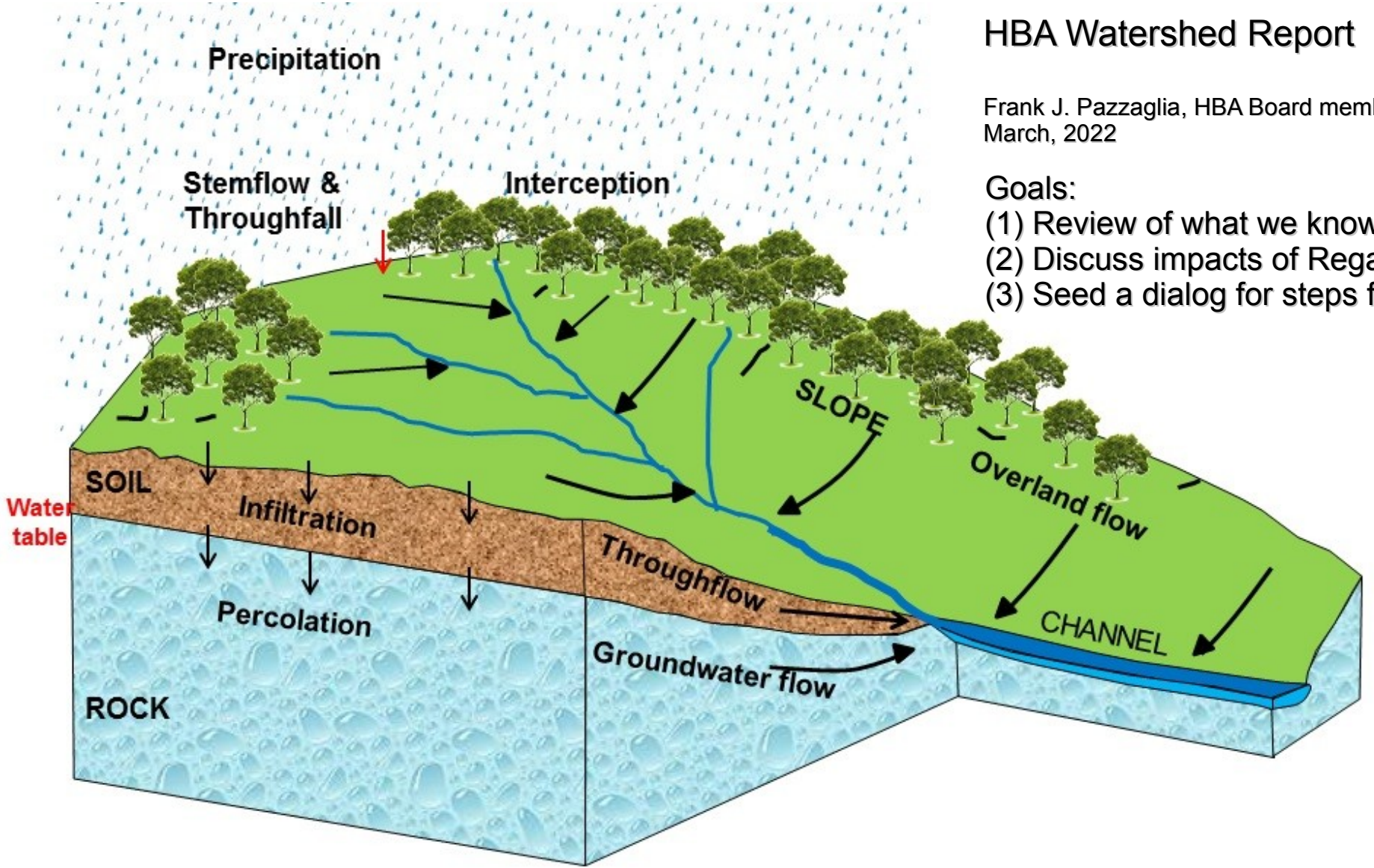
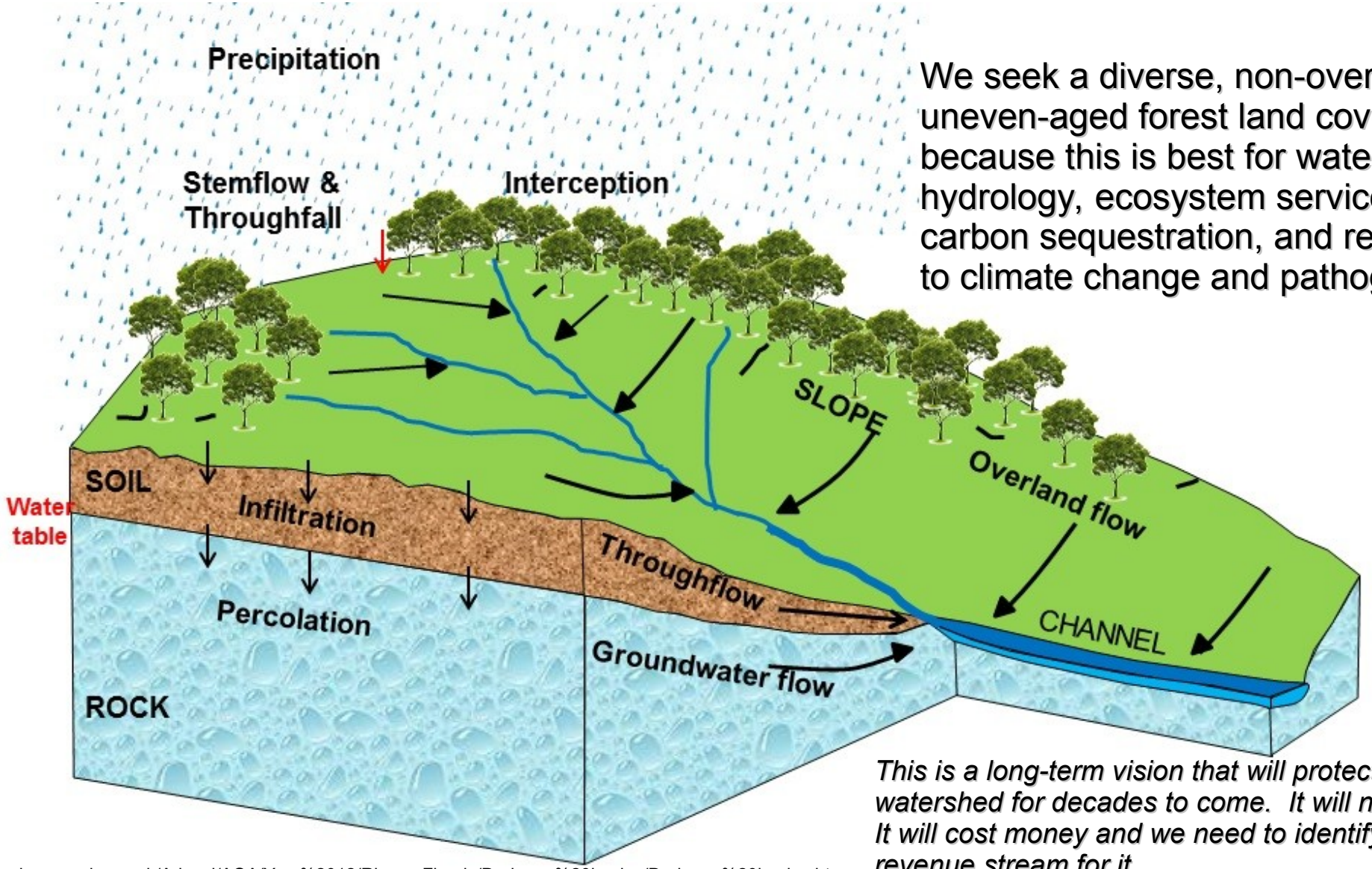
HBA Watershed Report

Frank J. Pazzaglia, HBA Board member
March, 2022

Goals:
(1) Review of what we know
(2) Discuss impacts of Regan report
(3) Seed a dialog for steps forward



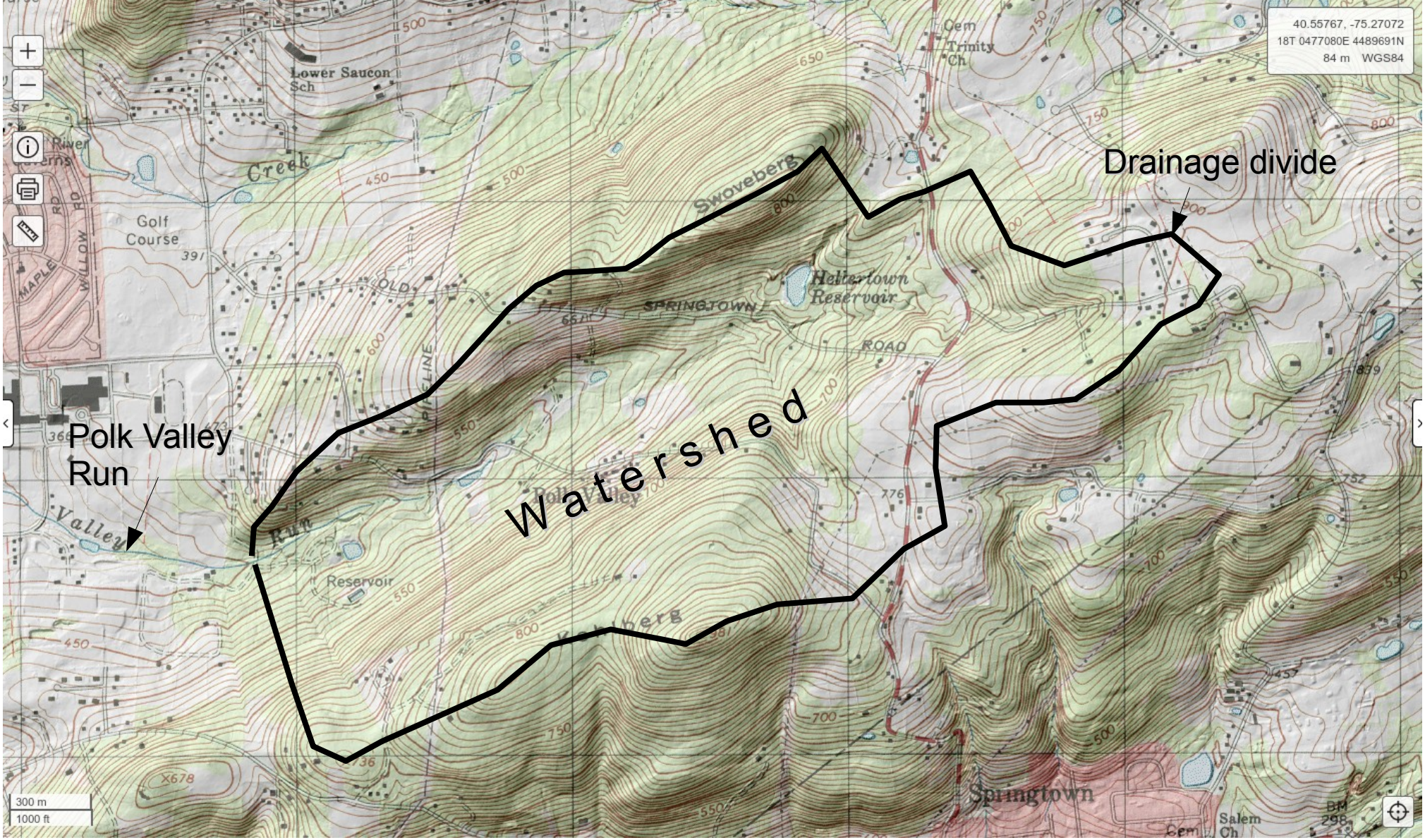
http://coolgeography.co.uk/A-level/AQA/Year%2012/Rivers_Floods/Drainage%20basins/Drainage%20basins.htm

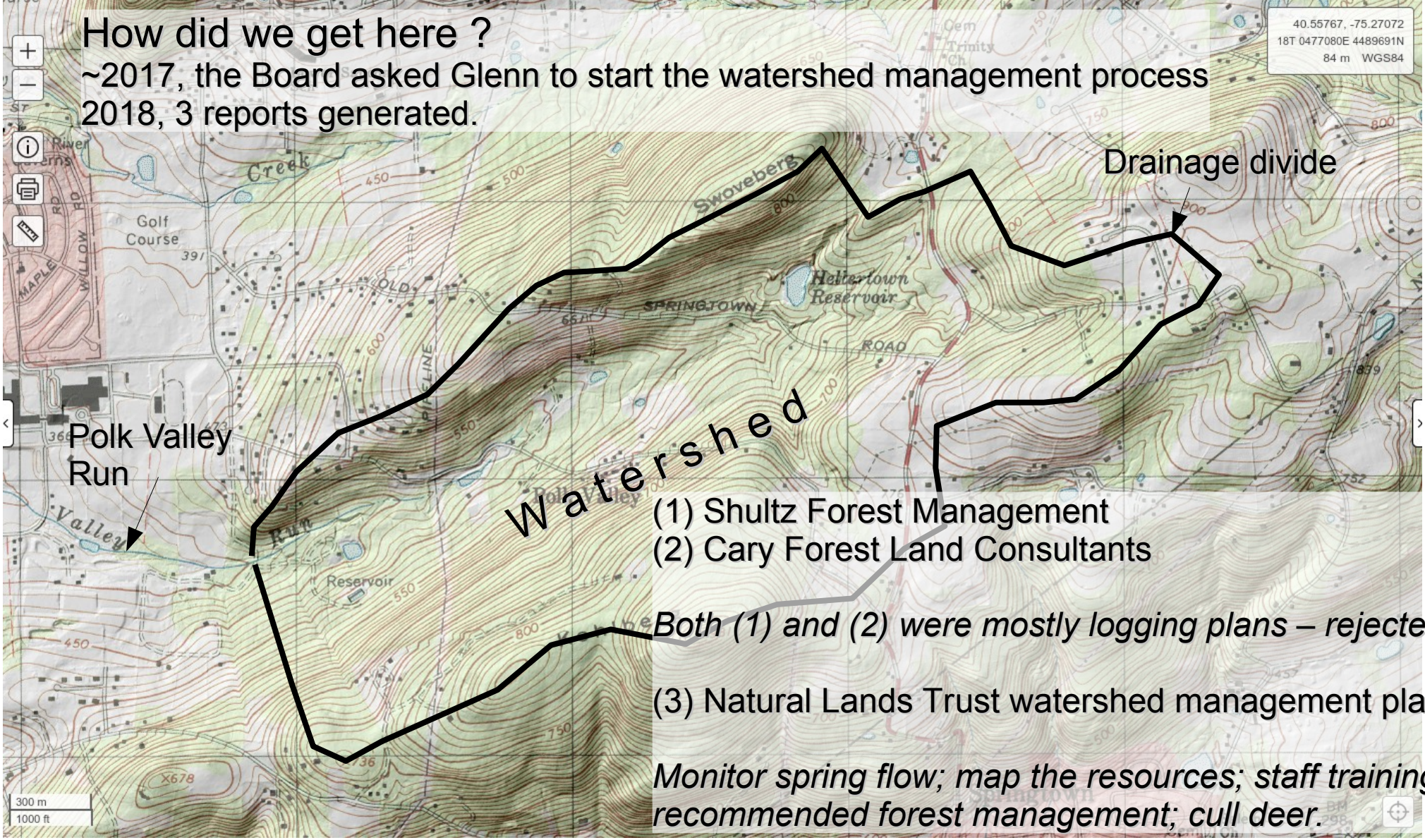


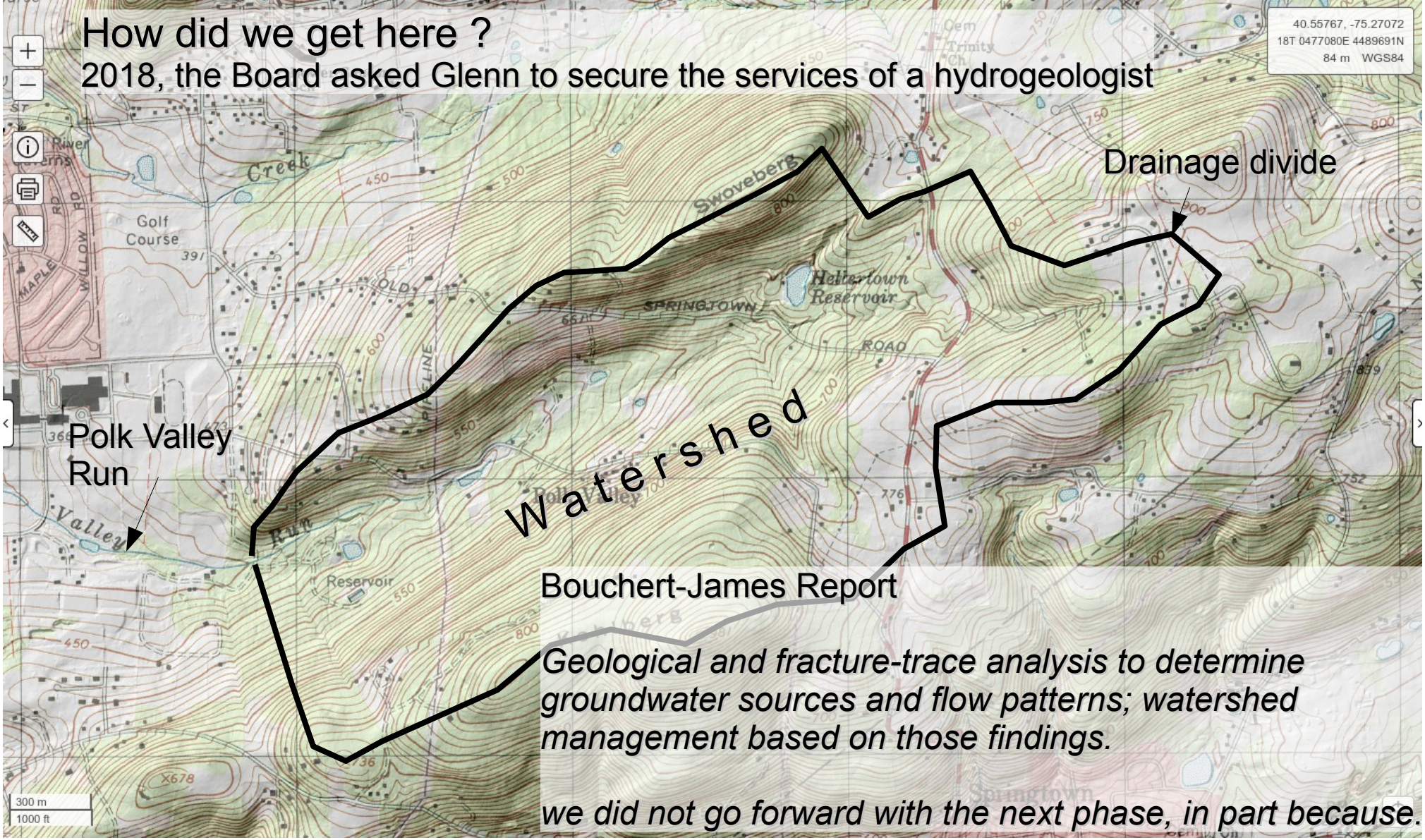
We seek a diverse, non-overstocked, uneven-aged forest land cover because this is best for watershed hydrology, ecosystem services, carbon sequestration, and resilience to climate change and pathogens.

This is a long-term vision that will protect our watershed for decades to come. It will not be free. It will cost money and we need to identify a revenue stream for it.

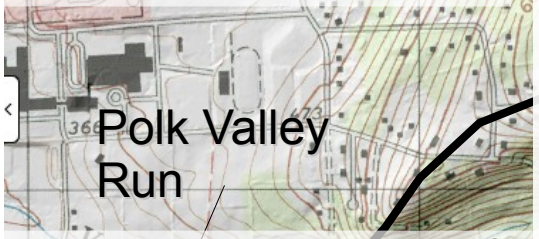
http://coolgeography.co.uk/A-level/AQA/Year%2012/Rivers_Floods/Drainage%20basins/Drainage%20basins.htm


Drainage divide
Watershed
Polk Valley Run
Lower Saucon Sch
Golf Course
Helfertown Reservoir
Springtown
Trinity Ch
Salem Ch
Reservoir
SPRINGTOWN ROAD
OLD
MAPLE
WILLOW RD
Swoveberg
40.55767, -75.27072
18T 0477080E 4489691N
84 m WGS84
300 m
1000 ft


How did we get here ?
~2017, the Board asked Glenn to start the watershed management process
2018, 3 reports generated.
Drainage divide
Polk Valley Run
Watershed
(1) Shultz Forest Management
(2) Cary Forest Land Consultants
Both (1) and (2) were mostly logging plans – rejected
(3) Natural Lands Trust watershed management plan
Monitor spring flow; map the resources; staff training; recommended forest management; cull deer.


How did we get here ?
2018, the Board asked Glenn to secure the services of a hydrogeologist
Drainage divide
Polk Valley Run
Watershed
Bouchert-James Report
Geological and fracture-trace analysis to determine groundwater sources and flow patterns; watershed management based on those findings.
we did not go forward with the next phase, in part because...

Lehigh students and HBA staff had collected data on the springs in 2017-2018, and we felt that any new data from the Boucher-James effort would have been incremental, rather than novel.



We know the sources of our spring water. It reflects a combination of shallow and deep ground water that takes, on average, 3 months to arrive at our springs following precipitation.

Groundwater Sources of the Polk Valley Run Watershed

Patrick Yun, Advised by Dr. Frank Pazzaglia

Abstract

The Polk Valley Run watershed is the public water source for Hellertown, PA, a mostly residential community of ~4,500 people. The public water distribution system was developed in the 1930's and is based on passive, gravity collection of groundwater emerging in 14 springs. Fourteen months of water level, water temperature, air temperature, and precipitation data were collected in 2017-18 with the goal of characterizing the source of the ground water and its discharge over an annual cycle. The data was processed and standardized on a monthly basis and later assembled into seasons to better observe long-term trends (Figure 3-10). The seasonal graphs show patterns in how precipitation, spring water level, and spring water temperature are correlated. Notable patterns include short-term spikes in water temperature and level with the direction of change depending on the season. These results suggest that the springs are in part fed by infiltrated water at or near surface air temperatures that becomes part of a shallow, soil ground water aquifer. However, over seasonal time scales, temperature changes more gradually, following seasons with a time lag of several months. These results suggest that some of the infiltrated water follows deep flow paths into fractured rock that is more or less the same temperature over an annual cycle. To explore these trends, a simple two component temperature mixing model predicated on one component being in constant thermal equilibrium with the deep rocks, and a second fluctuating component being in thermal equilibrium with the seasonal air temperature was constructed (Table 1). Not all models can successfully predict the observed mixed ground water temperature, therefore, the basic assumption of an annual, fixed, deep groundwater temperature cannot be true for all seasons. These results are consistent with the lag time in the seasonal cycle.

Map of Polk Valley Run Watershed

- Yellow Outline Represents the boarder of the watershed
- The image of the cylindrical device, the HOBO Water Level Data Logger, was used to measure and record pressure and relative water level changes in 15 minute increments
- With pressure, temperature of the springs were calculated; however, spikes of water level changes can be observed in Figure (3-10) as recorded mistakes

Koller Spring – Polk Valley Run

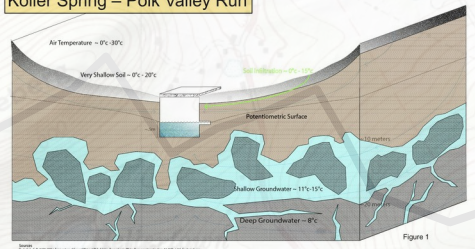


Figure 1

Getter Spring – Polk Valley Run

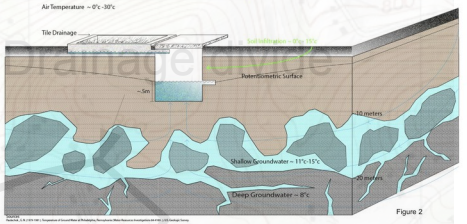


Figure 2

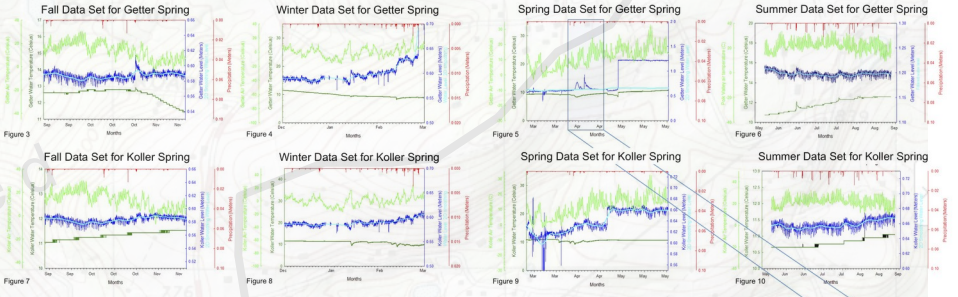


Figure 3 Figure 4 Figure 5 Figure 6 Figure 7 Figure 8 Figure 9 Figure 10

Temperature Mixing Model

$$F_a = \frac{(X_m - X_b)}{(X_a - X_b)}$$ Figure 11

X_m — Mid-Season Temperature
X_b — Soil Water Temperature in Equilibrium with Air Temperature
X_a — Groundwater Temperature in Equilibrium Deep Bedrock Temperature
F_a — Fraction of X_a

Table 1

X_b = 8°C

Spring	X_a	F_a
Getter Fall	13.59	0.14
Getter Winter	9.78	0.17
Getter Spring	13.59	0.74
Getter Summer	21.72	0.71
Koller Fall	11.32	-0.003
Koller Winter	10.91	0.05
Koller Spring	11.79	0.3
Koller Summer	21.72	0.8

Table 1 has a column of Getter and Koller spring in every season. The F_a column represents the calculated fraction of the deep groundwater temperatures (X_a). (X_b) is noted as 8°C. The circled value in red depicts a negative value which can not be true as a fraction. Thus, deep groundwater can not always be the end number for every season suggesting a more complex system (Figure 12).

Polk Valley Run

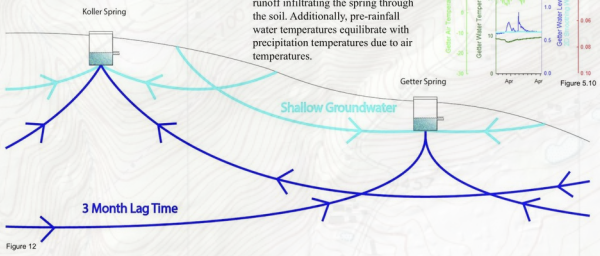


Figure 12

Fig. 5.10 represents the relationship between precipitation and water level change. This is an example of instant water level change due to surface runoff infiltrating the spring through the soil. Additionally, pre-rainfall water temperatures equilibrate with precipitation temperatures due to air temperatures.

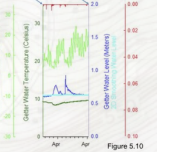


Figure 5.10

- Short-term water level change is directly related to temperature and precipitation (Figure 5.10)
- The temperature mixing model suggests deep groundwater temperatures do not mix consistently and the watershed must have another water source (Table 1)
- Long-term equilibration of spring water is consistent of about 90 days or 3 months (Figure 12)

Thanks to George Yasko for the help of the HOBO and Hellertown Borough Authority for access to the site.

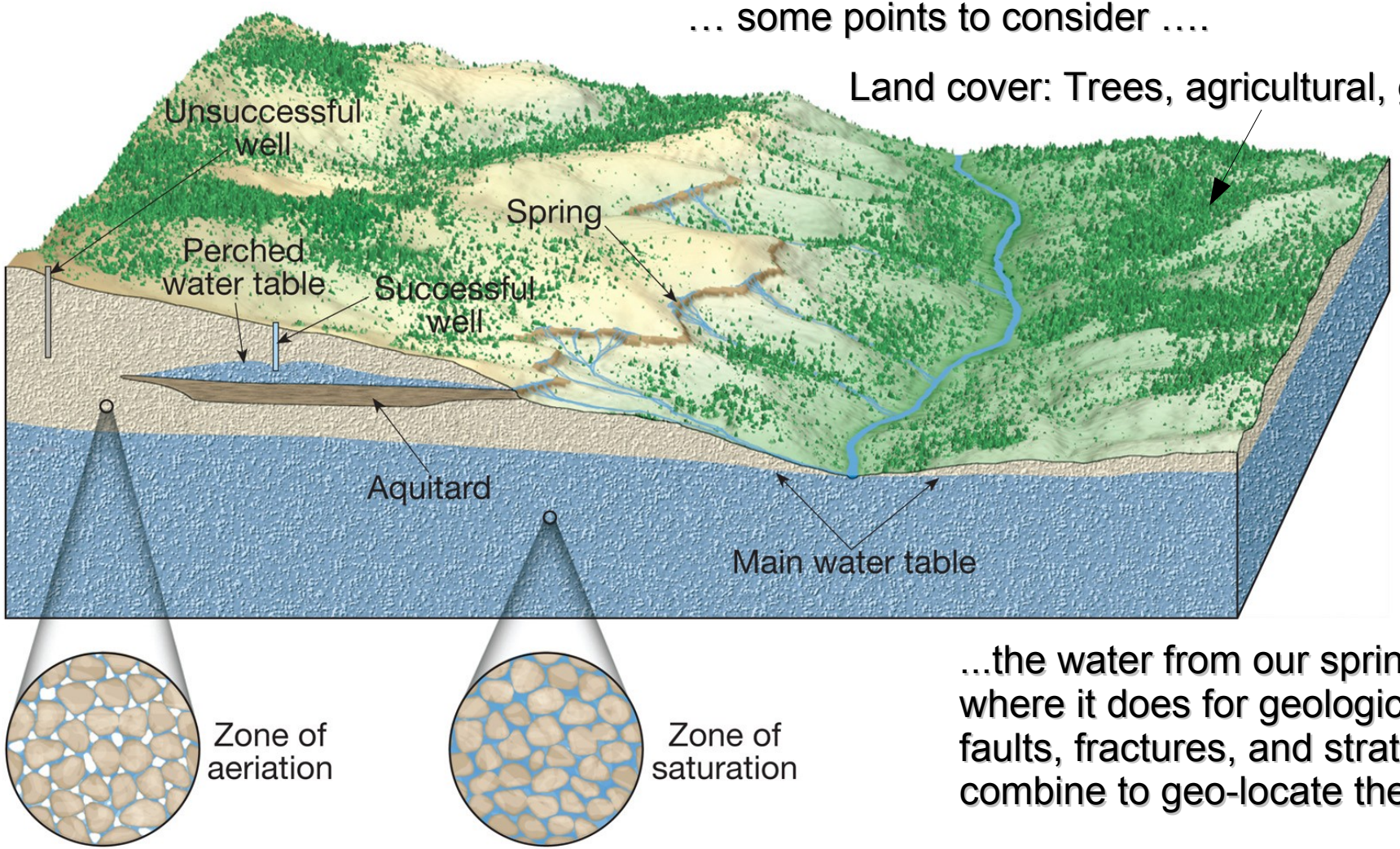
References Cited

Paulachok , G. N. (1979-1981). Temperature of Ground Water at Philadelphia, Pennsylvania (Water-Resources Investigations 84-4189). U.S. Geologic Survey.

Clark, I and Fritz, P. (1997) Environmental Isotopes in Hydrogeology. CRC Press, New York, 328 p.

… some points to consider ….

Land cover: Trees, agricultural, grass, shrubs

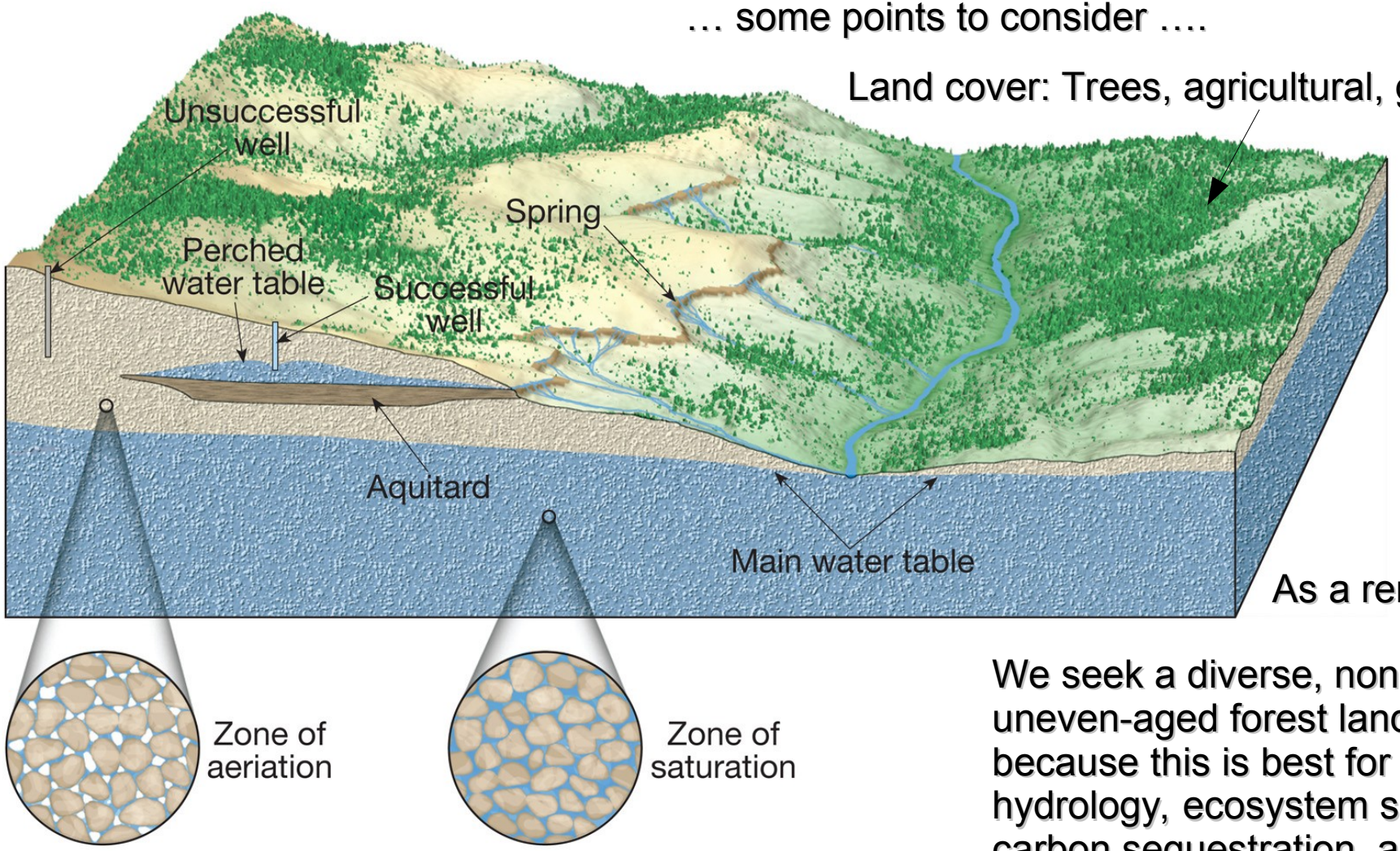


…the water from our springs, emerges where it does for geologic reasons - faults, fractures, and stratigraphy combine to geo-locate the springs

The major UNKNOWN is how to manage the land cover

… some points to consider ….

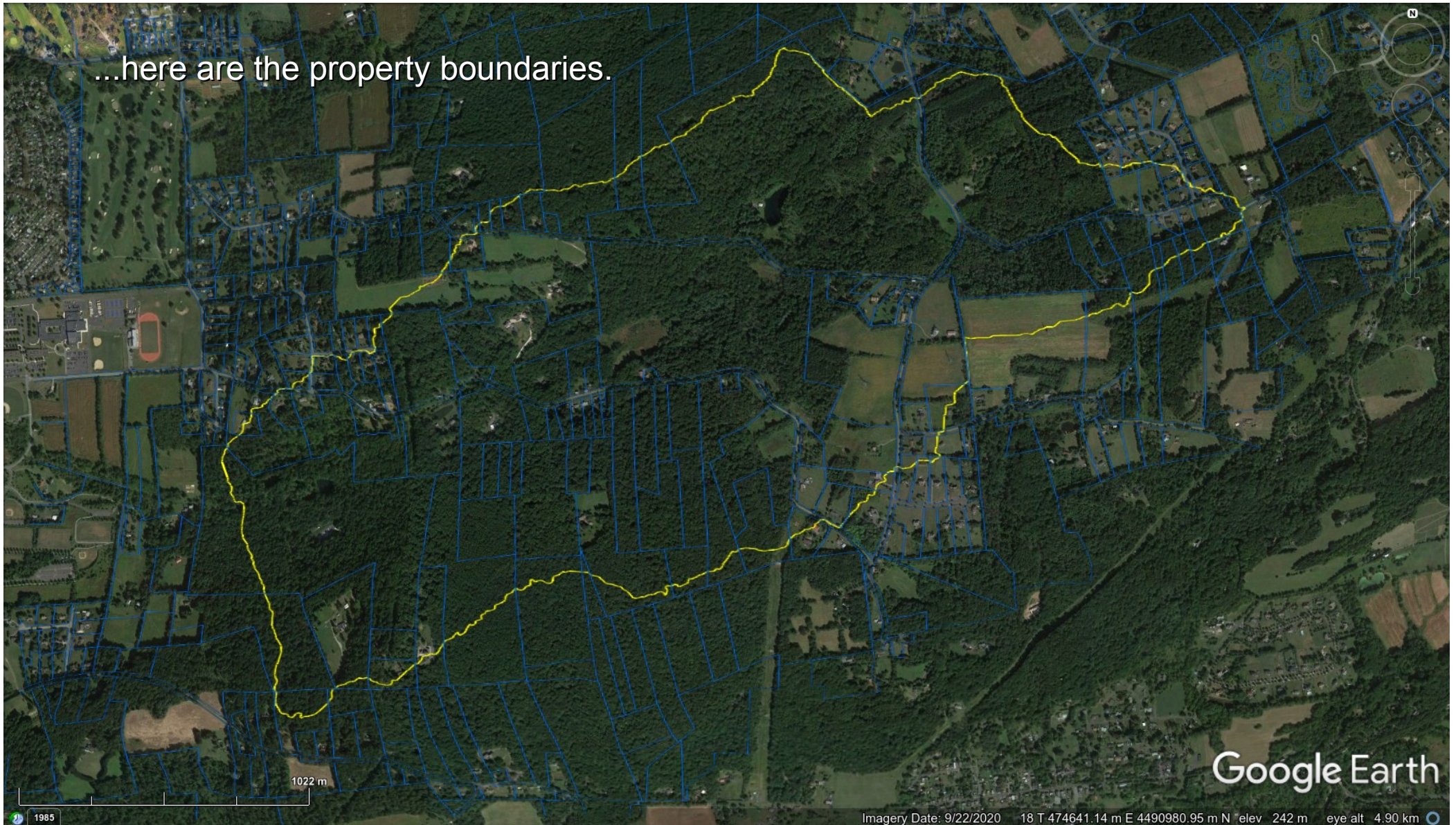
Land cover: Trees, agricultural, grass, shrubs

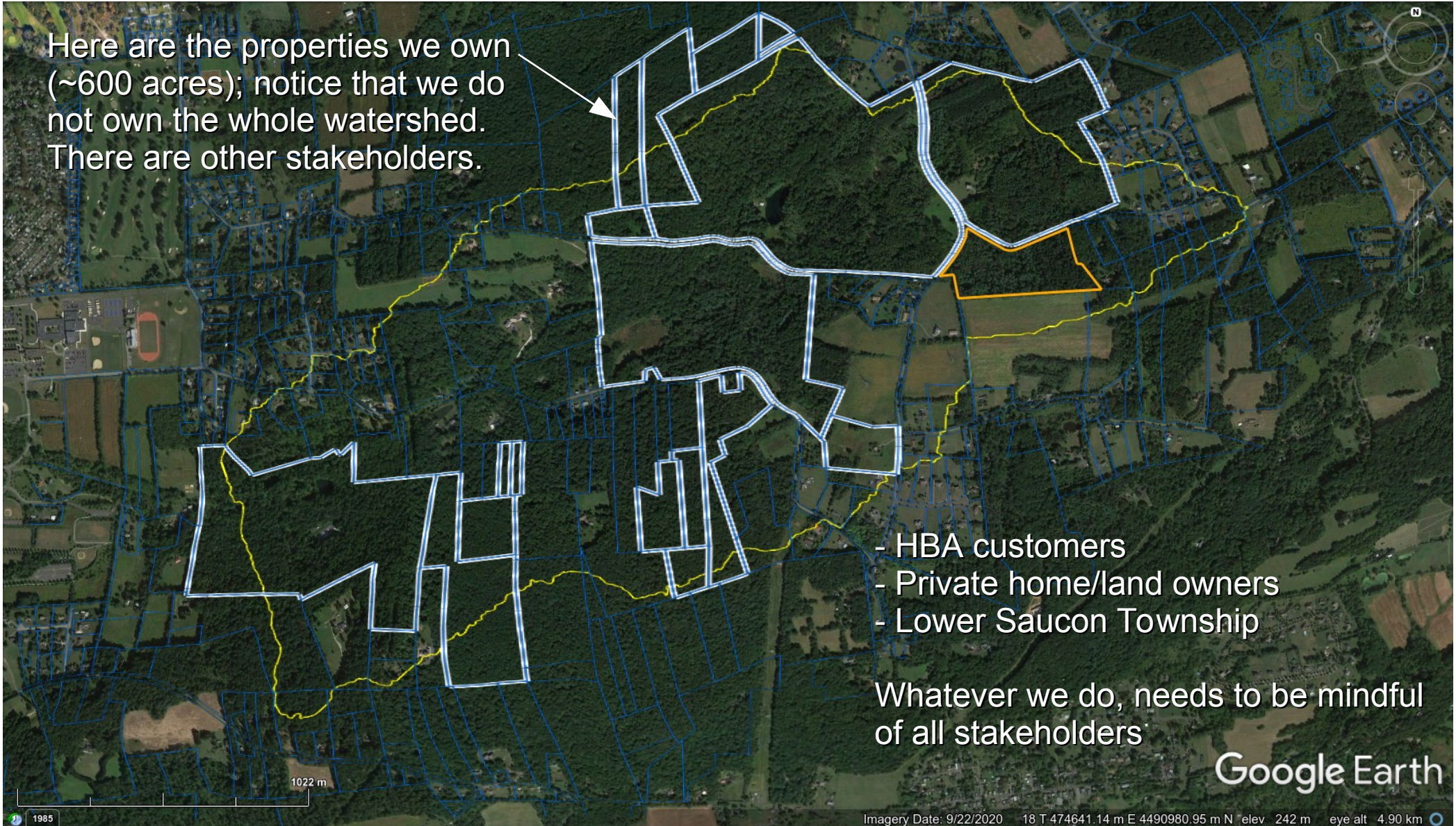


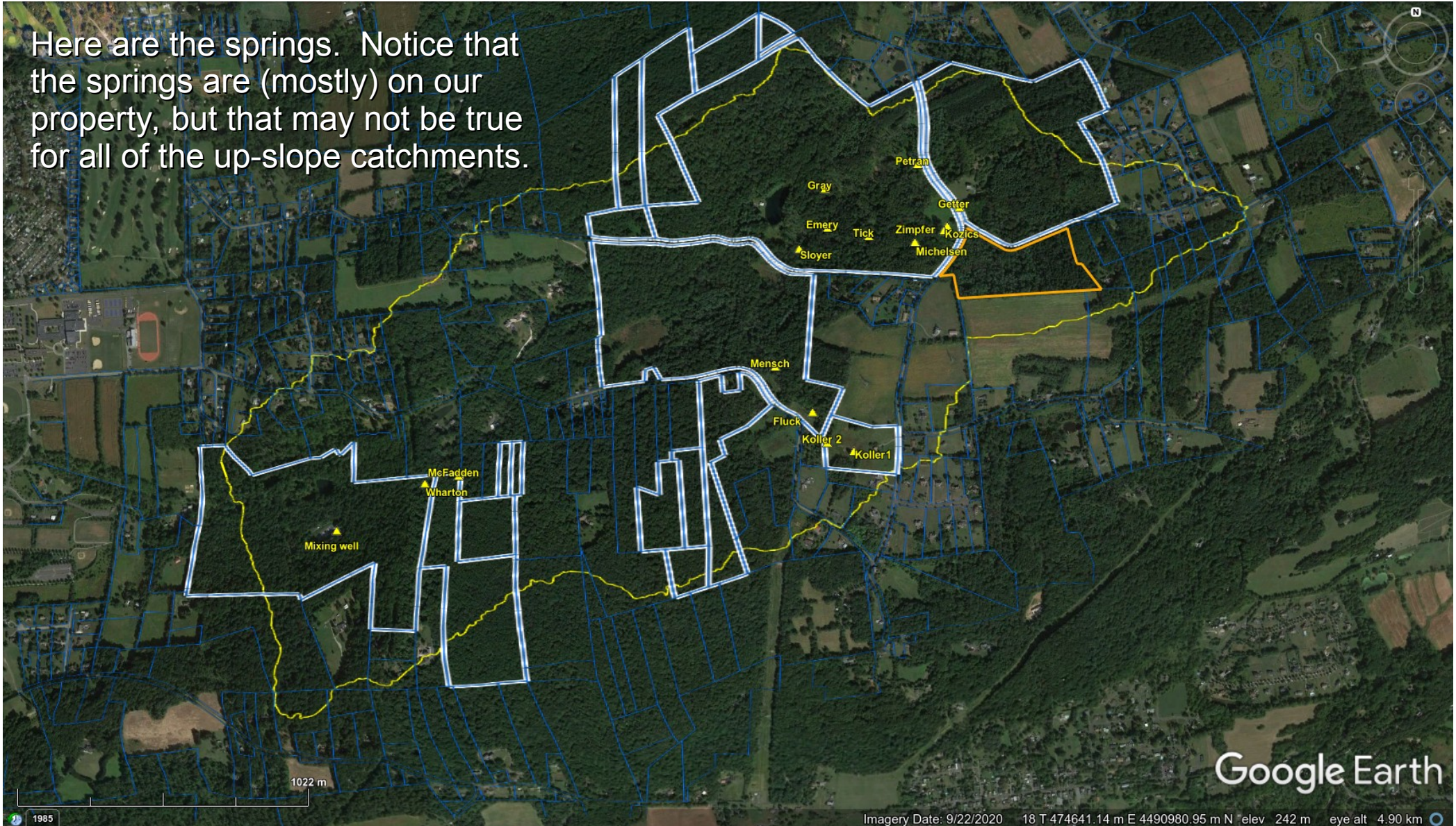
As a reminder,

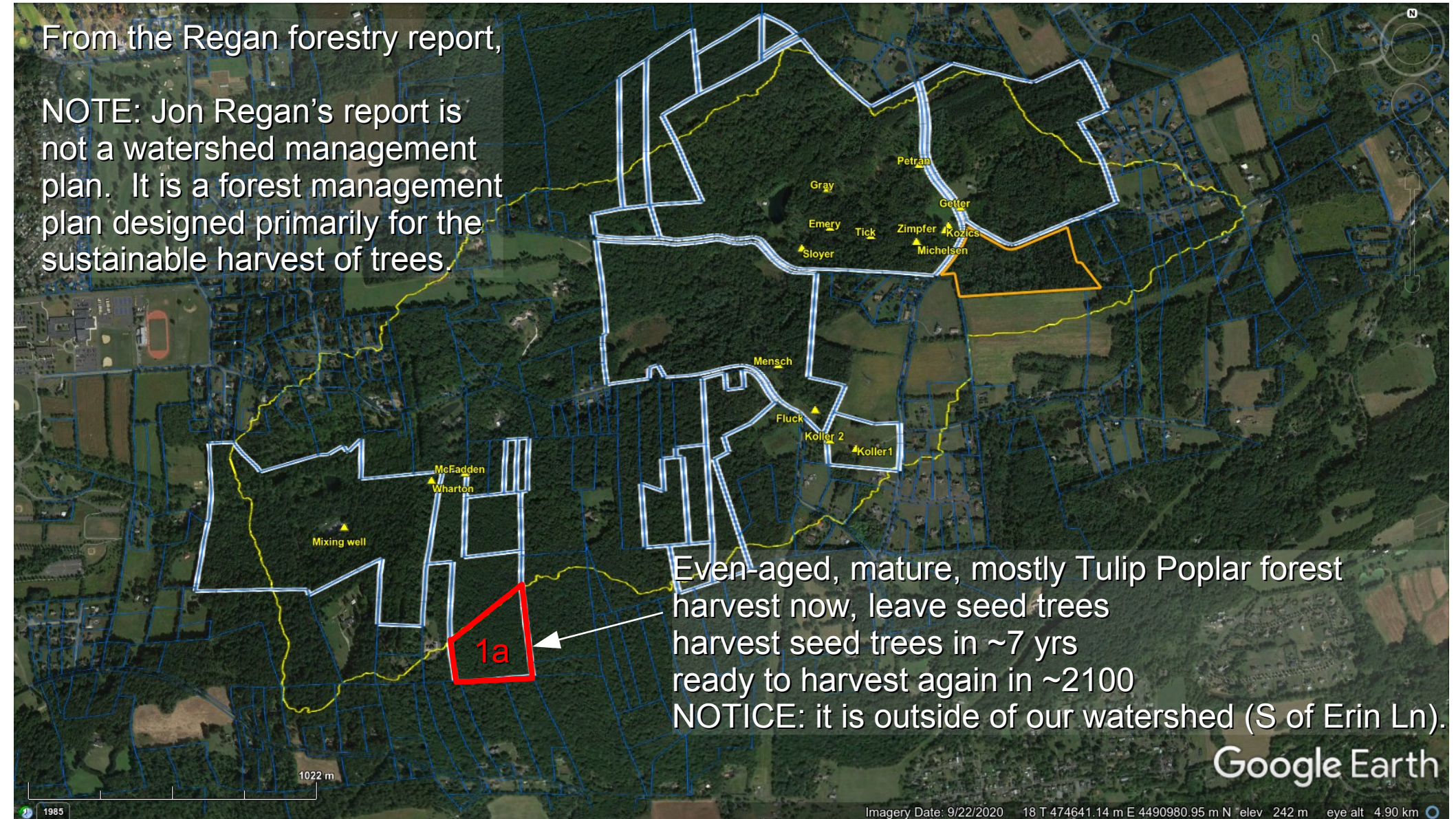
We seek a diverse, non-overstocked, uneven-aged forest land cover because this is best for watershed hydrology, ecosystem services, carbon sequestration, and resilience to climate change and pathogens.

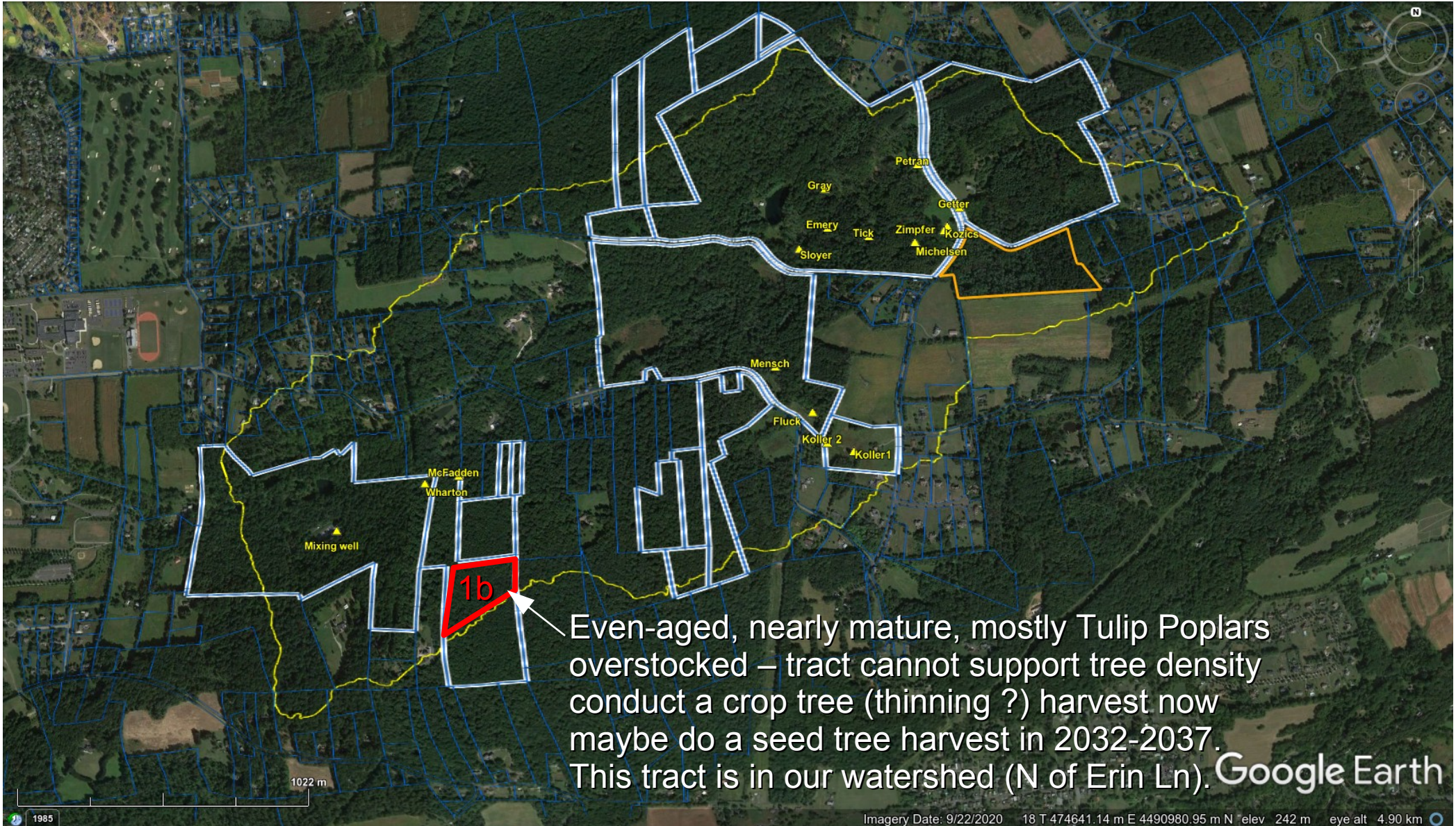

...let's return to our watershed, notice that most of it is forest cover
Reservoir Park
Drainage divide
1022 m
Google Earth
Imagery Date: 9/22/2020 18 T 474641.14 m E 4490980.95 m N elev 242 m eye alt 4.90 km

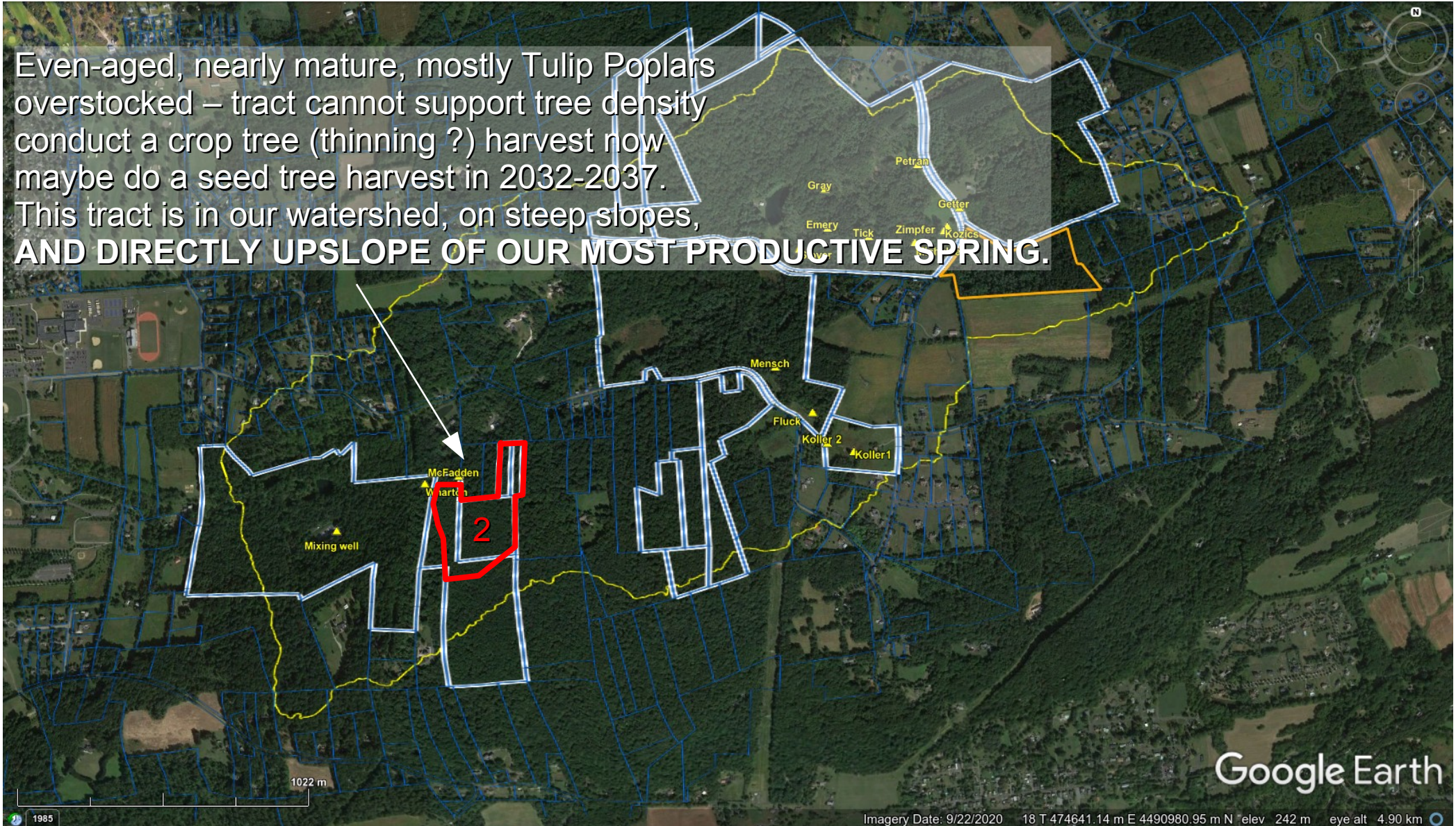

...here are the property boundaries.
1022 m
Google Earth
1985
Imagery Date: 9/22/2020 18 T 474641.14 m E 4490980.95 m N elev 242 m eye alt 4.90 km

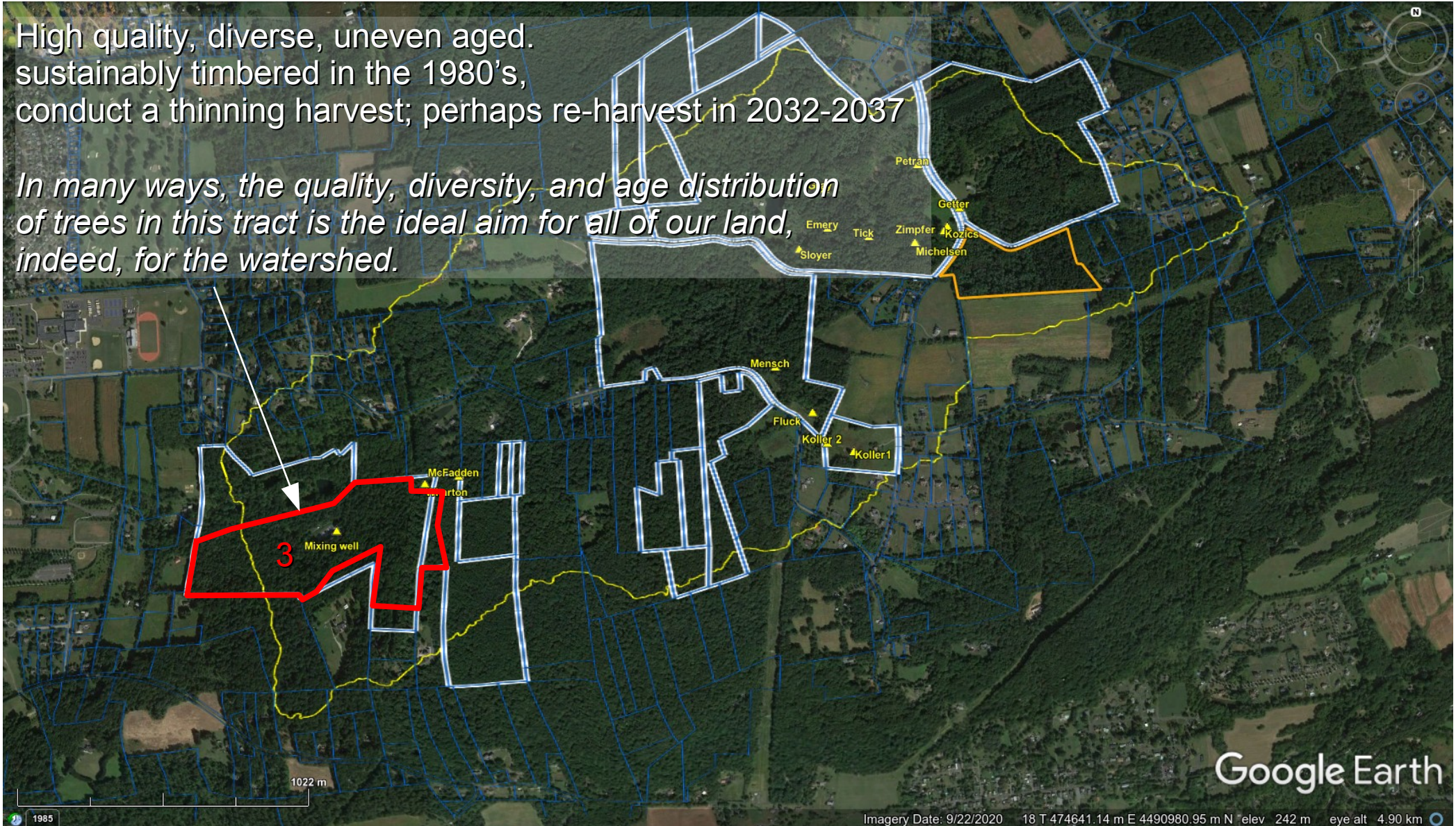

Here are the properties we own (~600 acres); notice that we do not own the whole watershed. There are other stakeholders.
- HBA customers
- Private home/land owners
- Lower Saucon Township
Whatever we do, needs to be mindful of all stakeholders
1022 m
Google Earth
1985
Imagery Date: 9/22/2020 18 T 474641.14 m E 4490980.95 m N elev 242 m eye alt 4.90 km

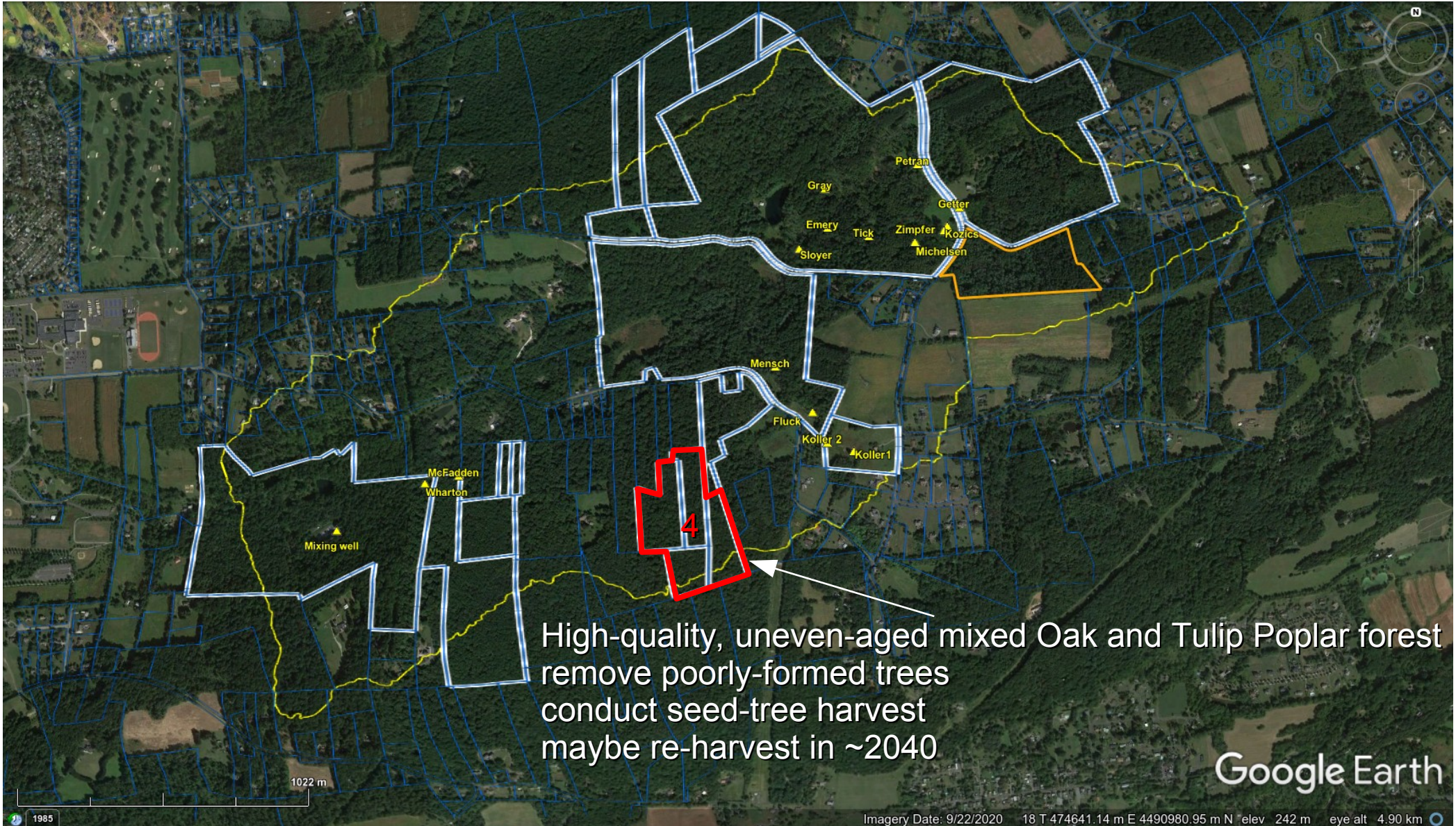

Here are the springs. Notice that the springs are (mostly) on our property, but that may not be true for all of the up-slope catchments.
Petran
Gray
Getter
Emery
Tick
Zimpfer
Kozics
Sloyer
Michelsen
Mensch
Fluck
Koller 2
Koller1
McFadden
Wharton
Mixing well
1022 m
Google Earth
1985
Imagery Date: 9/22/2020 18 T 474641.14 m E 4490980.95 m N elev 242 m eye alt 4.90 km

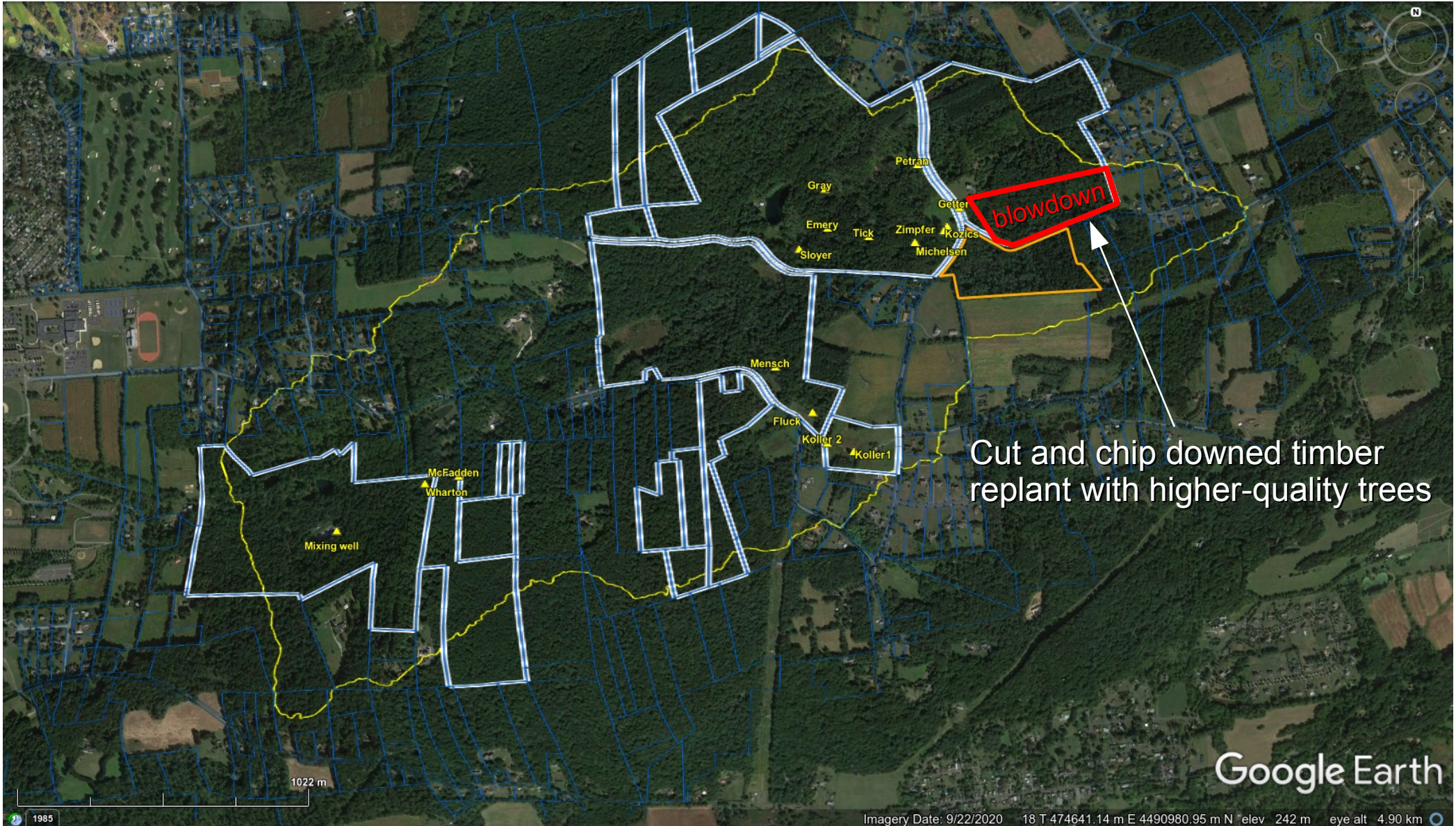

From the Regan forestry report,
NOTE: Jon Regan's report is not a watershed management plan. It is a forest management plan designed primarily for the sustainable harvest of trees.
Petran
Gray
Getter
Emery
Tick
Zimpfer
Kozics
Sloyer
Michelsen
Mensch
Fluck
Koller 2
Koller1
McFadden
Wharton
Mixing well
1a
Even-aged, mature, mostly Tulip Poplar forest
harvest now, leave seed trees
harvest seed trees in ~7 yrs
ready to harvest again in ~2100
NOTICE: it is outside of our watershed (S of Erin Ln).
1022 m
Google Earth
1985
Imagery Date: 9/22/2020 18 T 474641.14 m E 4490980.95 m N elev 242 m eye alt 4.90 km


Petran
Gray
Getter
Emery
Tick
Zimpfer
Kozics
Sloyer
Michelsen
Mensch
Fluck
Koller 2
Koller1
McFadden
Wharton
Mixing well
1b
Even-aged, nearly mature, mostly Tulip Poplars overstocked – tract cannot support tree density conduct a crop tree (thinning ?) harvest now maybe do a seed tree harvest in 2032-2037. This tract is in our watershed (N of Erin Ln).
1022 m
Google Earth
1985
Imagery Date: 9/22/2020 18 T 474641.14 m E 4490980.95 m N elev 242 m eye alt 4.90 km


Even-aged, nearly mature, mostly Tulip Poplars
overstocked – tract cannot support tree density
conduct a crop tree (thinning ?) harvest now
maybe do a seed tree harvest in 2032-2037.
This tract is in our watershed, on steep slopes,
AND DIRECTLY UPSLOPE OF OUR MOST PRODUCTIVE SPRING.
Petran
Gray
Getter
Emery
Tick
Zimpfer
Kozics
Mensch
Fluck
Koller 2
Koller1
McFadden
2
Mixing well
1022 m
Google Earth
1985
Imagery Date: 9/22/2020 18 T 474641.14 m E 4490980.95 m N elev 242 m eye alt 4.90 km


High quality, diverse, uneven aged.
sustainably timbered in the 1980's,
conduct a thinning harvest; perhaps re-harvest in 2032-2037
In many ways, the quality, diversity, and age distribution of trees in this tract is the ideal aim for all of our land, indeed, for the watershed.
Petran
Getter
Emery
Tick
Zimpfer
Kozics
Sloyer
Michelsen
Mensch
Fluck
Koller 2
Koller1
McFadden
3
Mixing well
1022 m
Google Earth
Imagery Date: 9/22/2020 18 T 474641.14 m E 4490980.95 m N elev 242 m eye alt 4.90 km

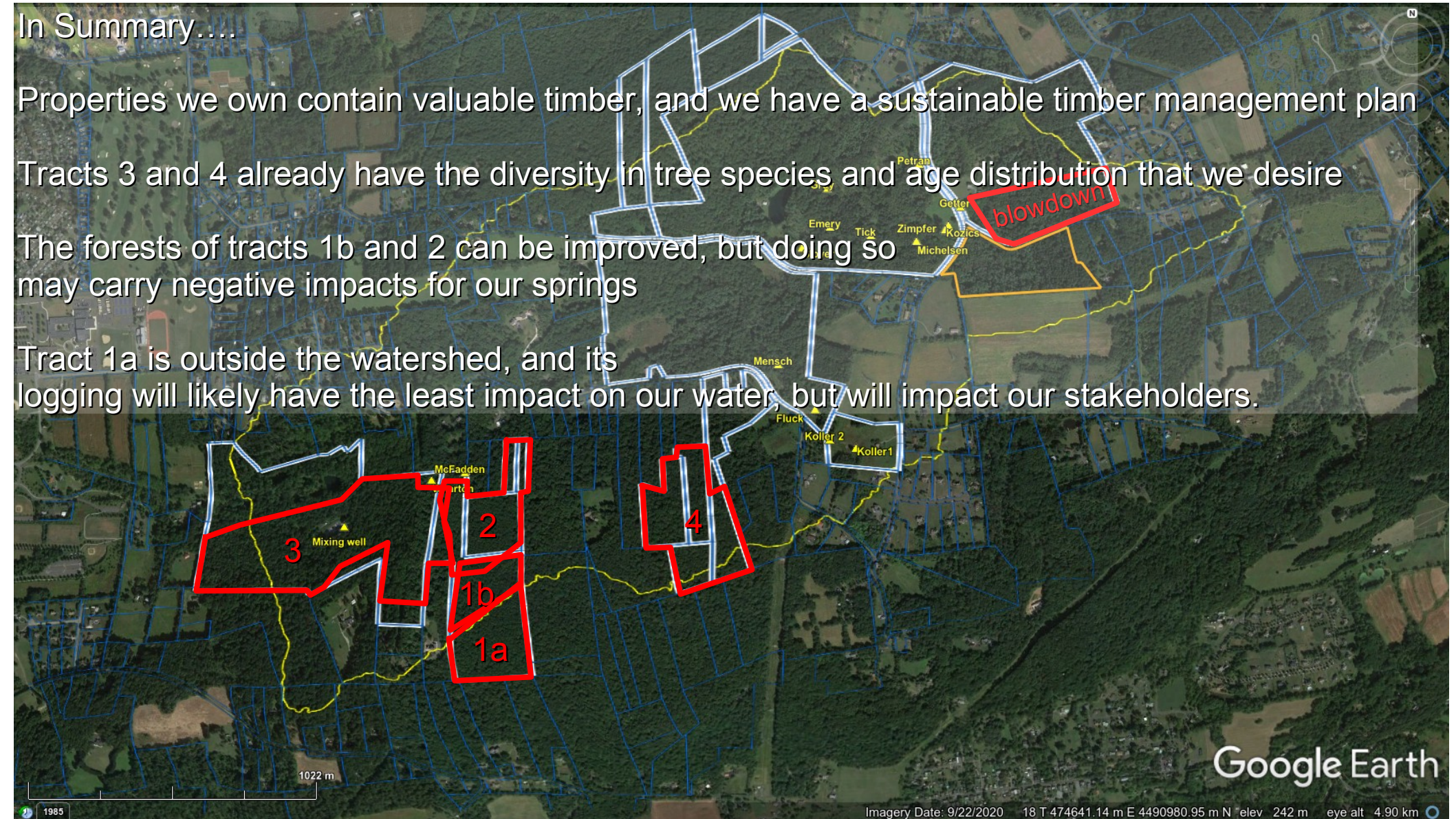

Petran
Gray
Getter
Emery
Tick
Zimpfer
Kozics
Sloyer
Michelsen
Mensch
Fluck
Koller 2
Koller1
McFadden
Wharton
Mixing well
4
High-quality, uneven-aged mixed Oak and Tulip Poplar forest
remove poorly-formed trees
conduct seed-tree harvest
maybe re-harvest in ~2040
1022 m
Google Earth
1985
Imagery Date: 9/22/2020 18 T 474641.14 m E 4490980.95 m N elev 242 m eye alt 4.90 km

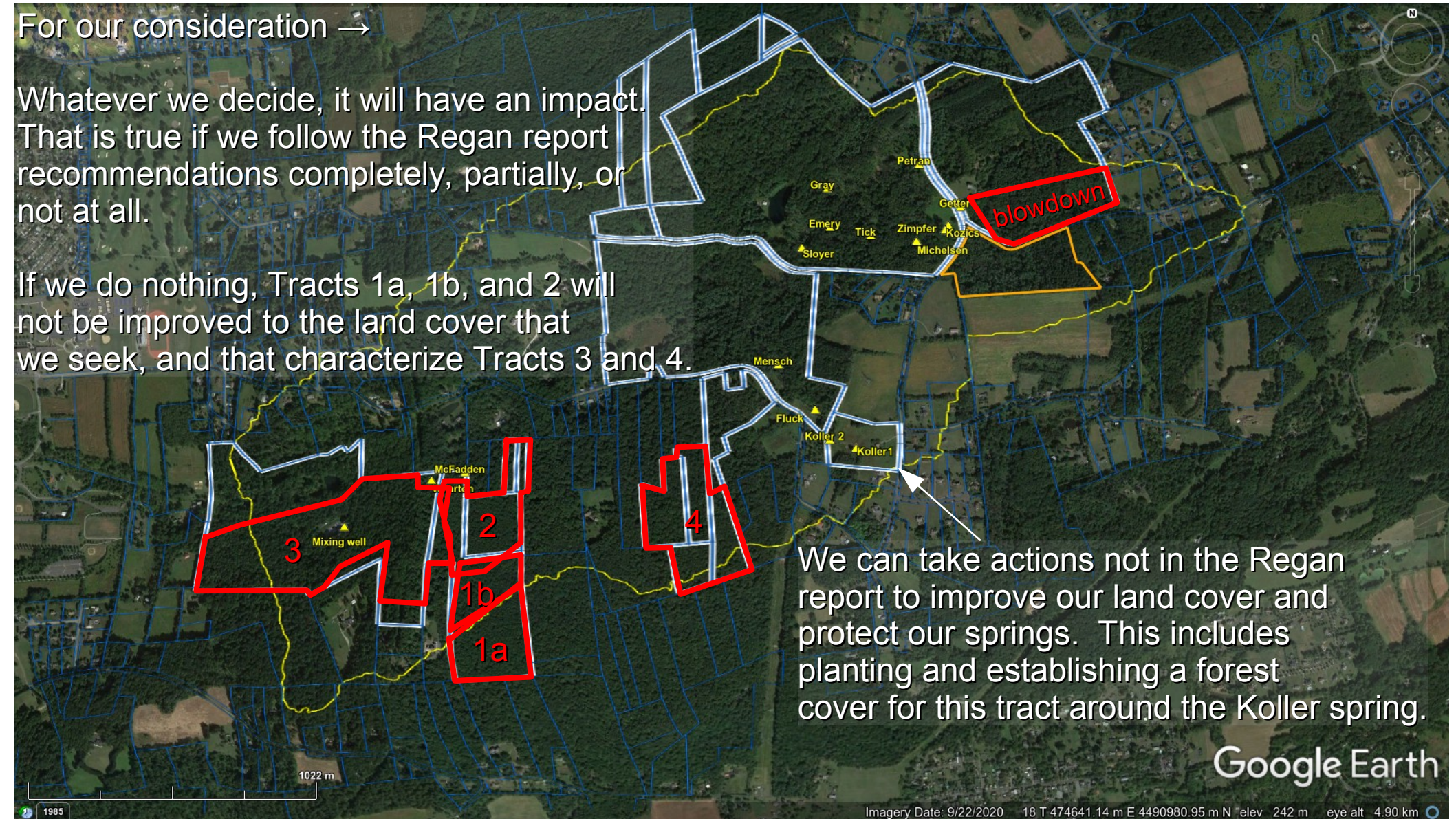

Petran
Gray
Getter
blowdown
Emery
Tick
Zimpfer
Kozics
Michelsen
Sloyer
Mensch
Fluck
Koller 2
Koller1
McFadden
Wharton
Mixing well
Cut and chip downed timber
replant with higher-quality trees
1022 m
Google Earth
1985
Imagery Date: 9/22/2020 18 T 474641.14 m E 4490980.95 m N elev 242 m eye alt 4.90 km

In all cases, the Regan report recommends repeated application of herbicides to reduce underbrush and allow young seedlings to thrive.

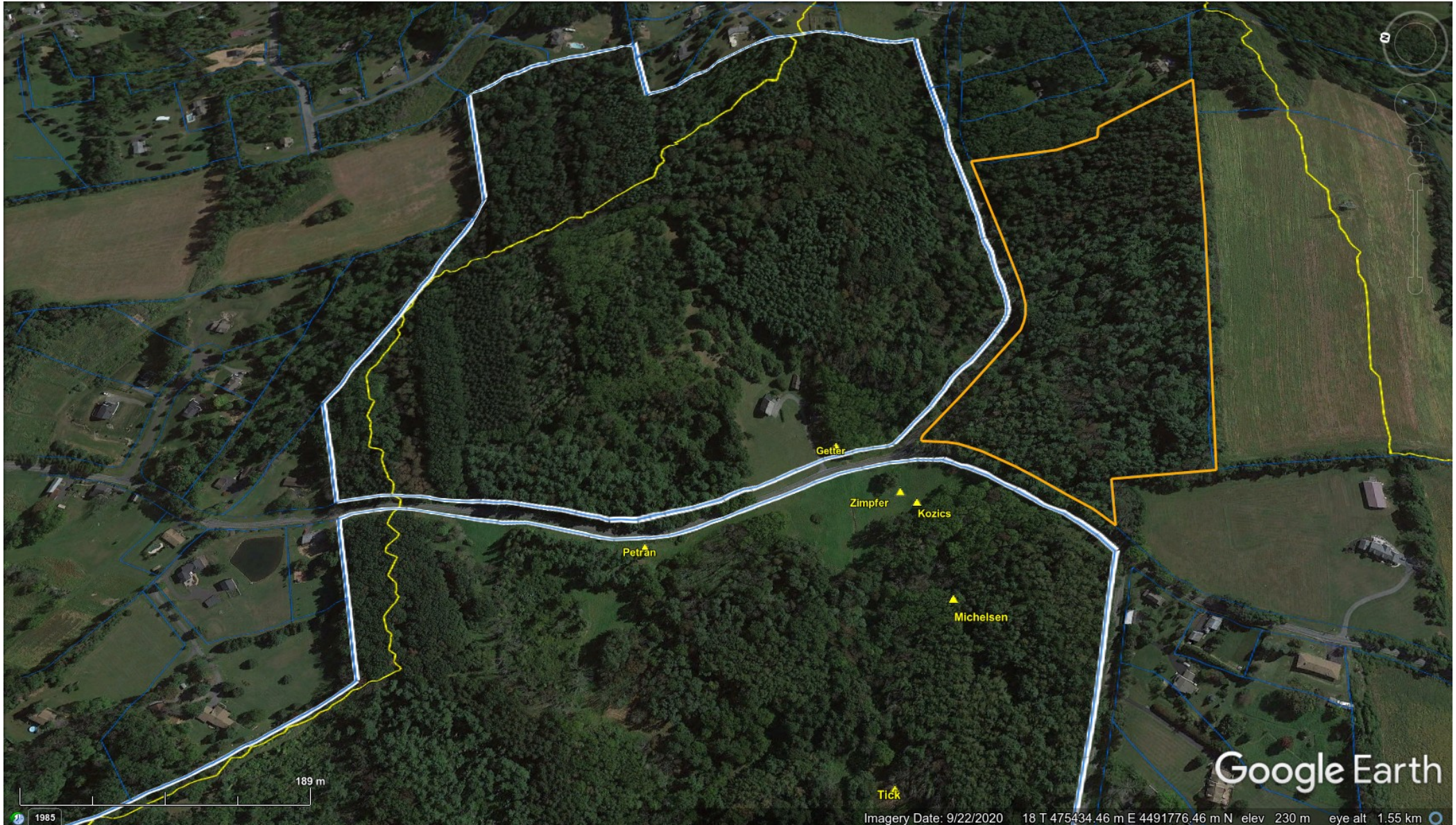
Cutting trees in 1b, 2, and 3 will likely result in larger, but less steady, and possibly more turbid spring discharge over ~10 yr period until larger trees are established.

Even if considered harmless, the optics of repeated application of herbicides directly upslope of our springs are not positive, and indefensible to our stakeholders.


In Summary….
Properties we own contain valuable timber, and we have a sustainable timber management plan
Tracts 3 and 4 already have the diversity in tree species and age distribution that we desire
The forests of tracts 1b and 2 can be improved, but doing so may carry negative impacts for our springs
Tract 1a is outside the watershed, and its logging will likely have the least impact on our water, but will impact our stakeholders.
blowdown
Petran
Getter
Emery
Tick
Zimpfer
Kozics
Michelsen
Mensch
Fluck
Koller 2
Koller1
McFadden
Mixing well
3
2
1b
1a
4
1022 m
1985
Google Earth
Imagery Date: 9/22/2020 18 T 474641.14 m E 4490980.95 m N elev 242 m eye alt 4.90 km


For our consideration →
Whatever we decide, it will have an impact. That is true if we follow the Regan report recommendations completely, partially, or not at all.
If we do nothing, Tracts 1a, 1b, and 2 will not be improved to the land cover that we seek, and that characterize Tracts 3 and 4.
Petran
Gray
Getter
blowdown
Emery
Tick
Zimpfer
Kozics
Sloyer
Michelsen
Mensch
Fluck
Koller 2
Koller1
McFadden
3
Mixing well
2
1b
1a
4
We can take actions not in the Regan report to improve our land cover and protect our springs. This includes planting and establishing a forest cover for this tract around the Koller spring.
1022 m
Google Earth
1985
Imagery Date: 9/22/2020 18 T 474641.14 m E 4490980.95 m N elev 242 m eye alt 4.90 km

Extra slides.


Getter
Zimpfer
Kozics
Petran
Michelsen
Tick
189 m
1985
Google Earth
Imagery Date: 9/22/2020 18 T 475434.46 m E 4491776.46 m N elev 230 m eye alt 1.55 km

https://commons.wikimedia.org/wiki/File:Liriodendron_tulipifera12.jpg

70-90 ft, 40 ft wide

Fast growing, 2 ft/yr

Full sun

Colonization tree

~100-300 yrs