Flight Planning Challenge

Spring Semester 2021

Contact: Tony.Grichnik@BlueRoofLabs.com

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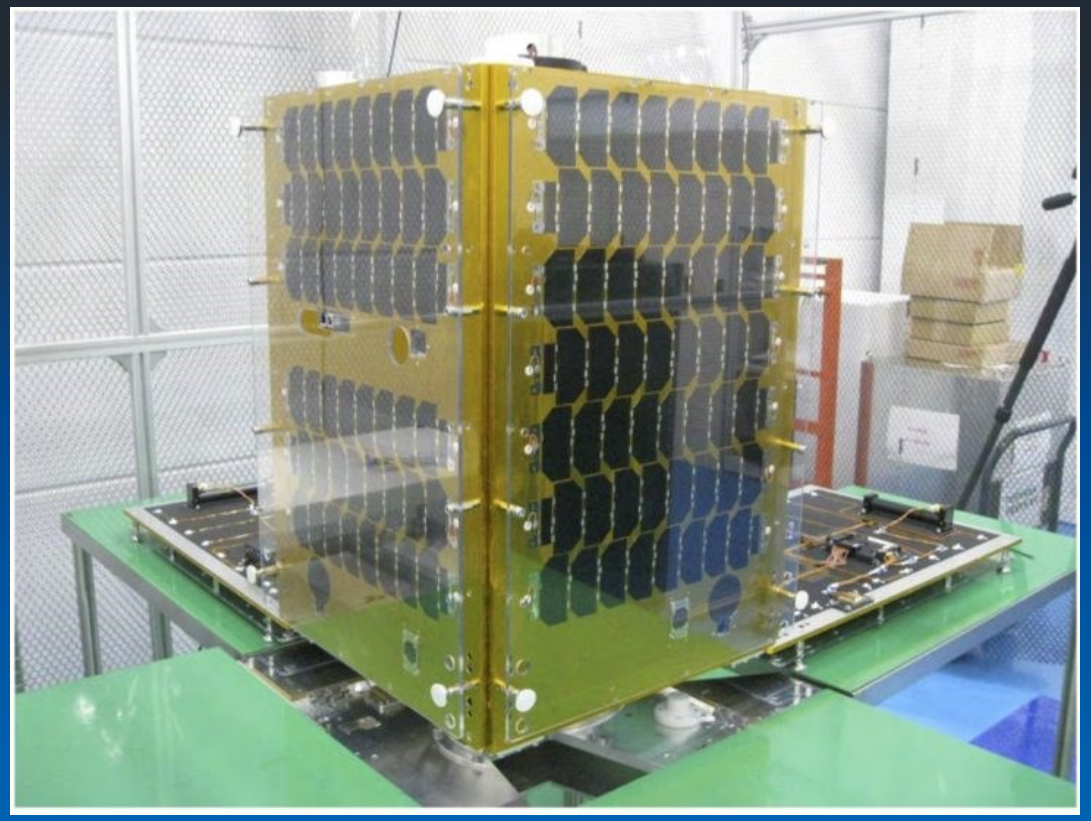
So, satellites?



- GREAT for large areas, but not great for higher resolution imaging of smaller areas
- Often not available on the desired schedule (e.g. users need the images when they NEED them, maybe not when the satellite is overhead)
- Retasking a satellite uses up precious on-board fuel, so they don't often change paths
- Can be a VERY expensive way to get an image (although it's getting cheaper over time)

Canon CE-1 "cubesat" for space photography via a website
Source: https://www.canonwatch.com/canons-satellite-ce-sat-1-is-in-orbit-building-a-high-resolution-earth-imaging-system-using-eos-5d-mark-iii/
See Also: https://www.diyphotography.net/canon-lets-you-shoot-photos-from-space-with-its-new-ce-sat-1-microsatellite-emulator/

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So, quadcopters?

- OK for short range cargo delivery and picture taking (e.g. everybody can!)
- While they are fast in short bursts, they are pretty slow vs. area covered when you include recharge or battery swap times
- Low battery conditions end ungracefully (read: it becomes an expensive rock)
- Loud, LOUD, ***LOUD!!!***

BRL Short-range EDF-powered quadcopter solution with 2 emergency blood delivery modules (2 x 500mL of blood delivered in sealed, temperature-controlled modules)

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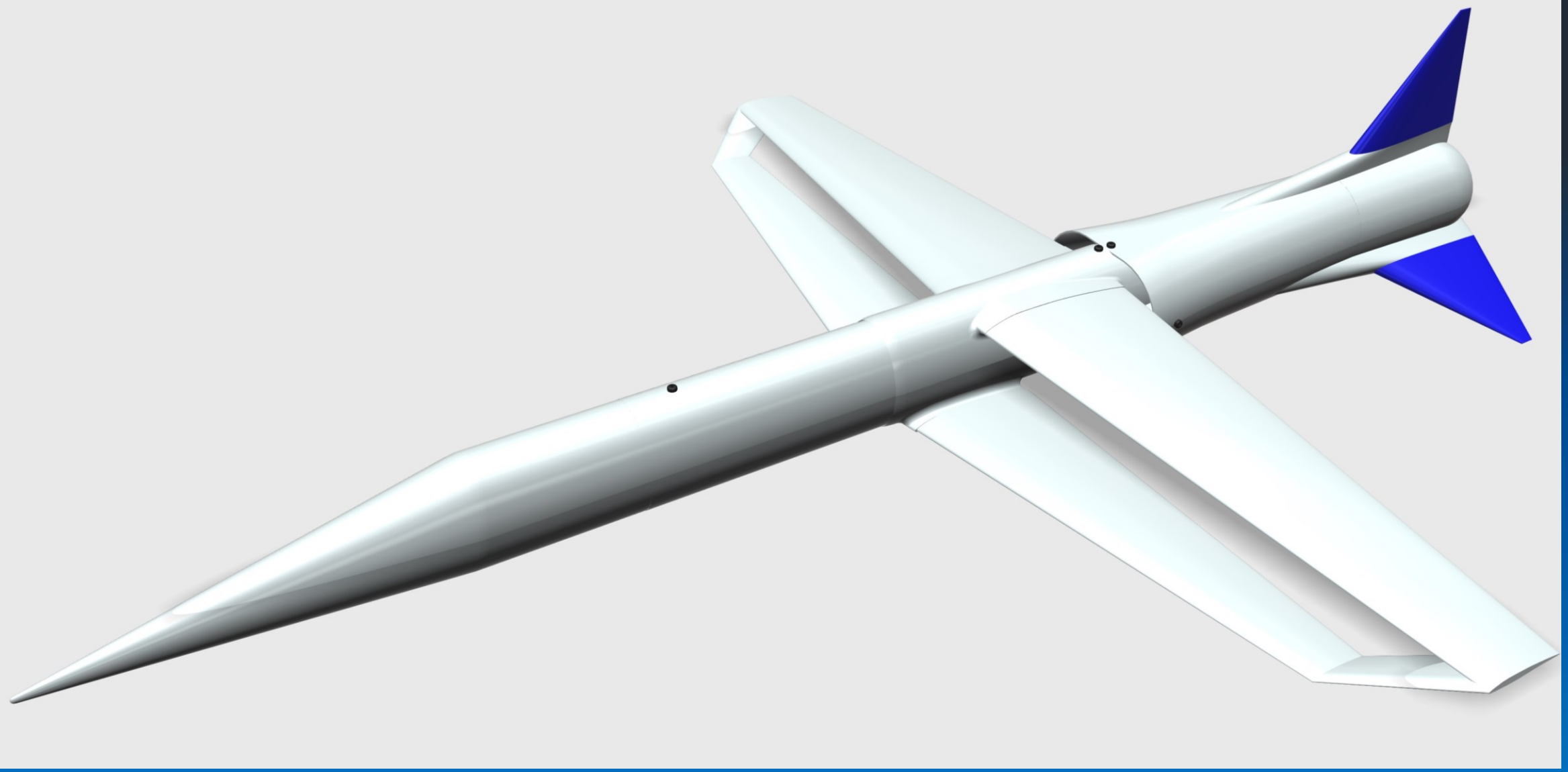

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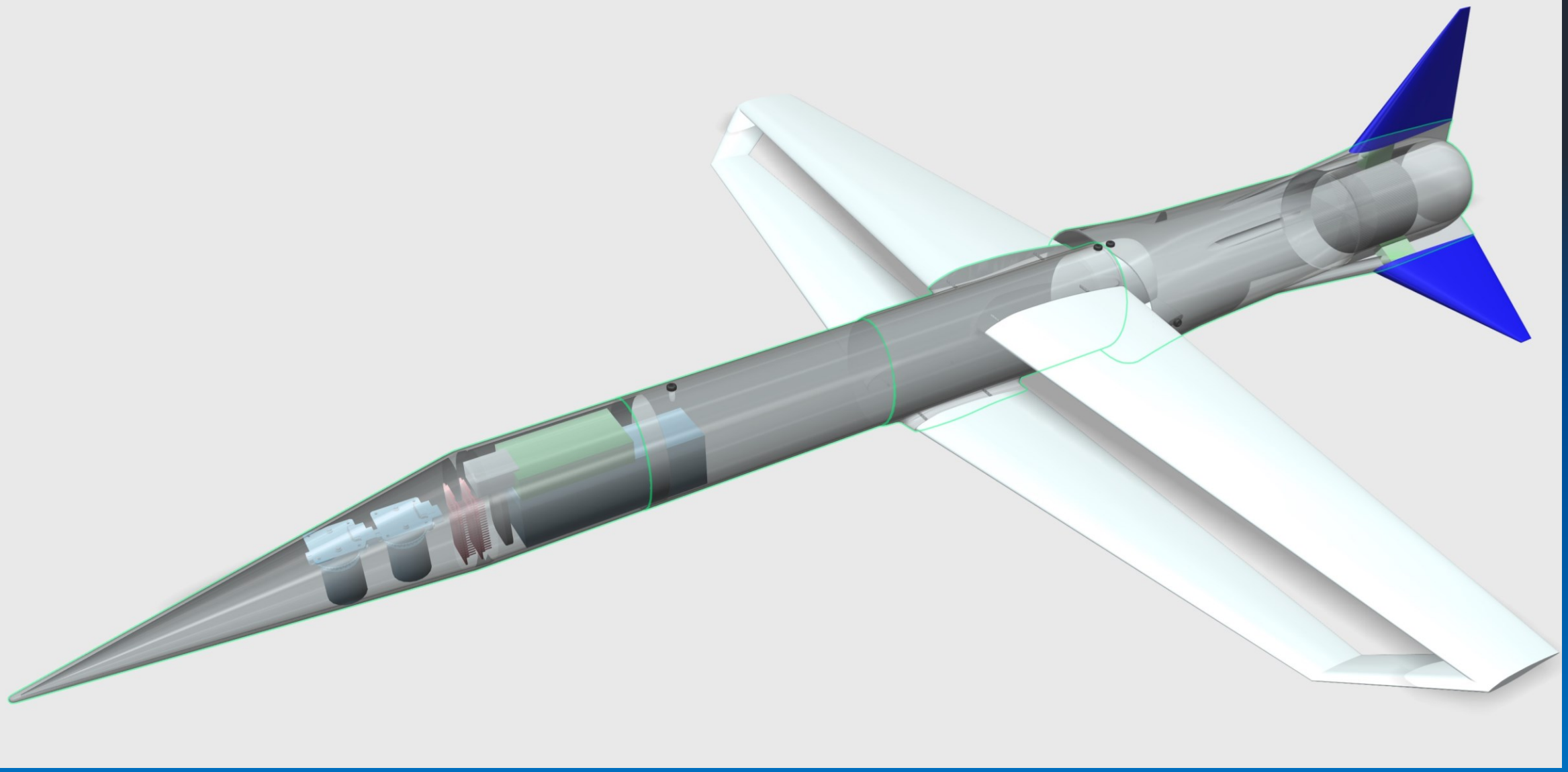

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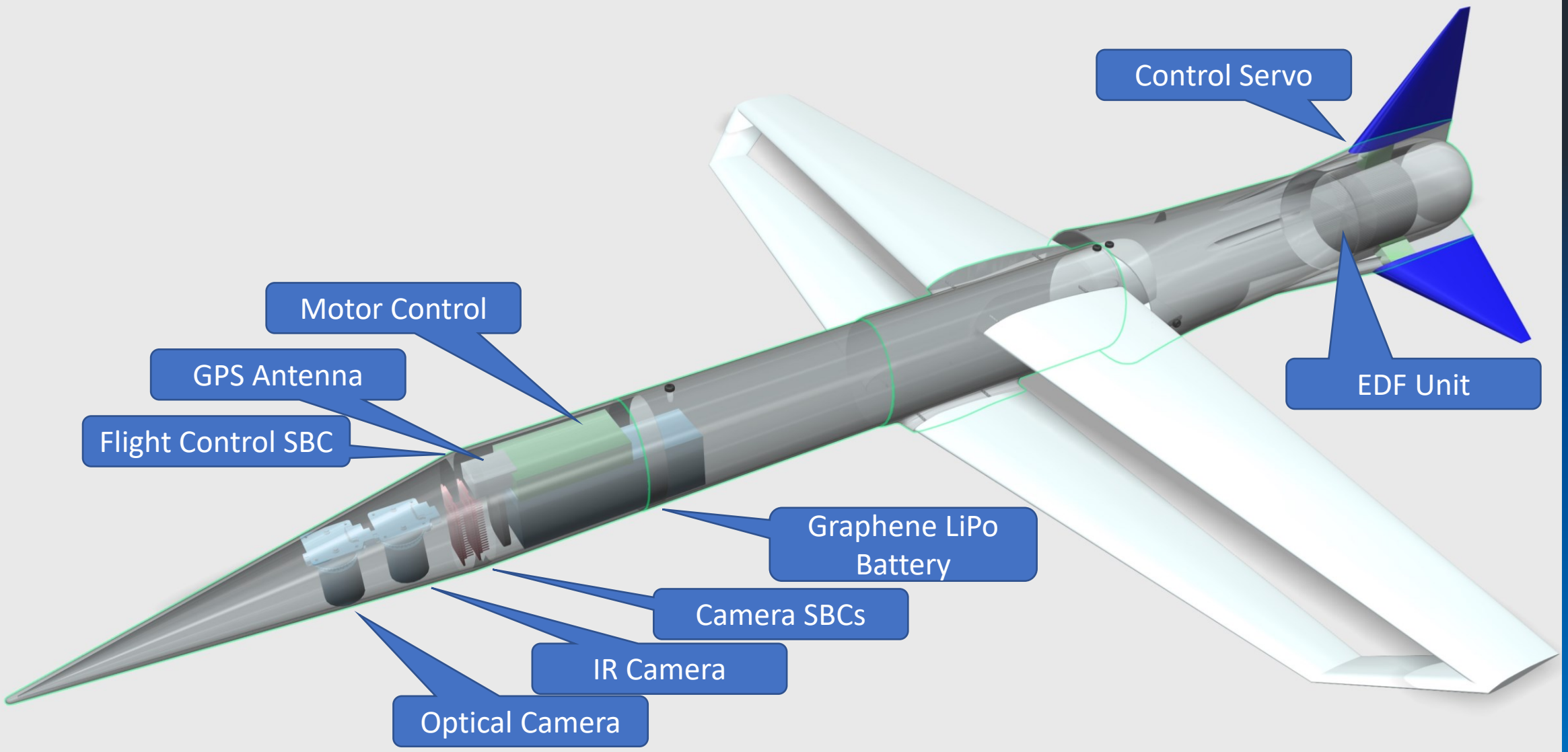

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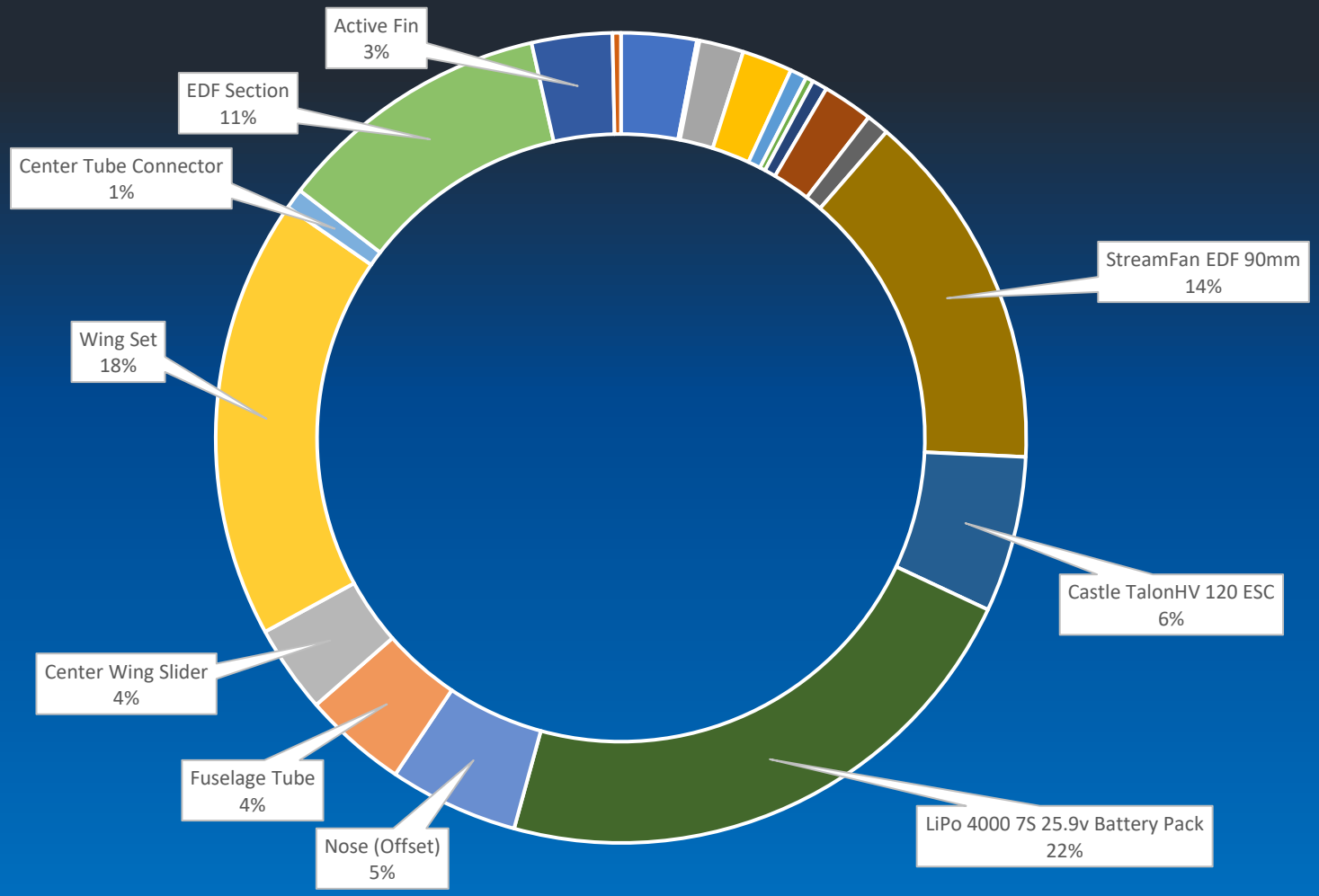
AG3-10 Weight Budget

2990g Total



43% Propulsion and Energy Storage
46% Structural Components
11% Controls and Sensor Package

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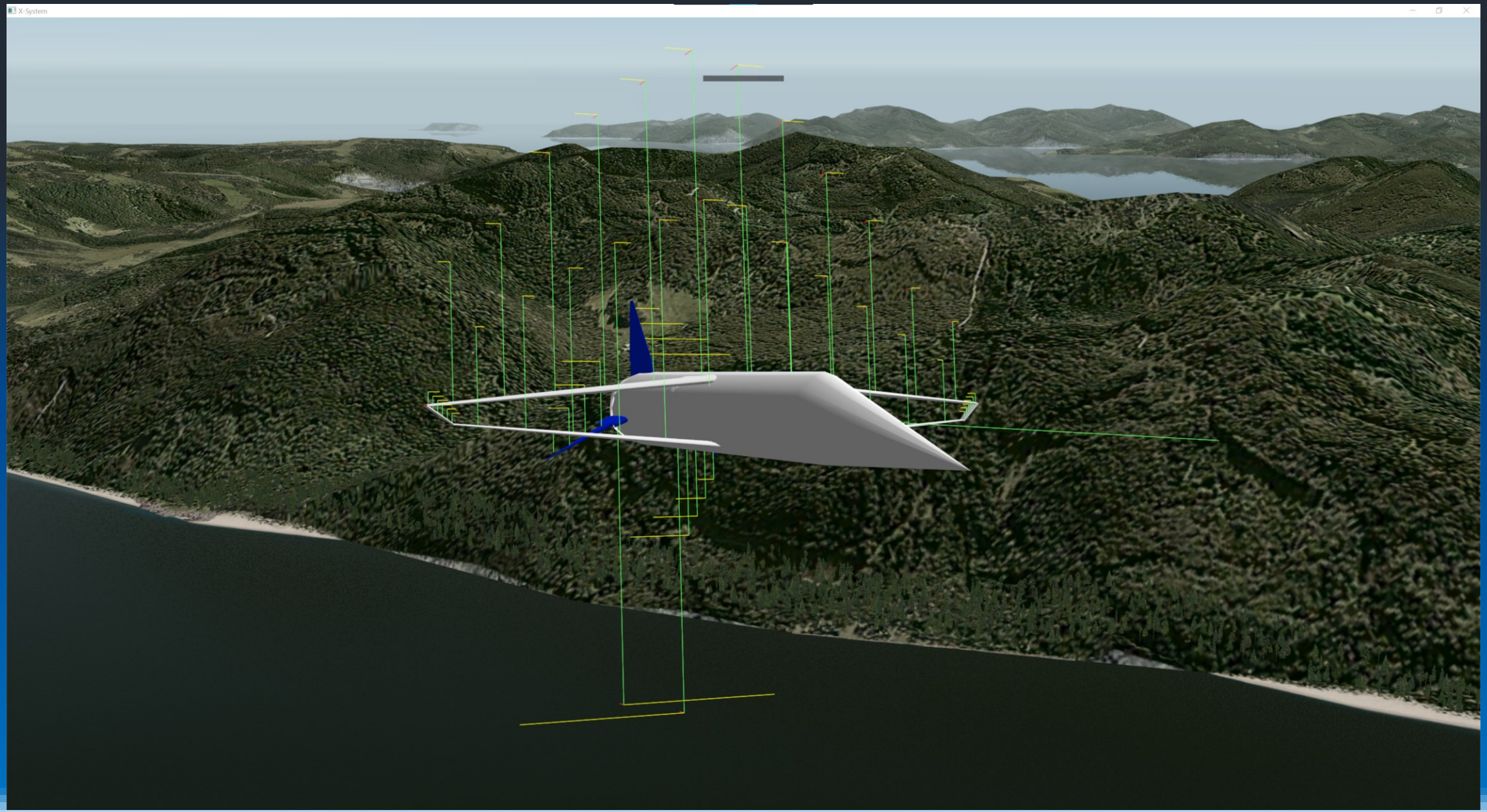

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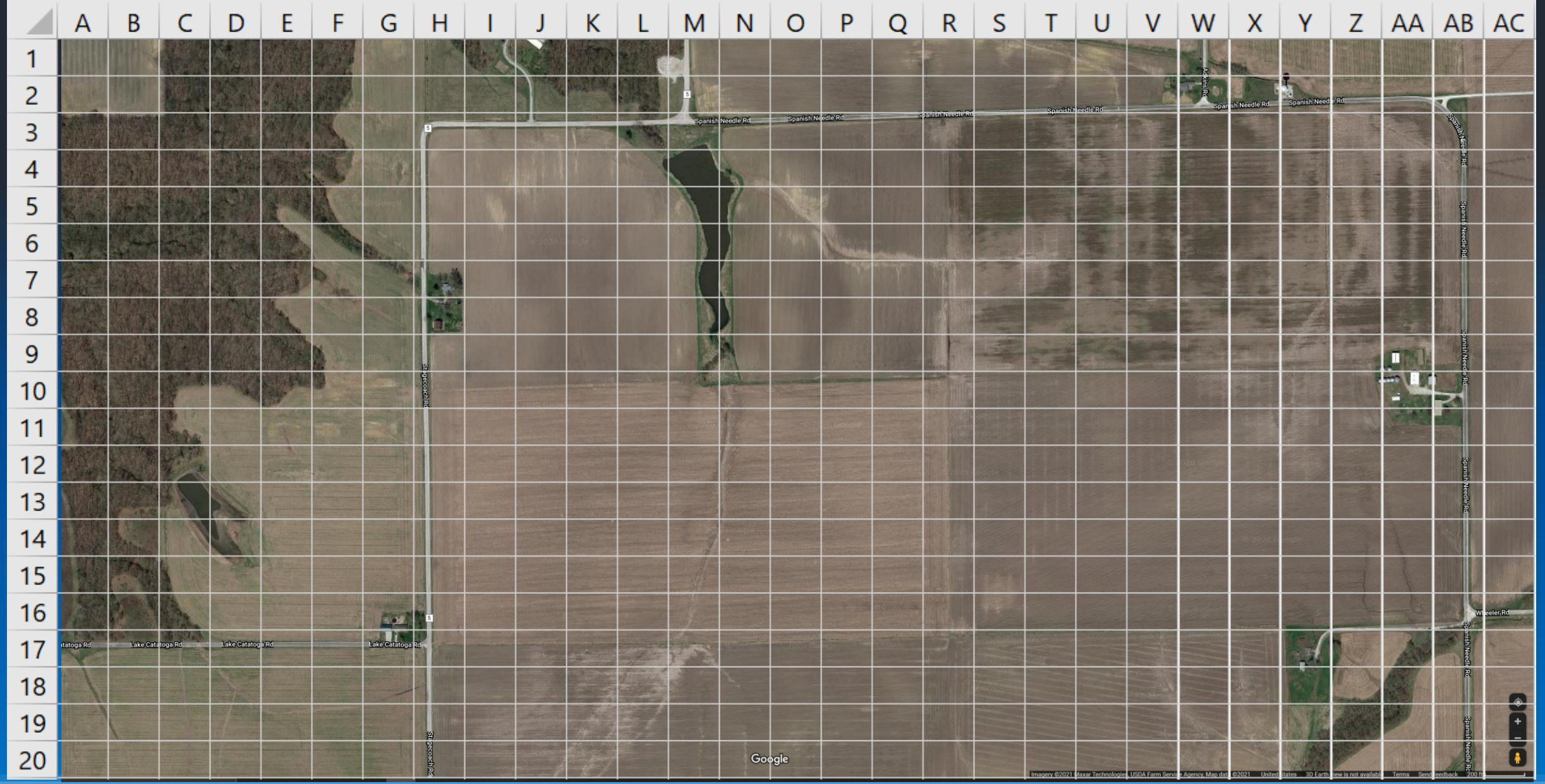

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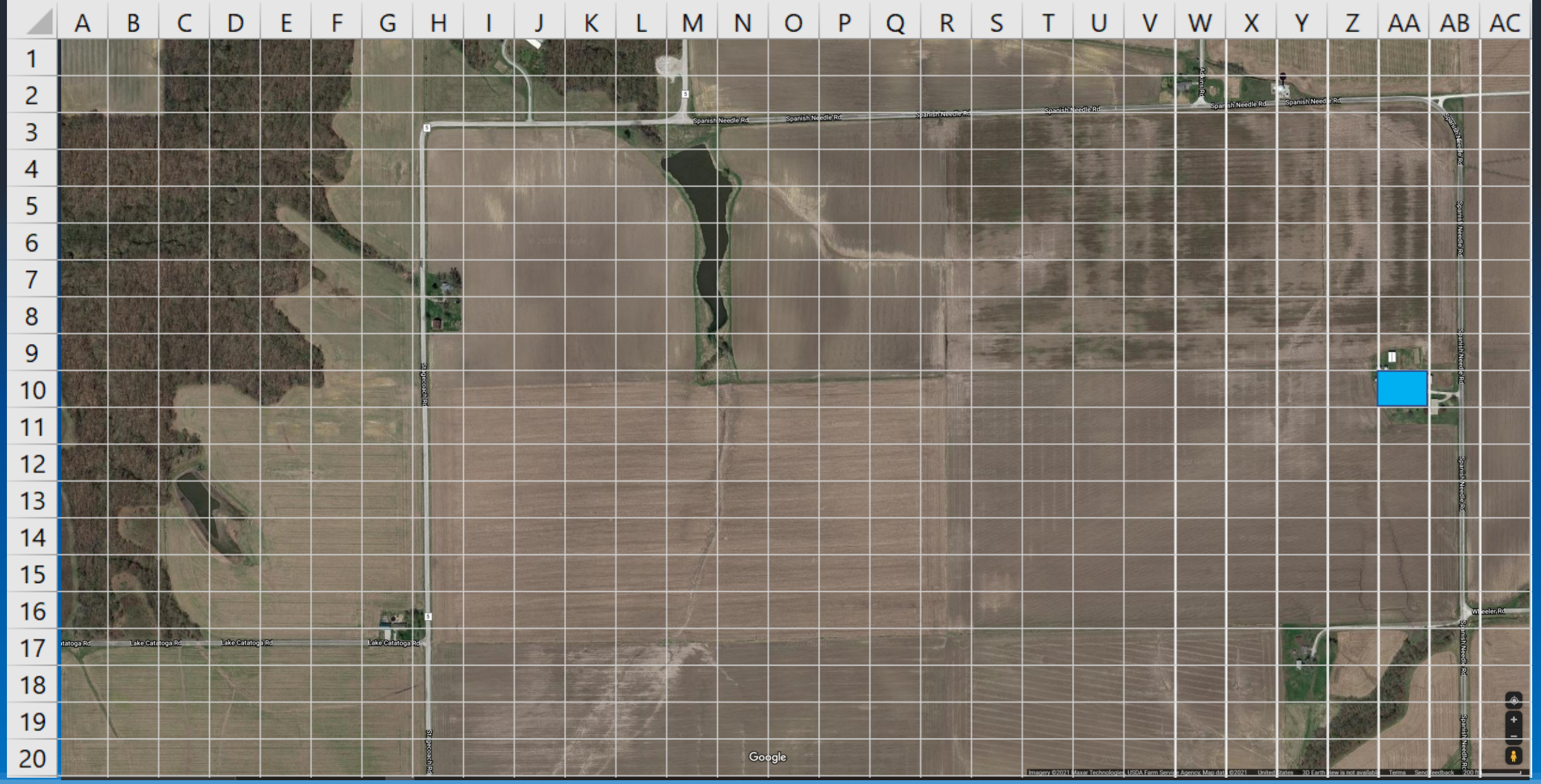

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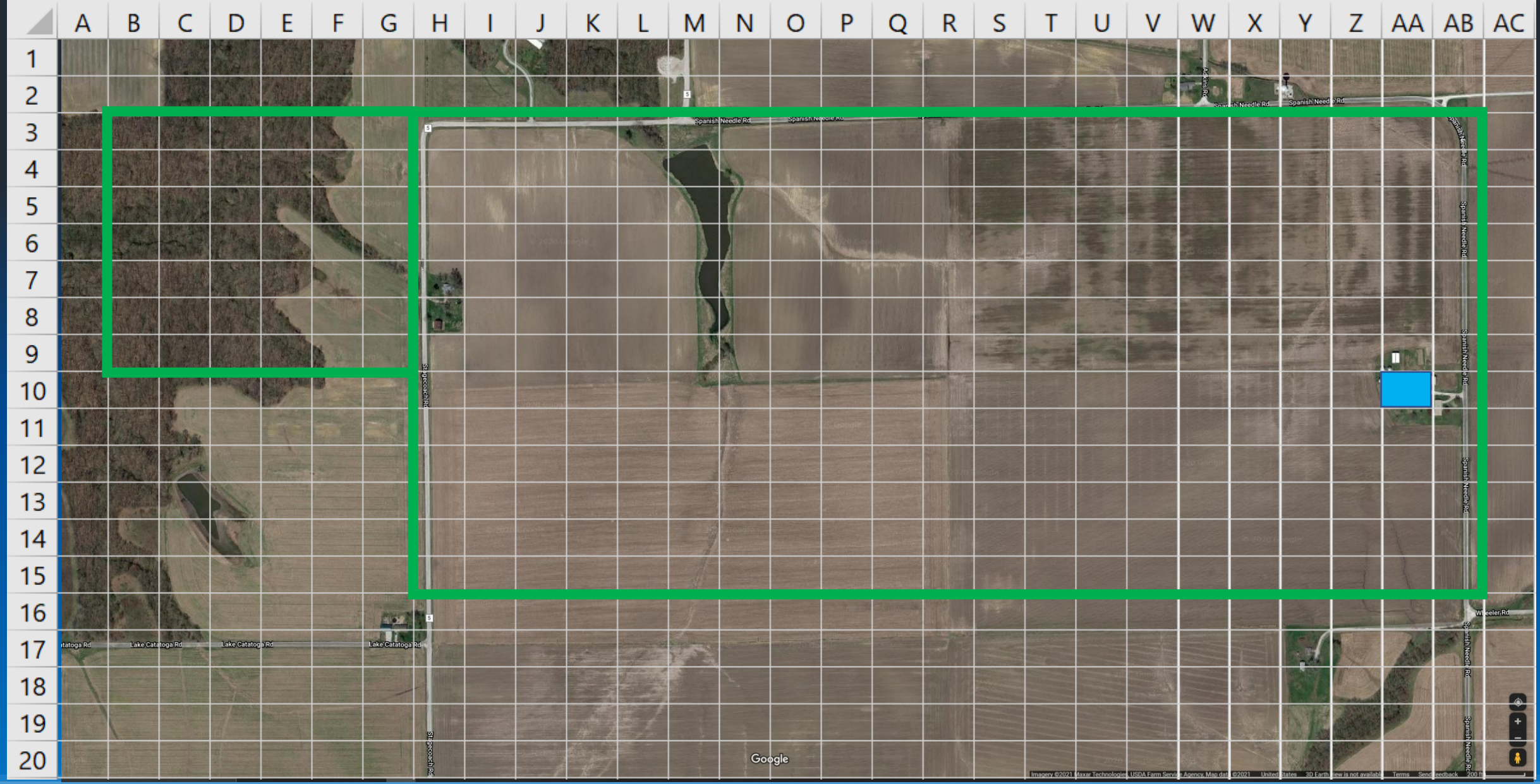

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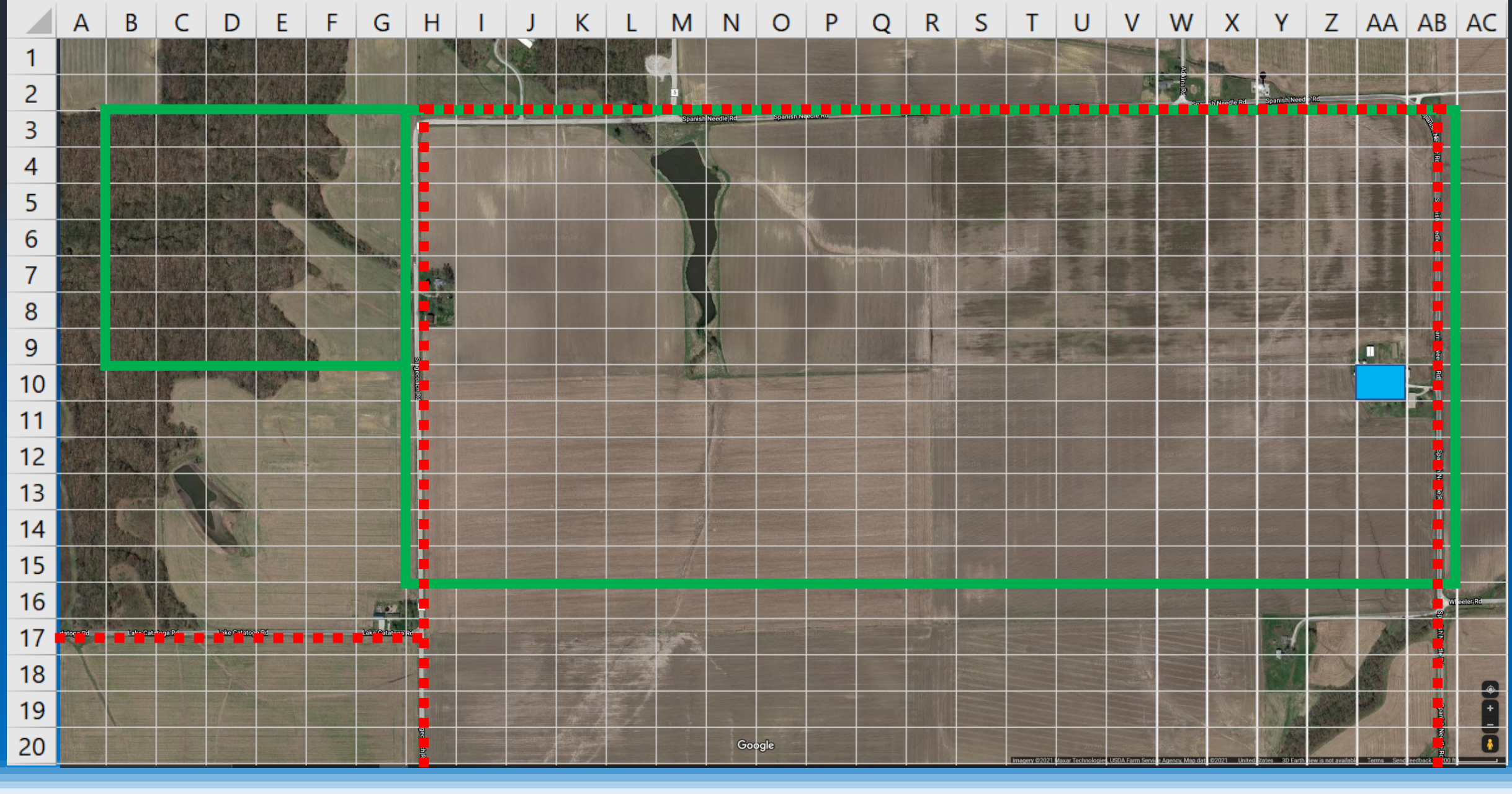

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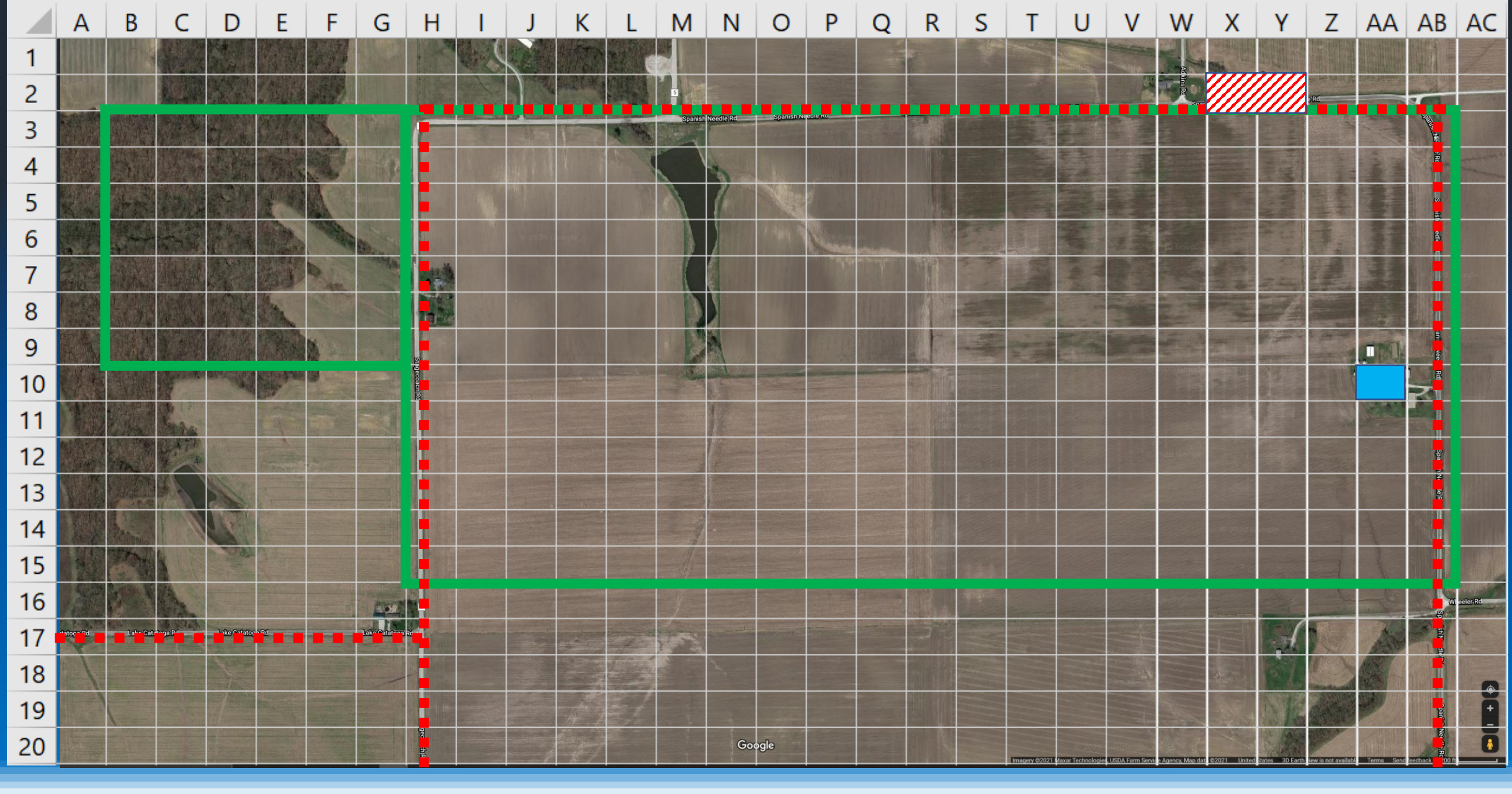

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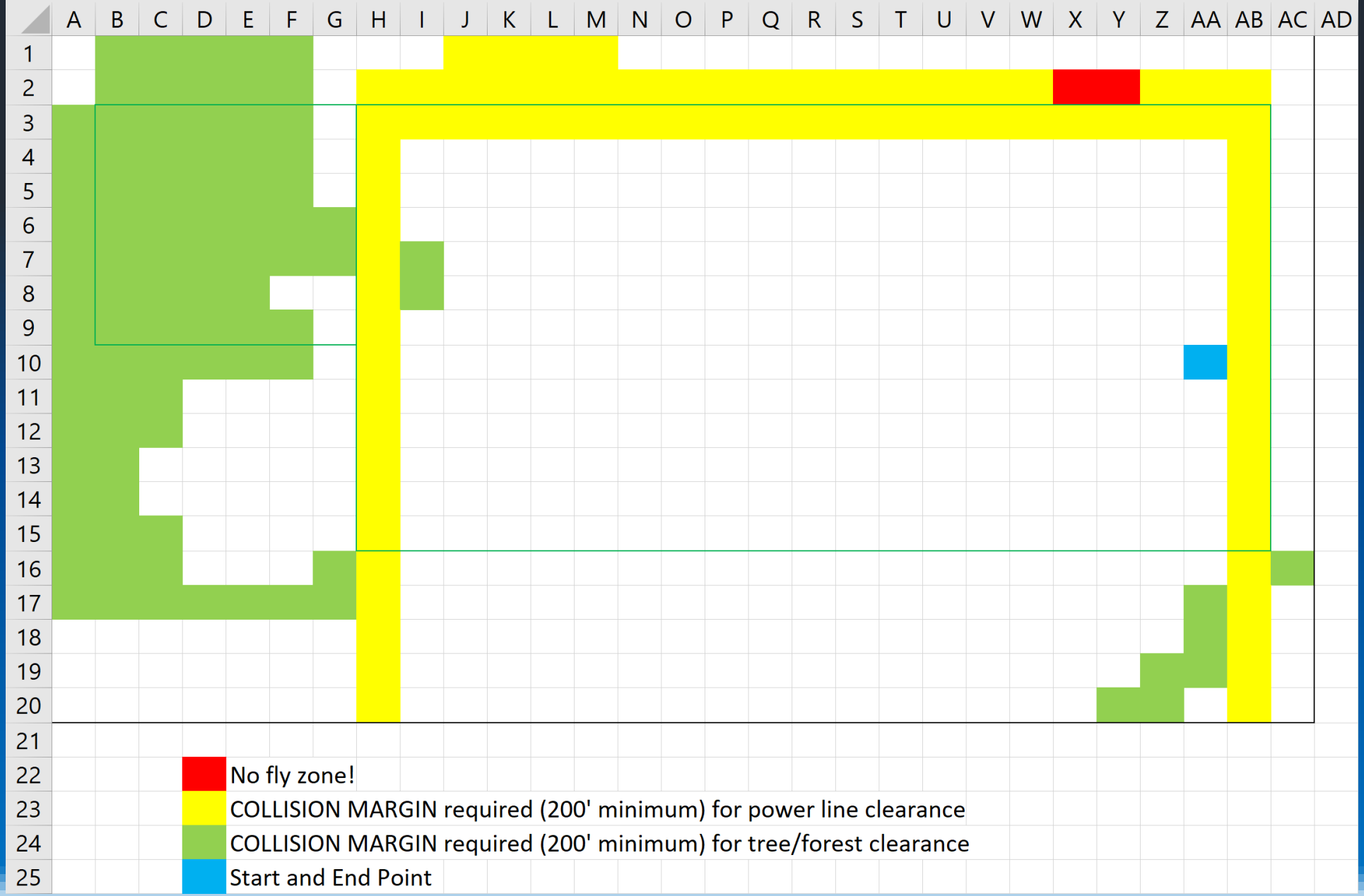

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Here's the basic game... (Page 1 of 3)

- Objective: Visit all the squares inside the GREEN border.
  - Game 1: In the minimum amount of time
  - Game 2: Using the minimum amount of energy (thrust points)

- Initial Conditions
  - Start at AA10 at an altitude of 200 feet and a velocity of 100 fps in any direction you choose.
  - You begin the game with an energy budget of 500 "thrust points."

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Here's the basic game… (Page 2 of 3)

Direction	Distance (ft)
N	200
NE	283
E	200
SE	283
S	200
SW	283
W	200
NW	283

Move Name	Altitude Change (ft)	Velocity Change (fps)	Thrust Point Cost
STEEP-DIVE	-40	20	0.0
DIVE	-30	10	0.0
GLIDE	-20	-5	0.0
GLIDE-CRUISE	-10	-5	0.5
CRUISE	0	0	1.0
ACCELERATE	0	20	1.5
MAX-ACCELERATE	0	40	2.0
CLIMB	20	20	2.0
STEEP-CLIMB	40	0	2.0

- Rules
  - On each turn / step, direct the drone to move in a compass direction shown in the table. Note that diagonals are longer than ordinal moves!
  - Each step in your flight plan results in moving to a new square. To move to each new square, choose a move type from the table and calculate the impacts to Altitude, Velocity and Thrust Points.
  - Your path must return to AA10 to complete the mission. Your final altitude and speed can be any value within the constraints, and you can return from any cardinal direction.

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Here's the basic game… (Page 3 of 3)

- Constraints:
  - At all times your drone must fly faster than 60 fps (to avoid stalling, resulting in an immediate crash and loss of the drone!) and slower than 200 fps (which is the current legal limit for an autonomous drone in the US).
  - At all times your drone's altitude must stay BELOW 400 feet (upper legal limit in the US).
  - Your drone's minimum altitude must stay ABOVE 100 feet (for the best camera image) OR above the collision margin.
  - Do NOT crash into the power lines or the trees! To go over these obstacles your altitude must be ABOVE 200 feet (e.g. this is the COLLISION MARGIN shown on the map).
  - Do NOT enter the RED AND WHITE HASHED in the X2:Y2 area. EVER! (You CAN fly around it though, if all other constraints are met.)
  - Do NOT run out of thrust points. Remember that battery power is also needed for CONTROL! The minimum you can finish with is 1 thrust point – not zero.

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Output Format (Excel Compatible Please!) and Programming

Starting Location	Starting Altitude (ft)	Starting Velocity (fps)	Starting Elapsed Time (s)	Starting Thrust Points	Move Type	Move Direction	Ending Location	Ending Altitude (ft)	Ending Velocity (fps)	Ending Elapsed Time (s)	Ending Thrust Points
AA10	200	100	0	500	GLIDE	N	AA9	180	95	2.1	500
AA9	180	95	2.1	500	CRUISE	N	AA8	180	95	4.2	499
					…						
AA13	100	80	602.0	13	CLIMB	N	AA12	120	100	604.2	11
AA12	120	100	604.2	11	CRUISE	N	AA11	120	100	606.2	10
AA11	120	100	606.2	10	GLIDE	N	AA10	80	95	608.3	10

Preferred programming languages are Python, C++/C# and/or Java

Write the entire program in ONE language please!

Remember to DOCUMENT your drone's process…flowcharts are helpful here! Don't just assume someone will "figure it out" later.

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