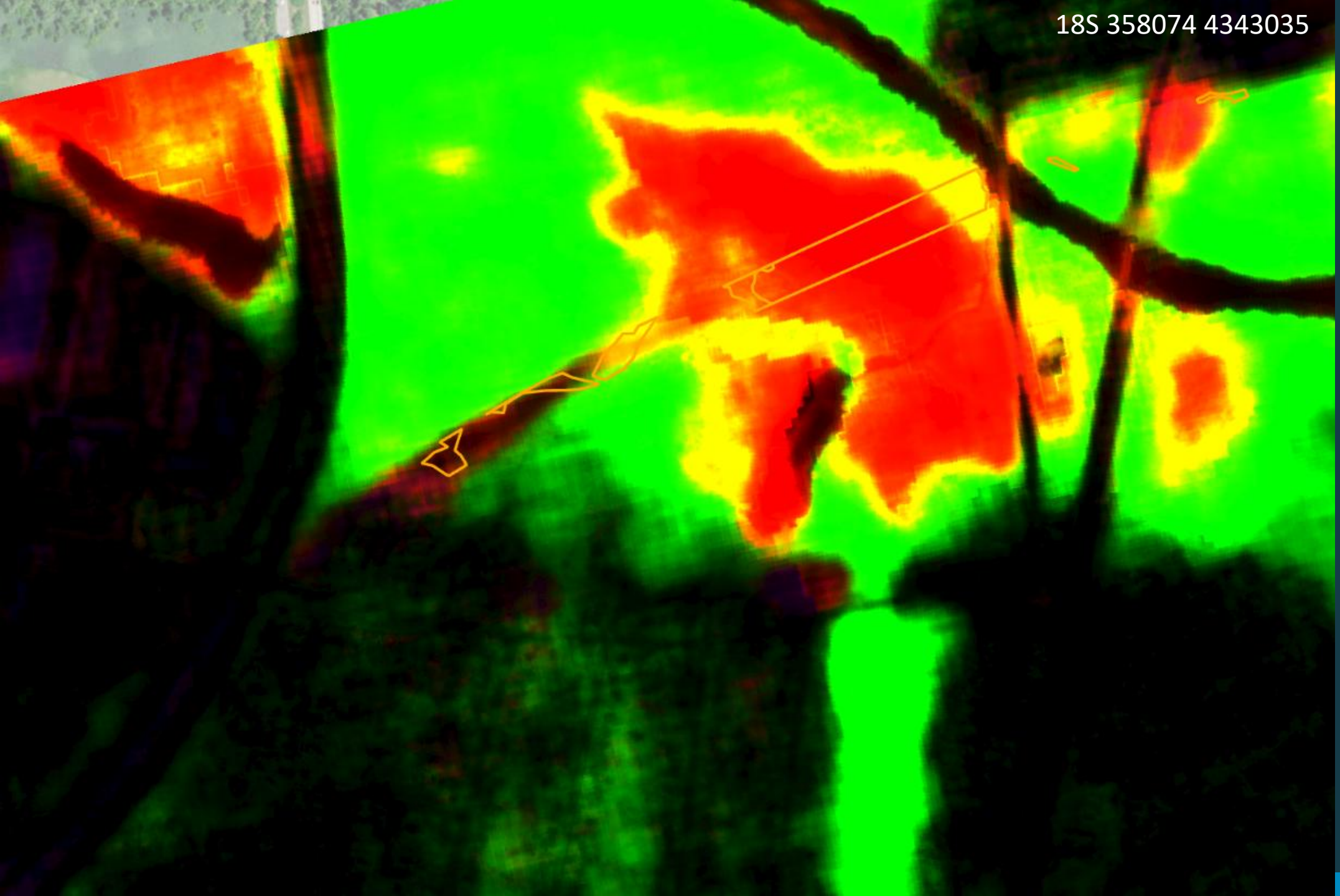


Wetland

Water

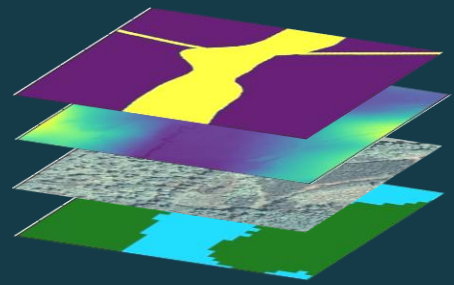
AI Wetland Probability

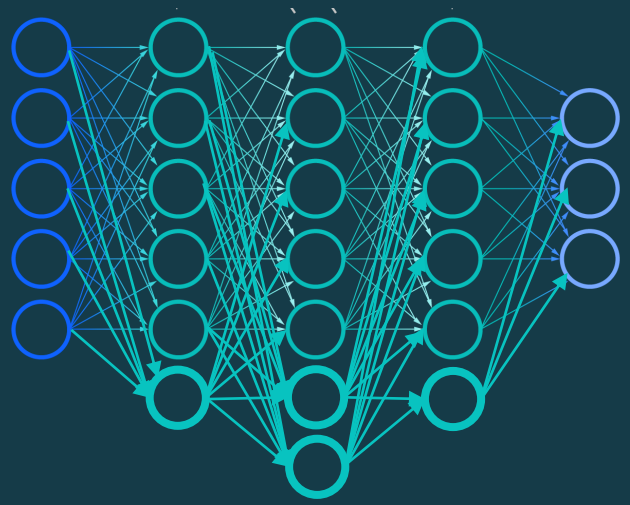
Emergent

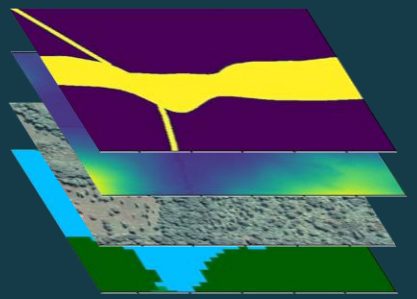
Wooded

Farmed

Model Training: Active Learning







Not Wetland = **0.83**

Emergent Wetland = **0.12**

Forested Wetland = **0.05**

Not Wetland = **0.33**

Emergent Wetland = **0.41**

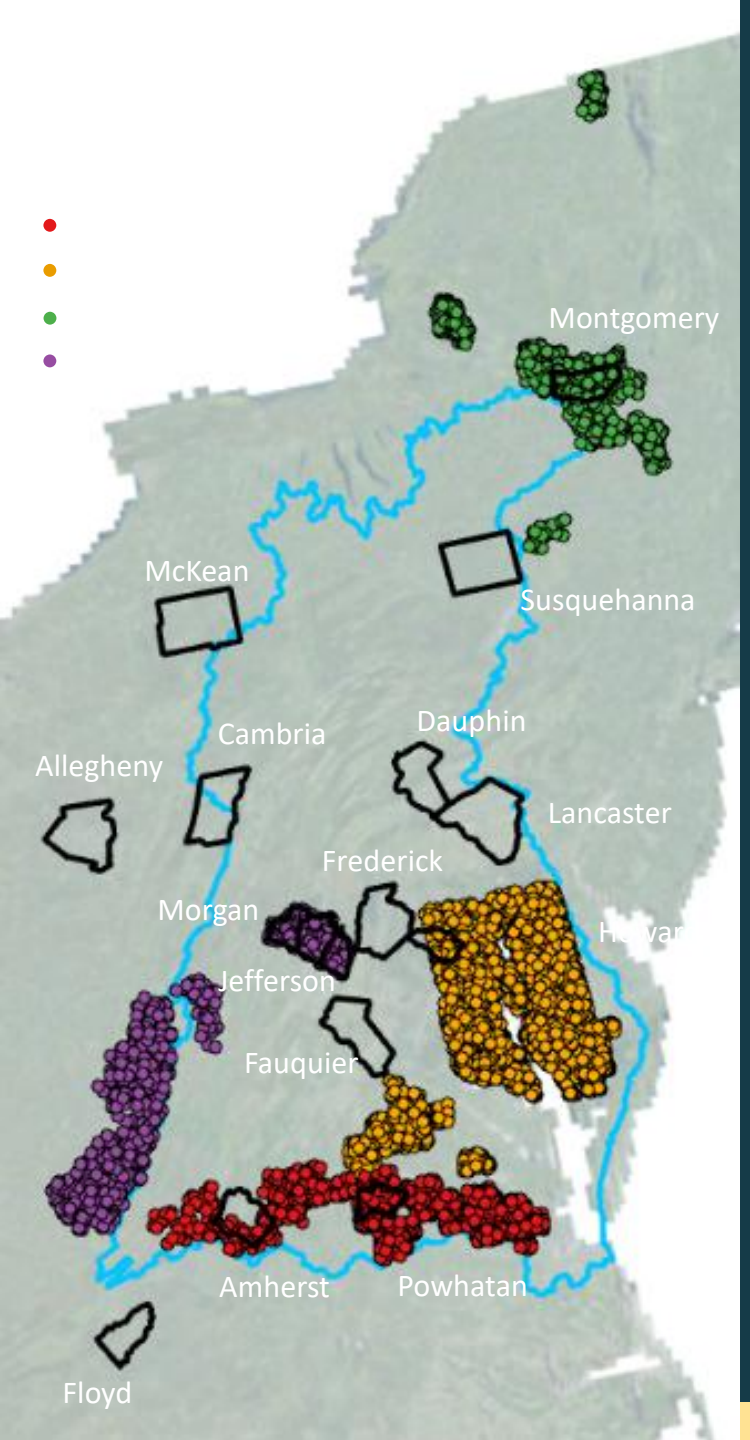
Forested Wetland = **0.26**

Model Outputs

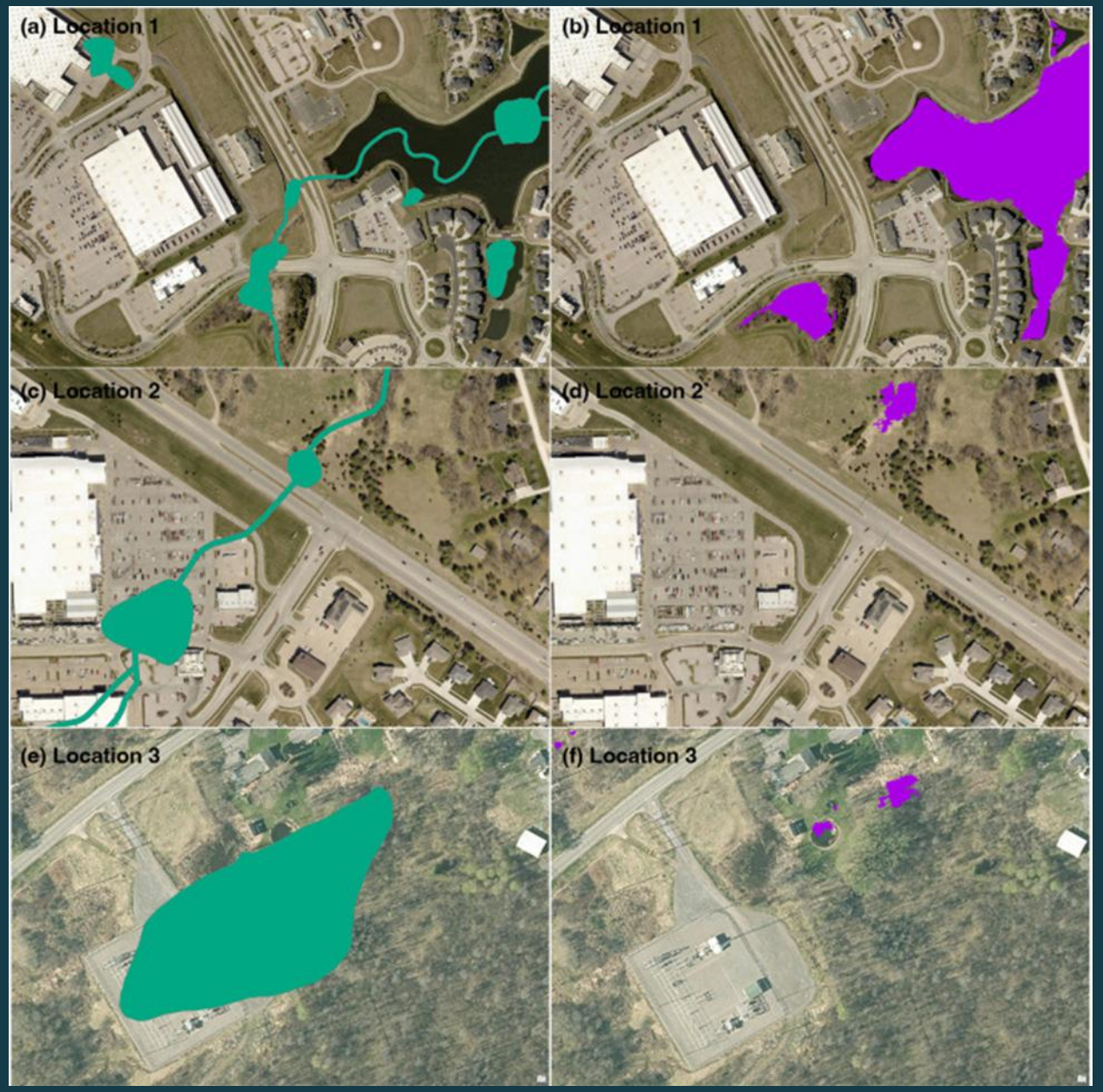
NWI label

Basic model prediction

Full model prediction


Montgomery
McKean
Susquehanna
Cambria
Dauphin
Allegheny
Lancaster
Frederick
Morgan
Jefferson
Fauquier
Amherst
Powhatan
Floyd

Model Outputs



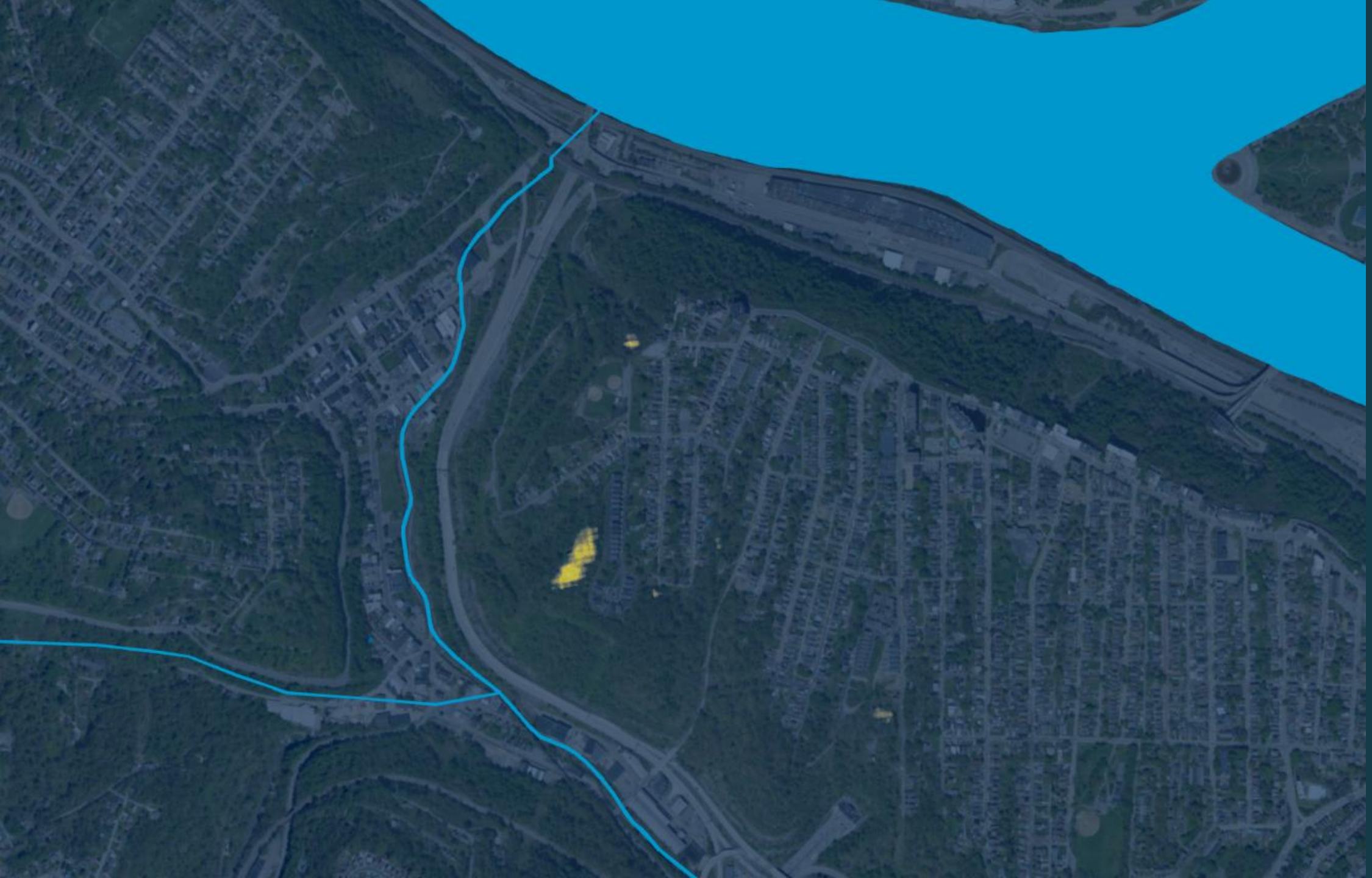
NWI label

Full model prediction

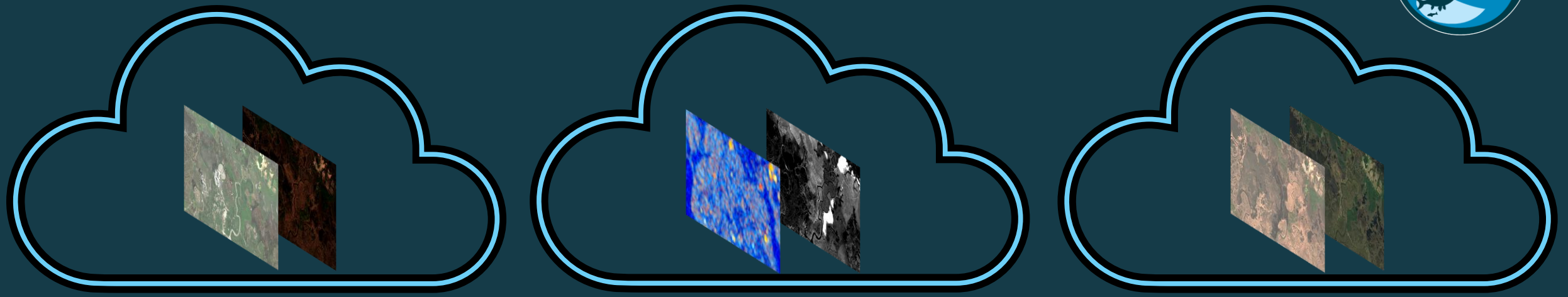
Model Outputs

NWI label

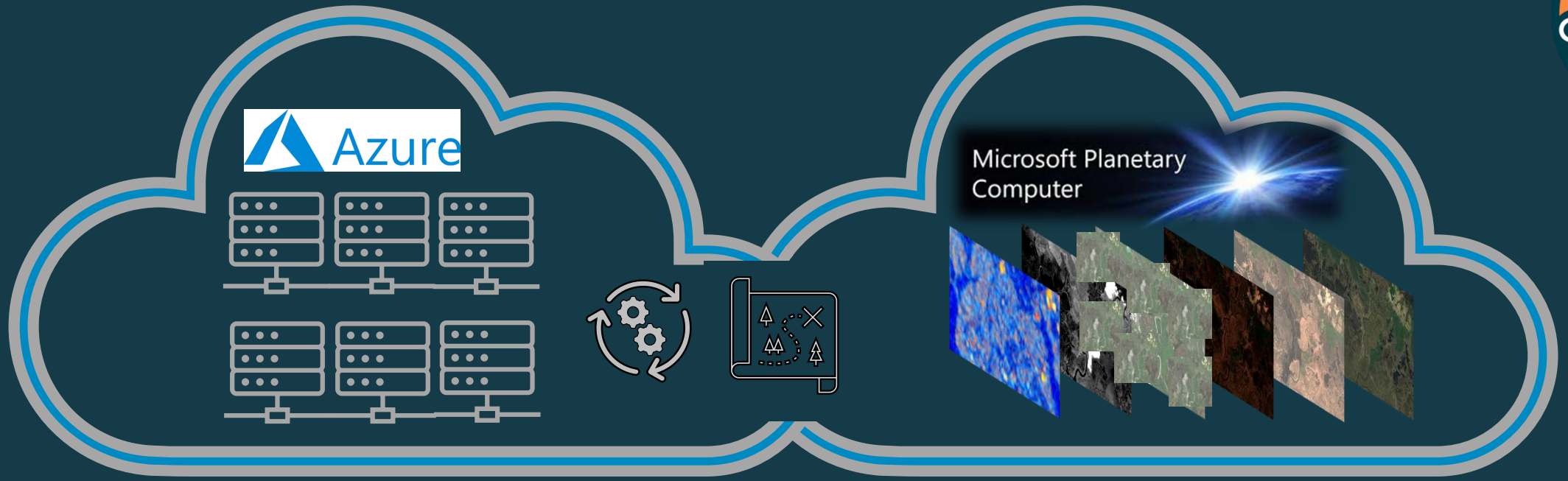
Full model prediction



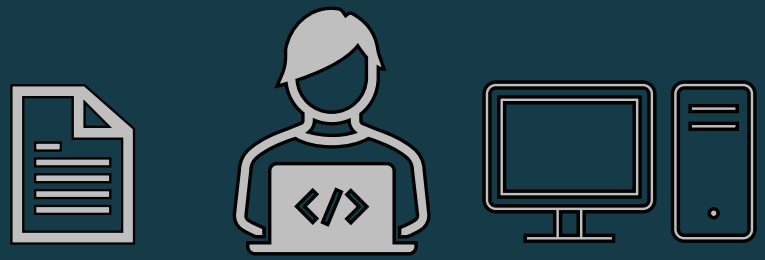
Cloud Computing



Cloud Computing



GEOMARVEL



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Model Training: Image Augmentation

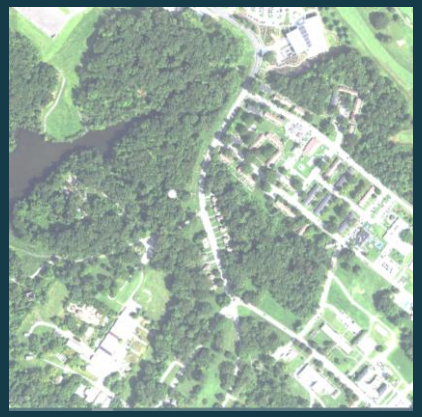
Original

Rotate 90°

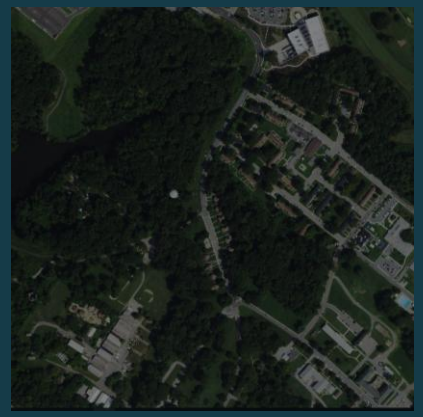
Rotate 180°

Rotate 270°

Brightness -5%
Contrast -5%



Brightness +5%
Contrast -5%



Brightness -5%
Contrast +5%

Brightness +5%
Contrast +5%