Historic Reconstruction of PFAS in Public Water Supplies Cape Cod, MA

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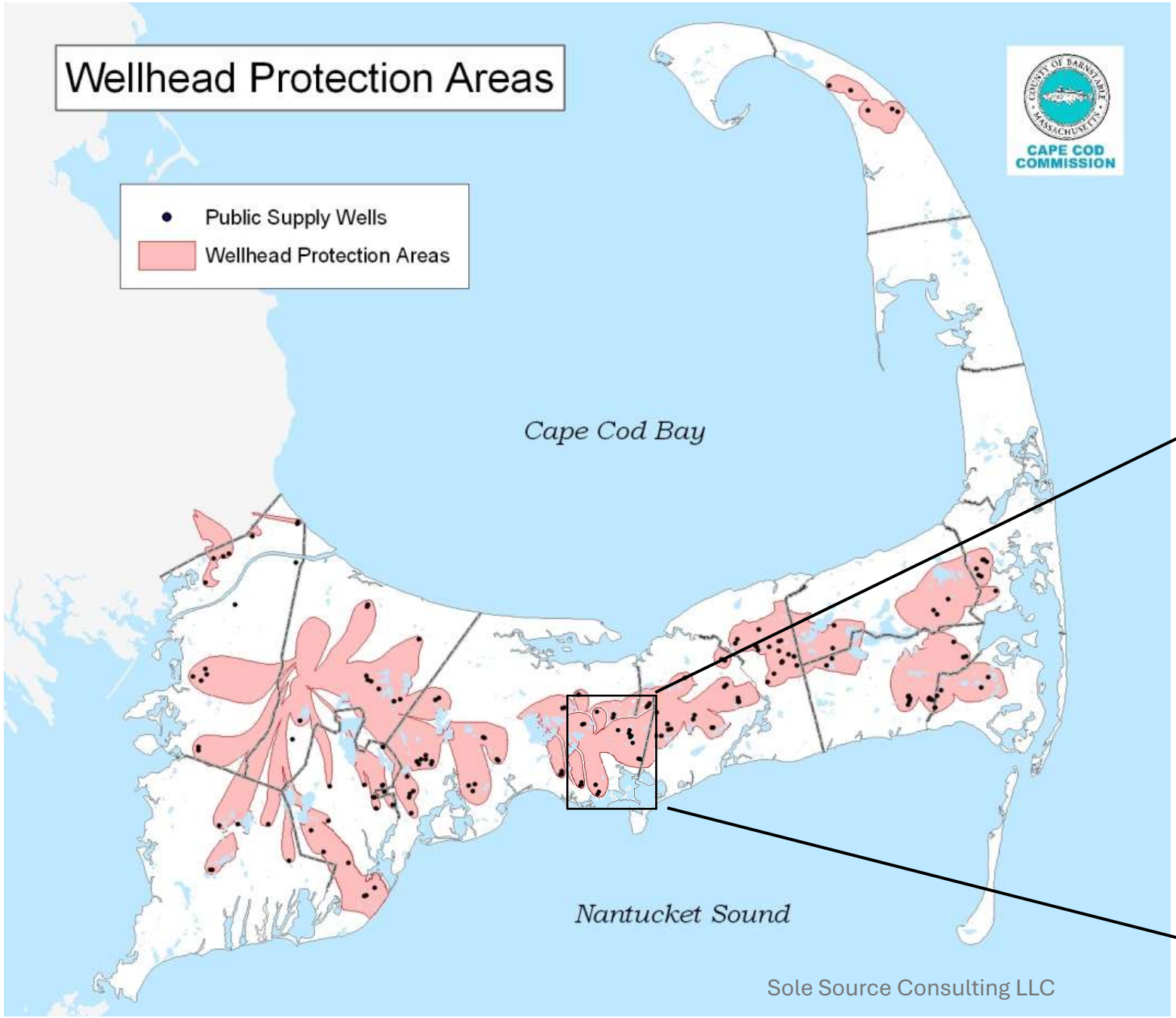
NEWMOA

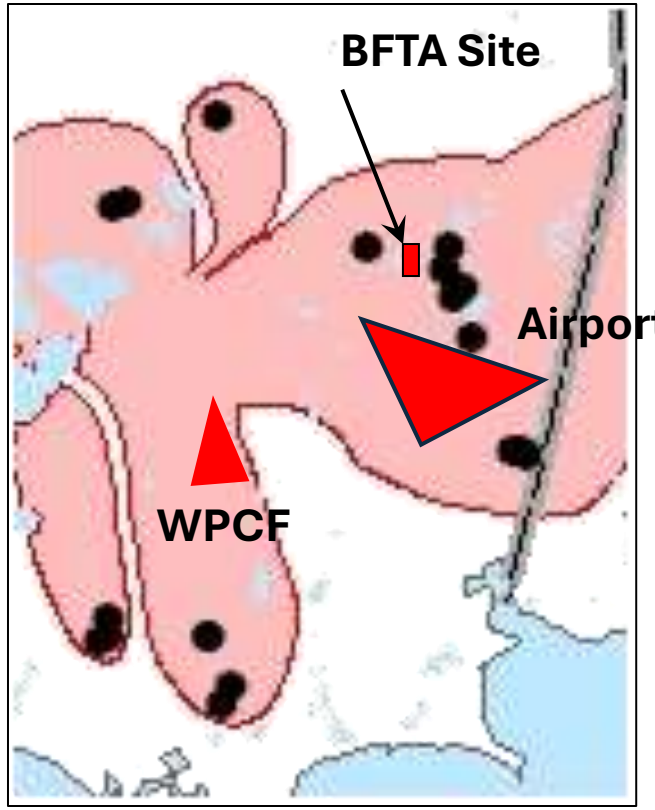
Science of PFAS: Public Health & The Environment
Best Western Royal Plaza Hotel & Trade Center
Marlborough, MA
10:45 AM Session AFFF Impacted Sites
April 4, 2024

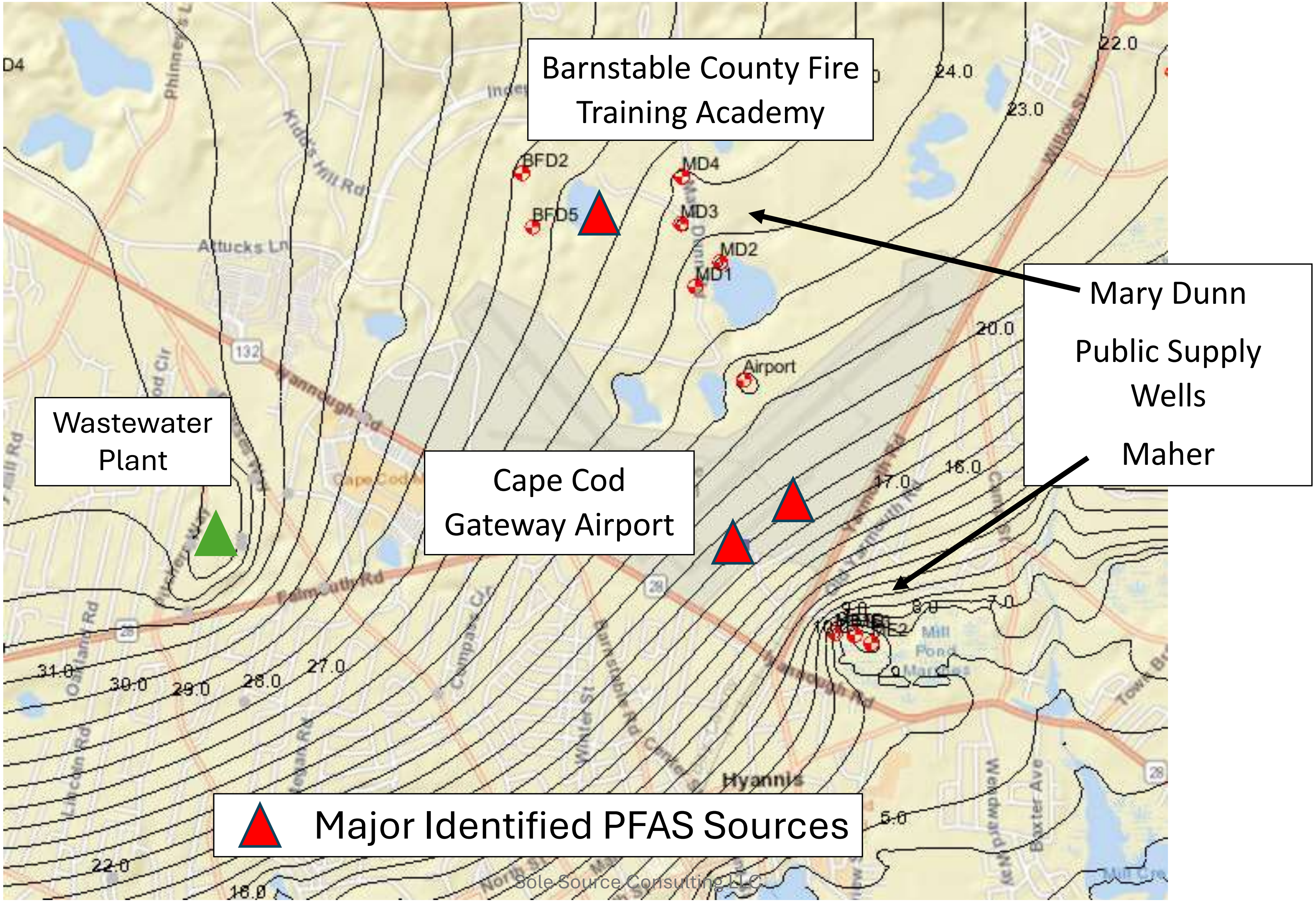
Background and Project Objectives

- PFAS concentrations in Hyannis drinking water is in the top 1% of the National UCMR 3 sampling data (2013-2015).
- Fire Training has occurred at major sites since the 1950's.
- Nearly 800 blood serum samples have been collected from Hyannis residents by Silent Spring Institute as part of CDC/ATSDR PFAS Multi-Site Study over the last year.
- Limited PFAS data for drinking water before 2014
- A groundwater solute transport model is used to reconstruct historical PFAS concentrations in the Hyannis area drinking water and length of exposures.

Hyannis Area Case Study







PFAS Compounds in 11 Hyannis Public Supply Wells

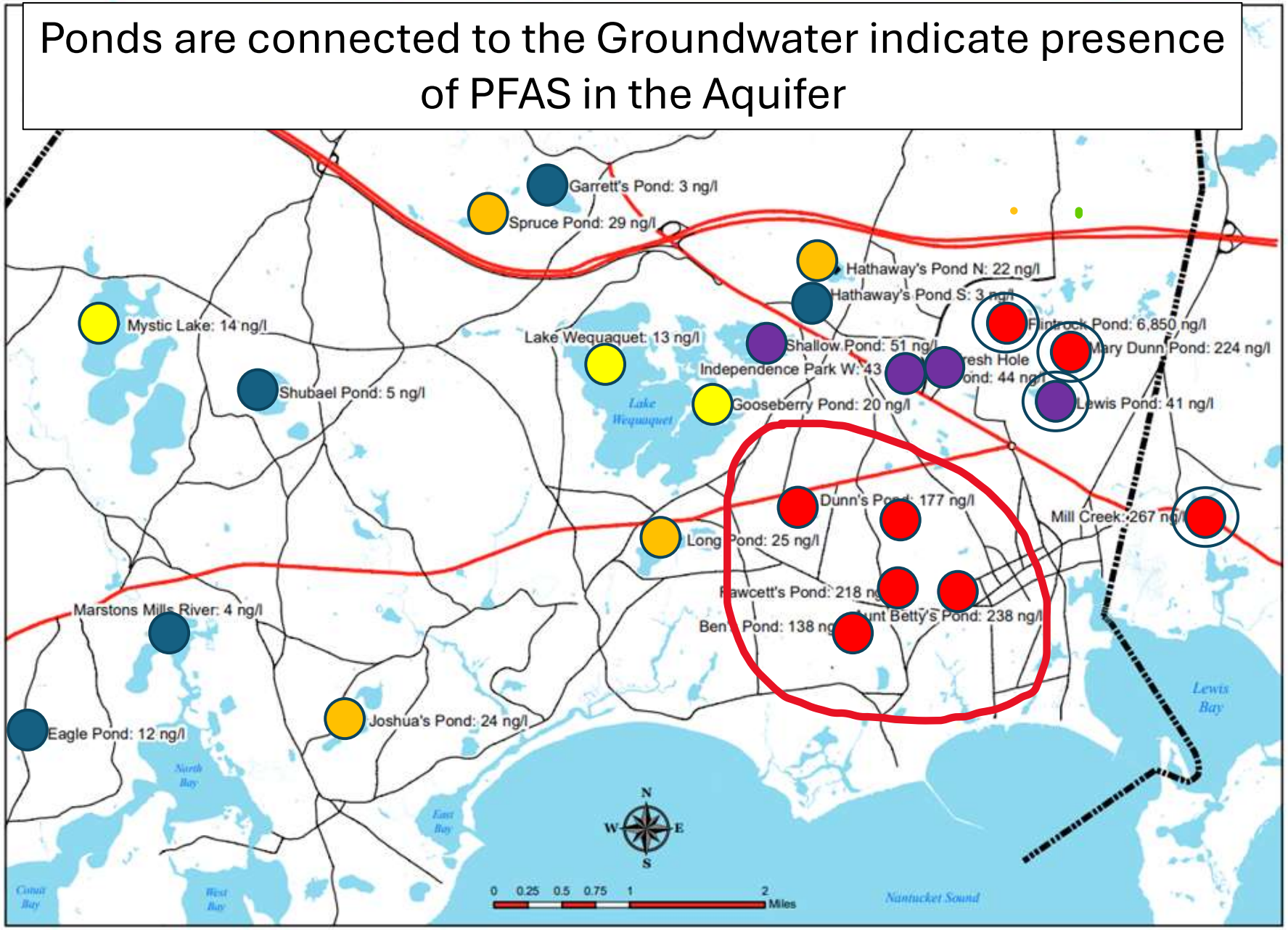
First Detected in 2009 (Schaider, 2010)

PFAS Data 2013 to 2023

Results in ng/l	PFOS		PFOA		PFHxS		PFHpA		PFDA		PFNA		6:2FTS		PFBS	
Well	**PFOS Ave**	**Count**	**PFOA Ave**	**Count**	**PFHxS Ave**	**Count**	**PFHpA Av**	**Count**	**PFDA Ave**	**Count**	**PFNA Ave**	**Count**	**6:2 FTS Av**	**Count**	**PFBS**	**Count**
Airport Well	18.19	18.0	9.33	8	24.20	9	9.40	10	NA	0	1.72	2	58.00	1	1.46	2
Hyannisport Well	15.69	7.0	6.61	6	15.98	4	2.77	3	NA	0	0.00	1	0.00	1	5.84	4
Maher 1	101.61	12.0	21.29	12	34.75	11	18.75	11	NA	0	16.83	6	36.00	5	2.03	8
Maher 2	83.14	12.0	14.43	12	51.72	10	12.78	10	NA	0	4.49	2	120.68	5	4.63	9
Maher 3	81.59	11.0	14.25	11	36.34	10	7.79	10	NA	0	4.71	5	7.07	5	1.52	7
MD 1	80.29	52.0	5.93	40	17.87	34	8.22	31	1.73	2	5.77	24	0.00	1	5.40	6
MD 2	239.59	56.0	21.56	54	96.69	38	21.88	39	1.18	1	18.00	33	11.20	1	8.88	27
MD 3	171.22	45.0	23.52	44	89.97	32	20.79	31	2.02	1	10.14	29	41.10	1	7.70	25
Simmons Pond Well	35.62	6.0	10.95	6	29.60	4	4.84	4	0	1	0.00	1	0.00	1	4.90	4
Straightway Well 1	16.28	4.0	12.95	4	21.03	3	7.53	2	NA	0	4.40	1	0.00	1	8.09	2
Straightway Well 2	36.00	6.0	15.33	6	29.08	4	5.29	4	NA	0	0.00	1	0.00	1	3.93	4

Treatment incrementally installed on wells from 2015 to 2020

Ponds are connected to the Groundwater indicate presence of PFAS in the Aquifer



Total PFAS in Hyannis Area Ponds (ng/l) 2019-2020

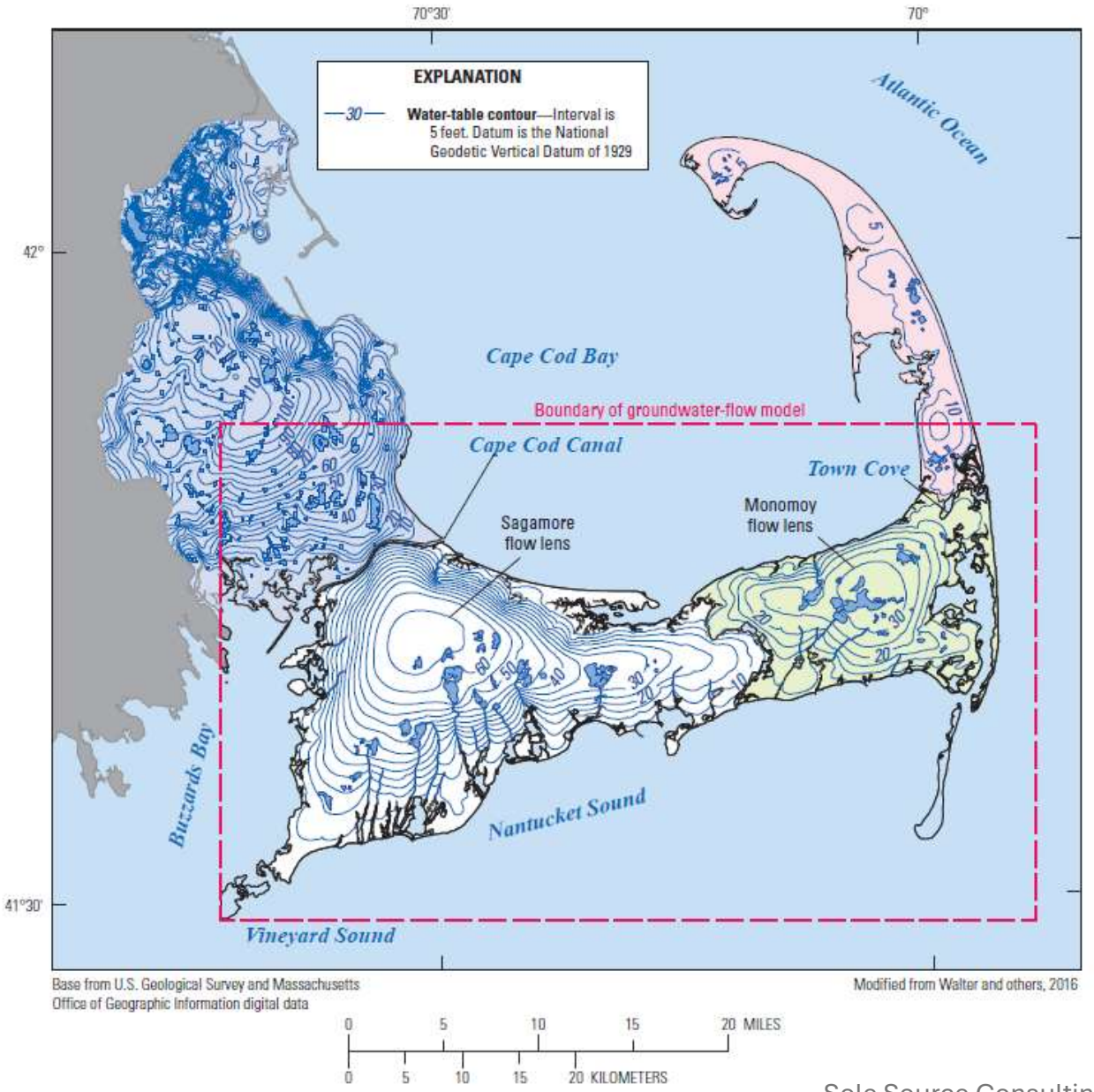
- ≤ 10
- ≤ 20
- ≤ 30
- ≤ 55
- > 100 ≤ 300

Tested by Others

Sole Source Consulting, 2020

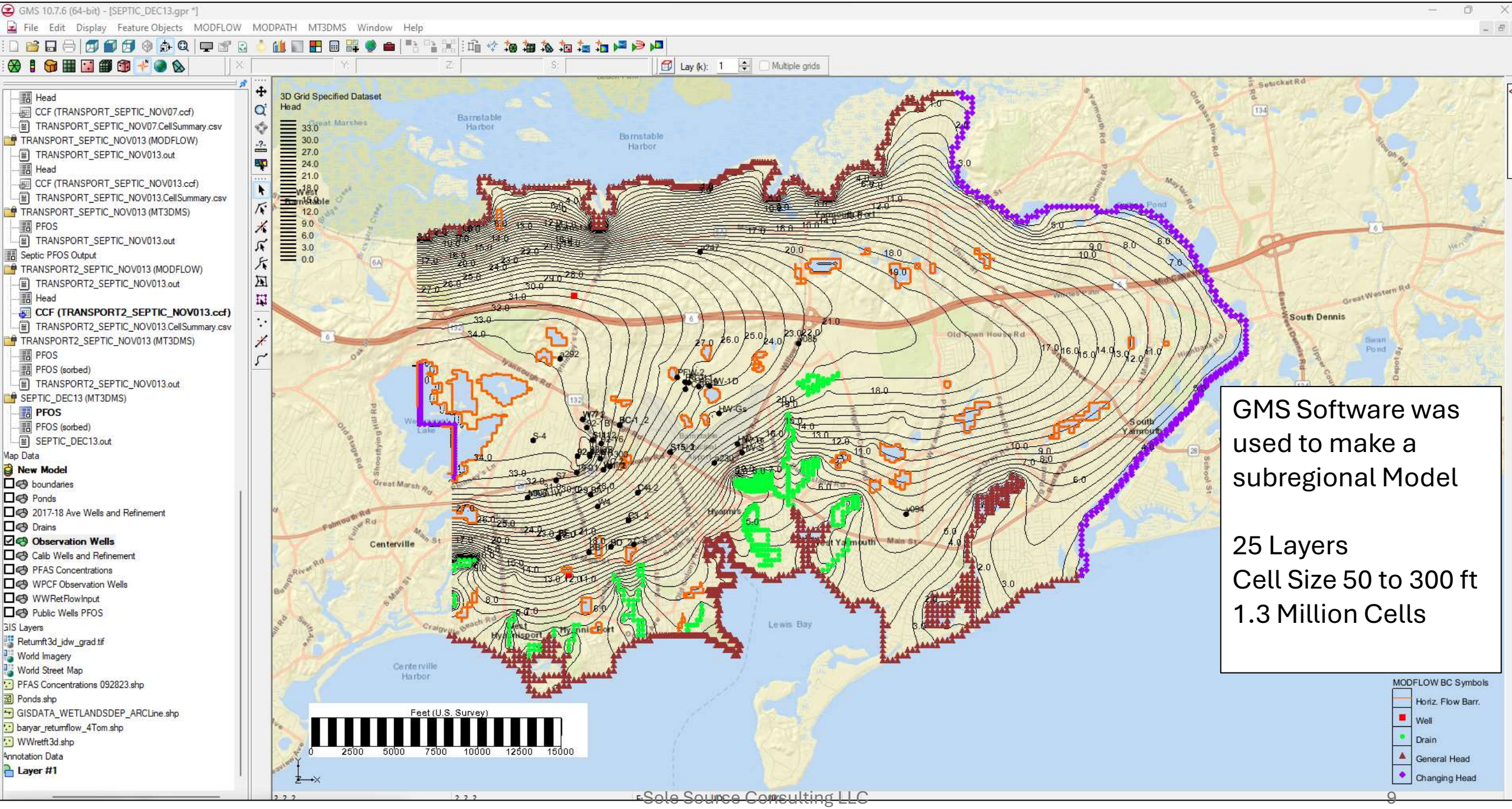
Modeling Approach

- Model conditions from 1970 to 2022 (52 Years)
- Simulate PFOS from the Major Point Sources over time
  - FTA and Impacts on Mary Dunn and Maher Water Supply Wells
  - Airport and Impacts on Maher Water Supply Wells
- Calculate PFOS concentrations in the distribution system from additive impacts.
- Apply past PFOS concentrations to Wastewater Discharge
- Apply past PFOS concentrations to area Septic Systems.



The 2019 USGS regional groundwater model was used as the basis to model PFAS in the Aquifer.

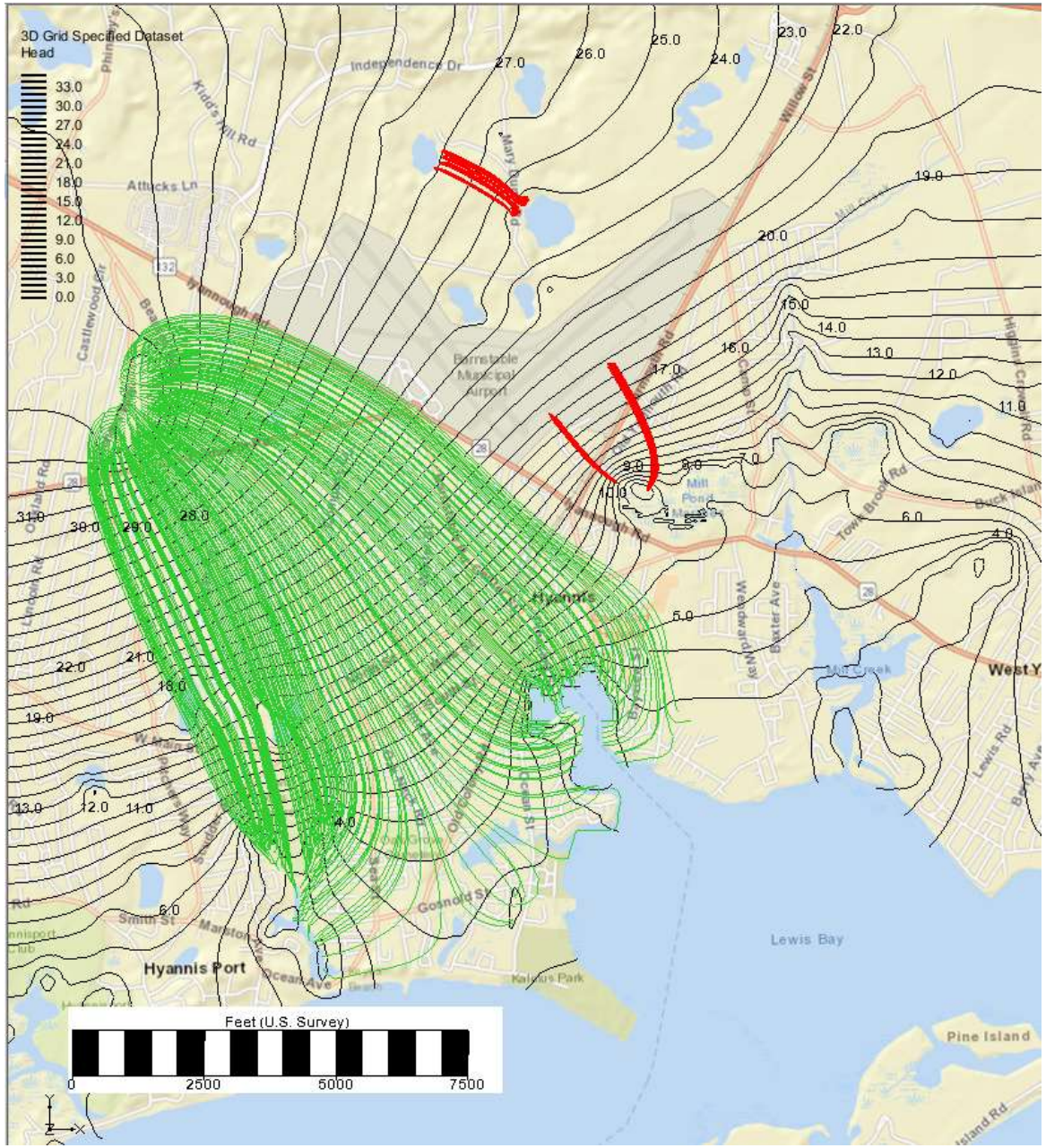
USGS SIR 2019-5121

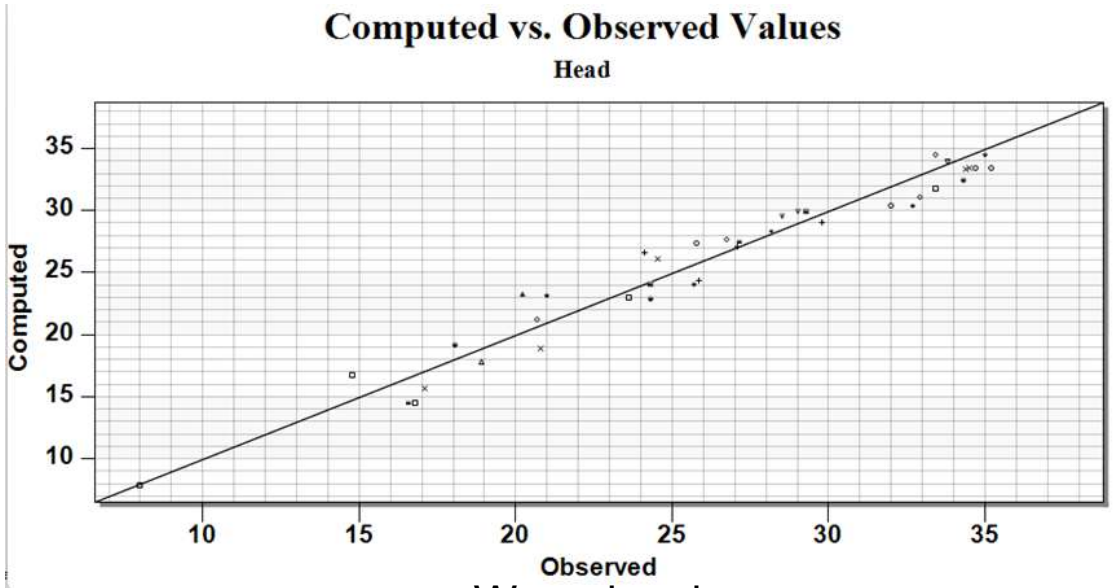


GMS Software was used to make a subregional Model

25 Layers
Cell Size 50 to 300 ft
1.3 Million Cells

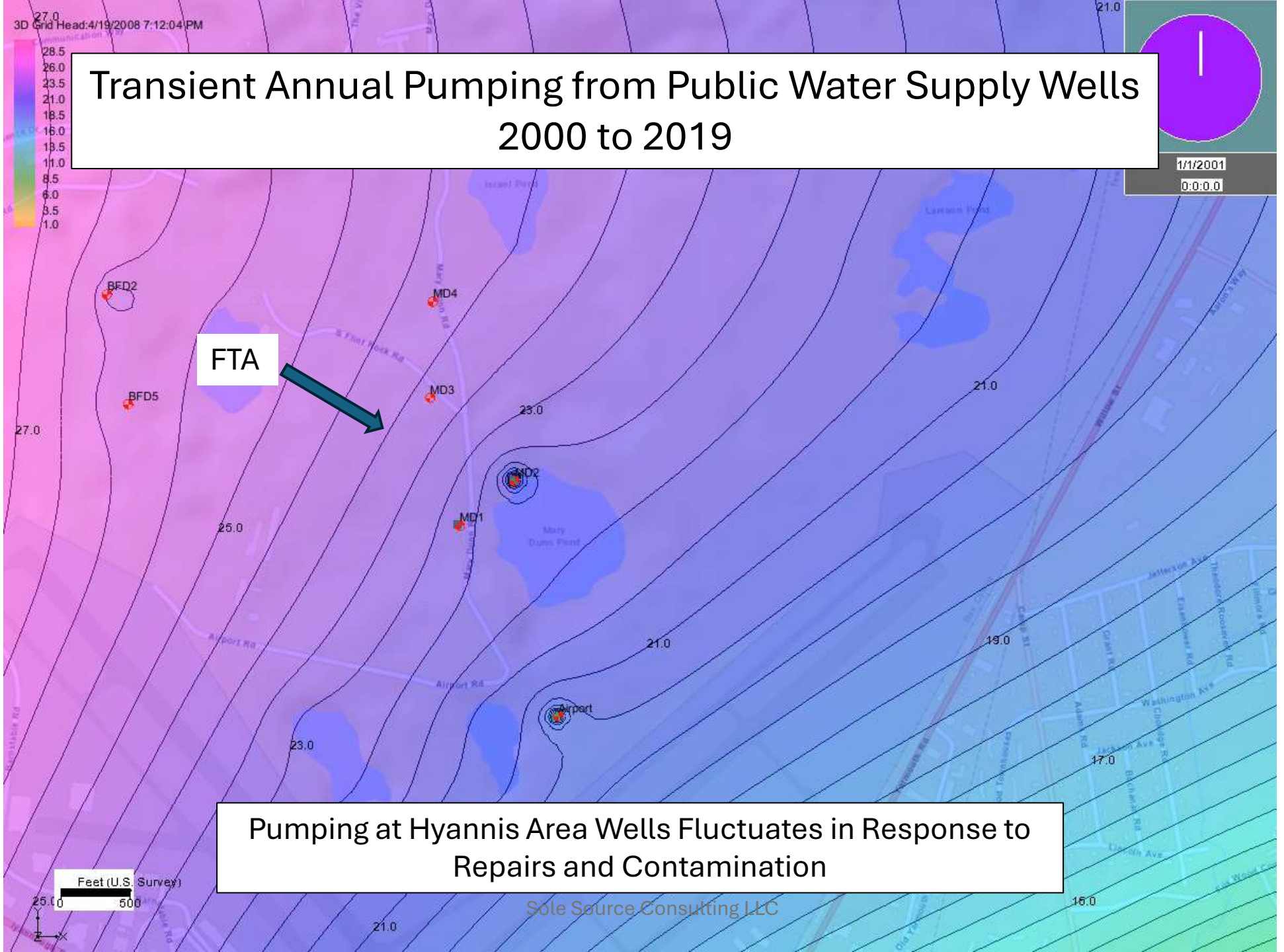
Sub Regional Model Calibration and Initial Particle Tracks





Water levels

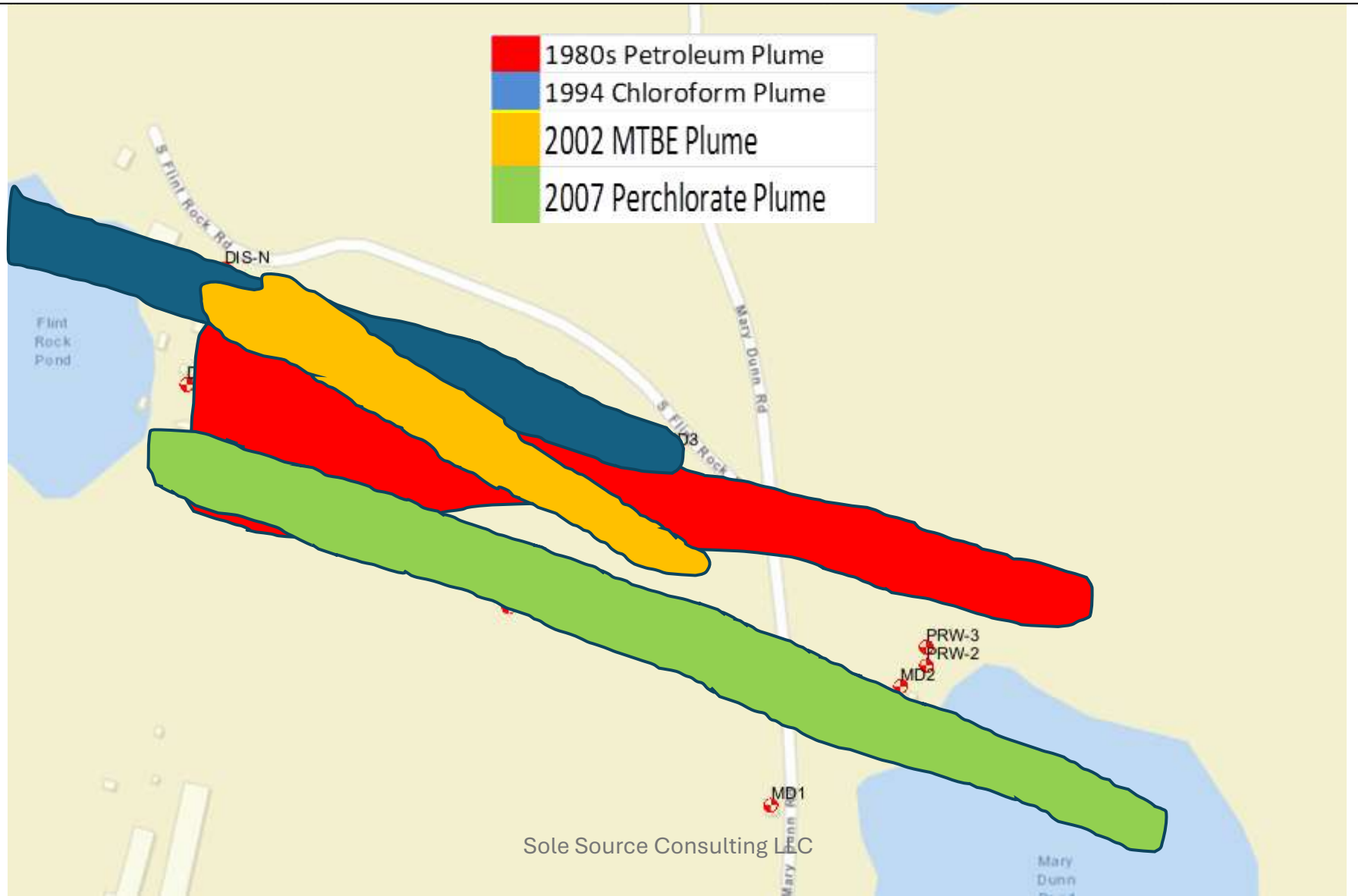
Property	Value
Mean Residual (Head)	0.25
Mean Absolute Residual (Head)	1.28
Root Mean Squared Residual (Head)	1.47



Transient Annual Pumping from Public Water Supply Wells 2000 to 2019

Pumping at Hyannis Area Wells Fluctuates in Response to Repairs and Contamination

Previous Remedial Pump and Treat Actions and Source Reductions have impact on PFAS Distribution



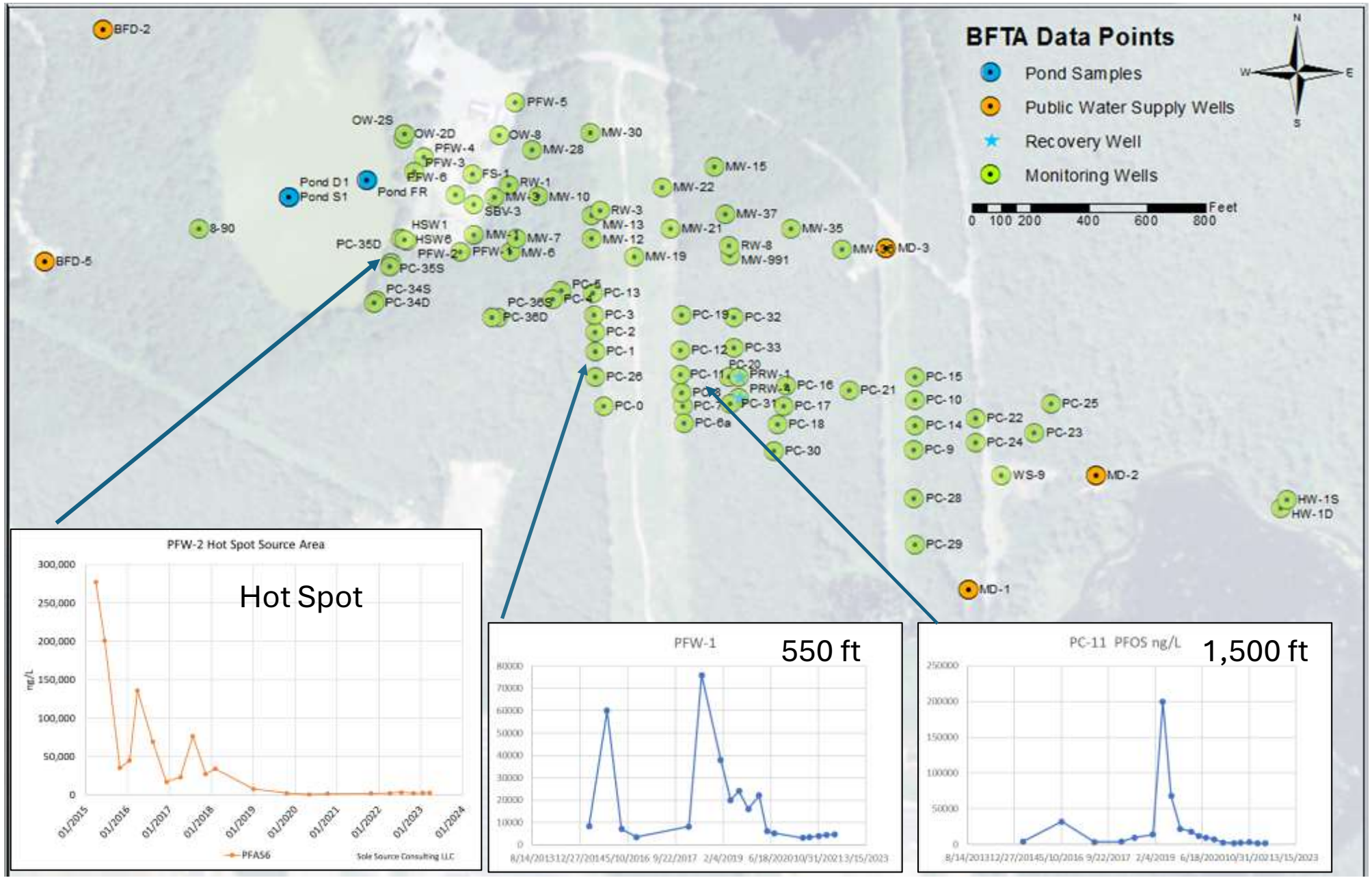
Variable Activity Areas over 50 Years

1968

1995

2014

Breakthrough curves are used to calculate PFOS transport velocity



Groundwater Flow and MT3DMS Solute Transport Terms

- Groundwater Flow Velocity ~1.3 Ft/d
- Porosity ~ .35
- Longitudinal Dispersivity (ft) ~ 35 / 3.5 / 0.35 (Regional Scale)
- PFOS Transport ~ 1.0 ft/d

- Bulk Density ~ 1.64 g/cm^3 ITRC – Weber 2018
- Retardation ~ 0.33 Calculated
- Kd ~ .017 cm^3/g Calculated

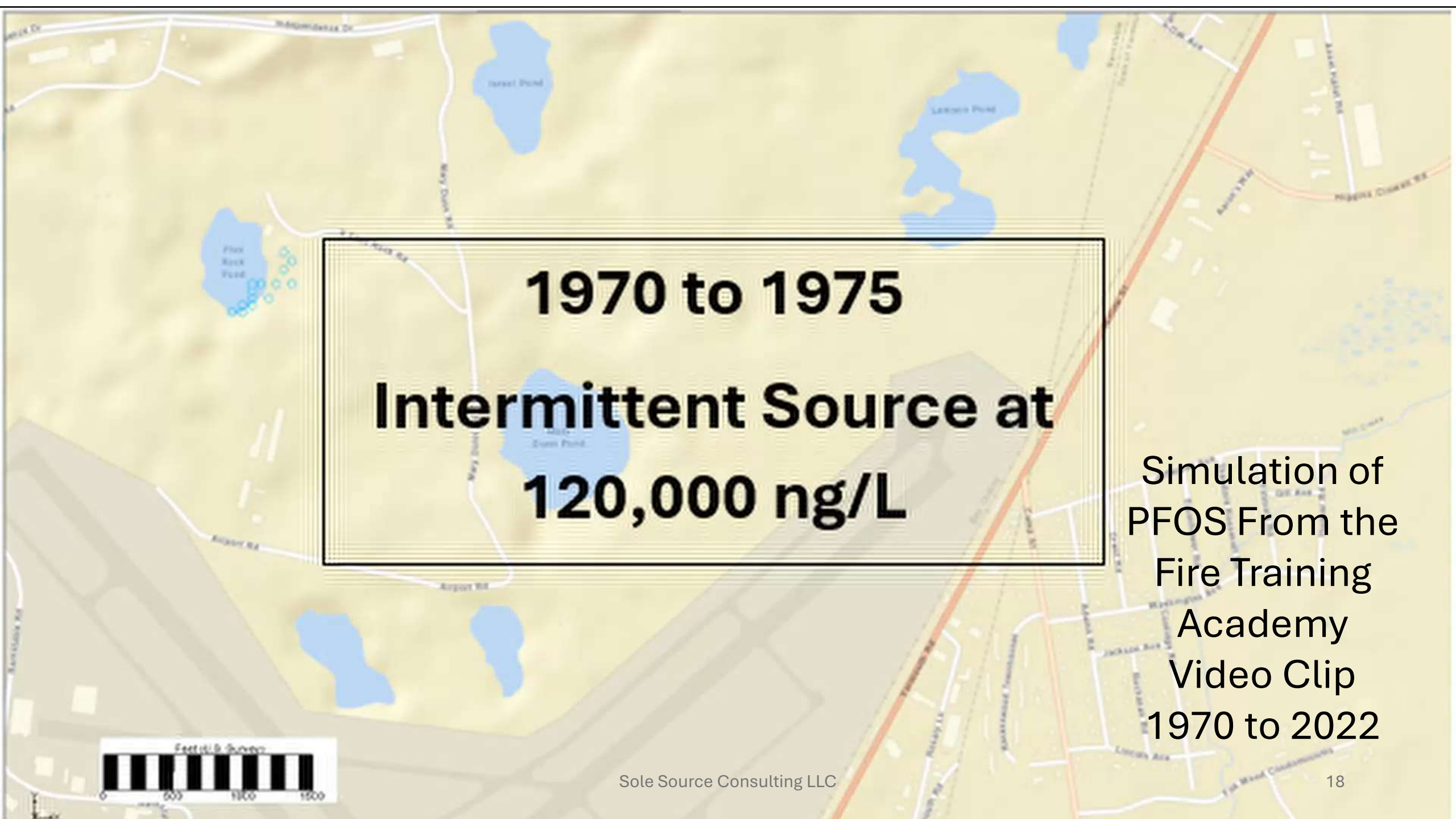
Source Term Approach

- Use Groundwater PFOS Concentrations /No Vadose Modeling
- Assumed 1970 as the beginning of Release
- Training Schedule indicated: 3 Months-Spring / 2 Months-Fall
  - Max Detections: BFTA -320,000 ng/L Airport 703 ng/L
- Variable and Intermittent Source Combines Average Highs and allows for changes in Source Position and Concentration
- Used 120,000 ng/L source alternating with 0 ng/L and increasing with assumed residual build-up
- Actual Source PFOS concentrations in later years - 2014+

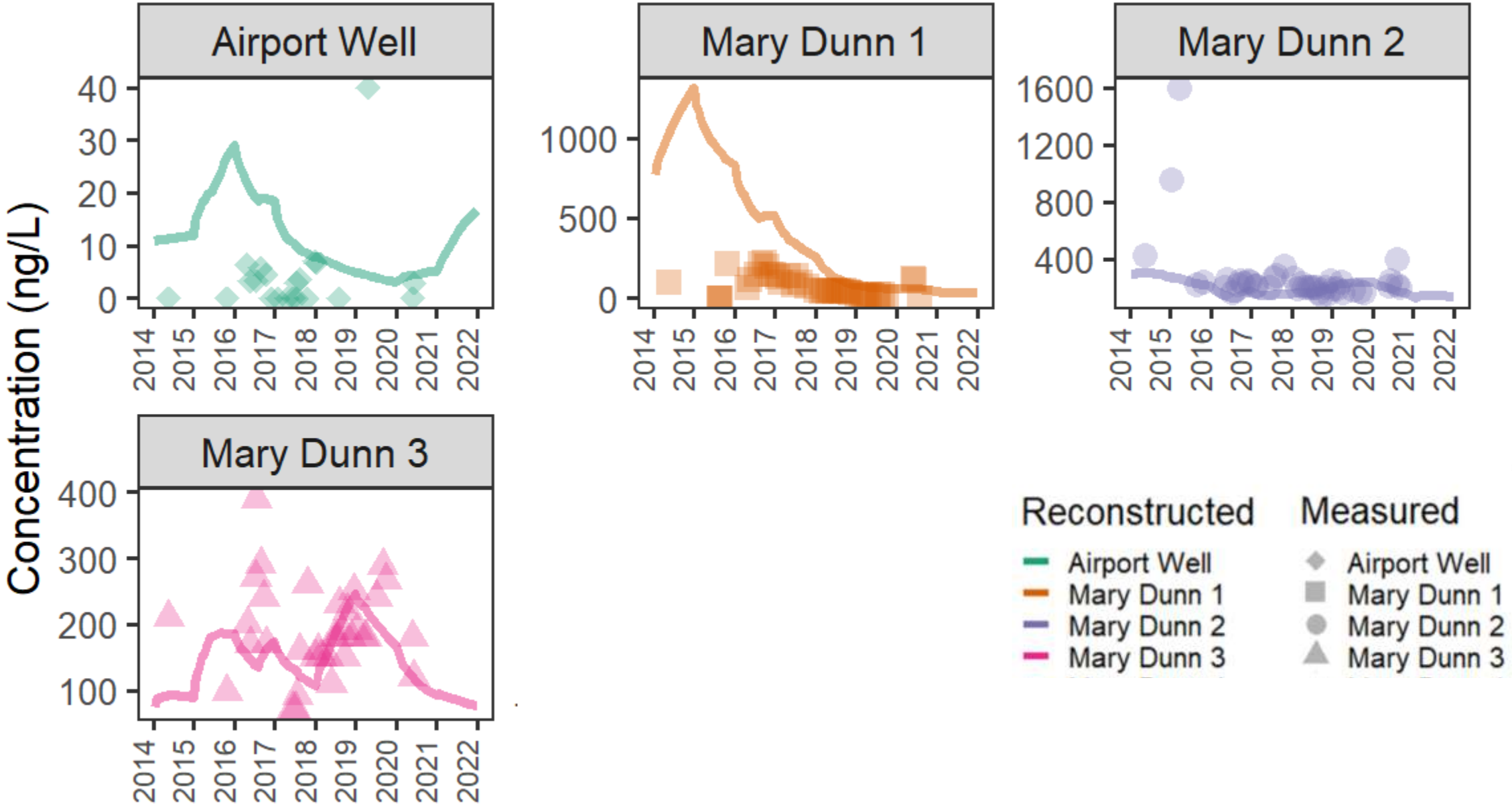
Discretization of Time
Activity, Pumping, Remedial Actions
Challenge and Practicality

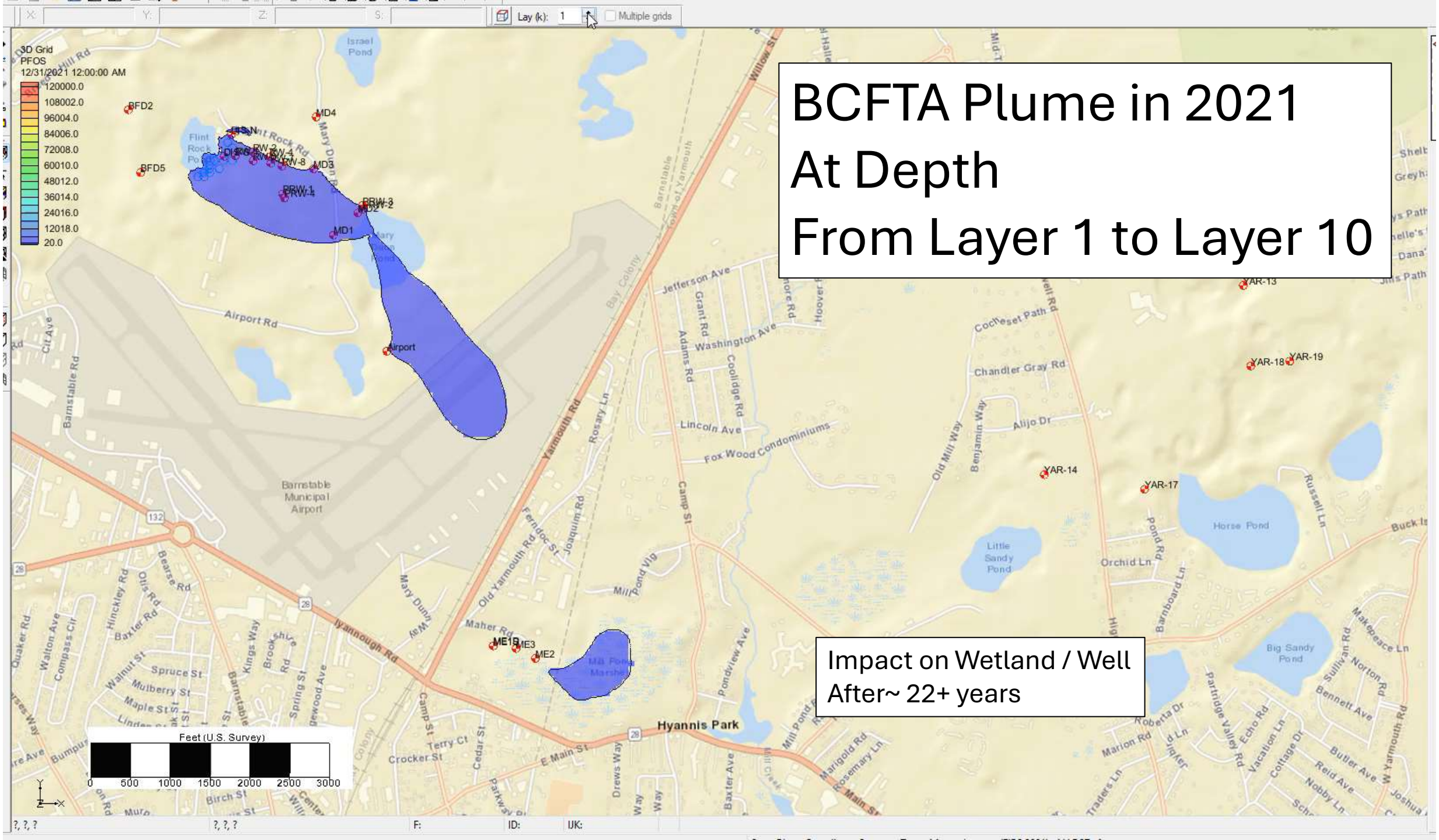
Scenario Development for Fire Training Academy
1970 to 2022

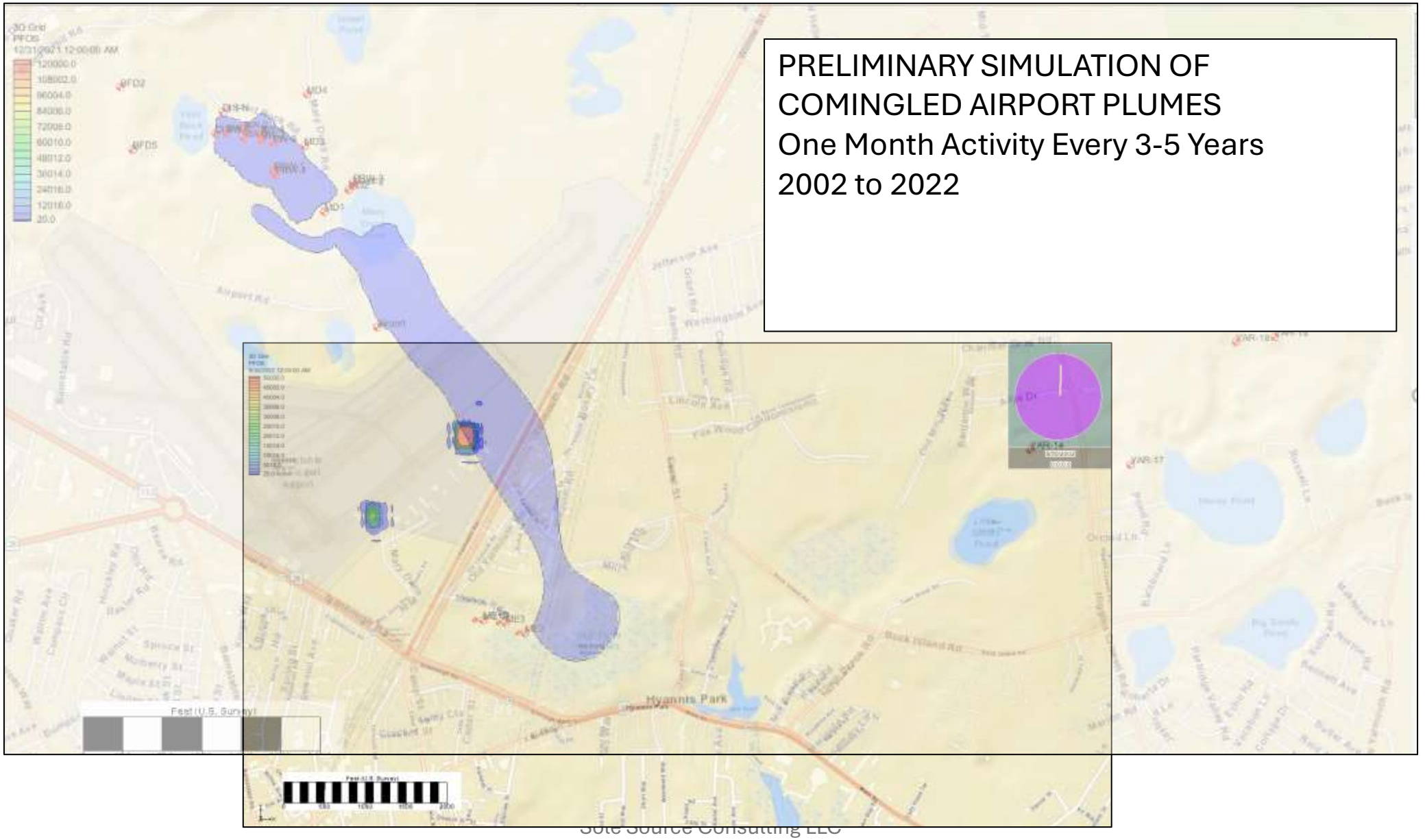
Scenario	Begin	End	Days	Run Time Hrs	Pumping	Hot Spot(s)	Historic Sources		Source Type
1970 Beginning of AFFF Release	Jan-70	Aug-72	943	2	Block	NA	120000	0	3/2/2/5-Month Intermittent
	Sep-72	Dec-75	1186	2.5	Block	NA	120000	10000	3/2/2/5-Month Intermittent
	Jan-75	Jan-80	1826	2.75	Block	NA	120000	10k to20k	3/2/2/5-Month Intermittent
	Jan-80	Jun-86	2343	3.5	Semi-Annual	NA	120000	10k to20k	3/2/2/5-Month Intermittent
Oil Spill Discovery 1986	Jun-86	Dec-89	1279	2	Semi-Annual	NA	20000	10000	No Active Source
	Jan-90	Jun-94	1612	2.25	Annual	120000	10000	10000	3/2/2/5-Month Intermittent
Hydrocarbon, Chloroform and MTBE Pump and Treat 1994	Jun-94	Dec-99	2009	2.5	Annual	21000	10000	10000	3/2/2/5-Month Intermittent
	Jan-00	Dec-04	1796	2.5	Annual	21000	10000	10000	3/2/2/5-Month Intermittent
Perchlorate Pump and Treat 2007-8	Jan-05	Dec-08	1430	1.6	Annual	21000	10000	10000	constant
No Sytems Less AFFF Training	Jan-09	Dec-13	1795	2	Annual	32000-10000	5000	5000	2/3/2/5-Month Intermittent
PFAS Discovery 2013 Pump and Treat Begins july 2015 +	Jan-14	Jul-15	546	1.5	Annual	32000-10000*	3400	3400	2/3/2/5-Month Intermittent
	Aug-15	Dec-17	853	1.25	Annual	Actual*	3400	3400	Actual
	Jan-18	Dec-21	1430	1.5	Annual	Actual*	2500	2500	Actual



Simulation of PFOS From the Fire Training Academy Video Clip 1970 to 2022

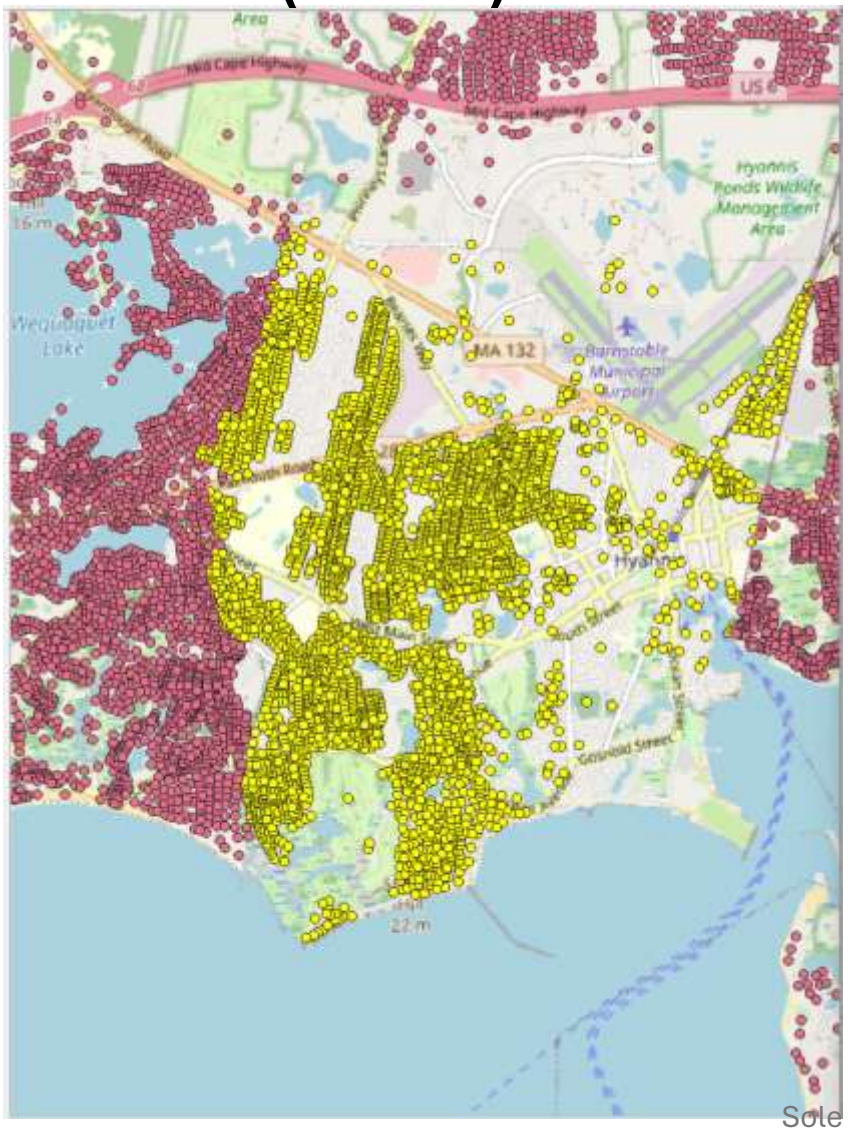

Airport Well
Mary Dunn 1
Mary Dunn 2
Mary Dunn 3
Concentration (ng/L)
0
10
20
30
40
0
500
1000
400
800
1200
1600
100
200
300
400
2014
2015
2016
2017
2018
2019
2020
2021
2022
Reconstructed
Airport Well
Mary Dunn 1
Mary Dunn 2
Mary Dunn 3
Measured
Airport Well
Mary Dunn 1
Mary Dunn 2
Mary Dunn 3


3D Grid
PFOS
12/31/2021 12:00:00 AM
120000.0
108002.0
96004.0
84006.0
72008.0
60010.0
48012.0
36014.0
24016.0
12018.0
20.0
BCFTA Plume in 2021
At Depth
From Layer 1 to Layer 10
Impact on Wetland / Well
After~ 22+ years
BFD2
BFD5
MD1
MD2
MD3
MD4
PRW-1
PRW-2
PRW-3
PRW-4
RW-1
RW-2
RW-3
RW-4
RW-8
ME1B
ME2
ME3
YAR-13
YAR-14
YAR-17
YAR-18
YAR-19
Airport
Airport Rd
Barnstable Municipal Airport
Hyannis Park
Yarmouth Rd
Old Yarmouth Rd
Lincoln Ave
Fox Wood Condominiums
Chandler Gray Rd
Washington Ave
Jefferson Ave
Camp St
Mill Pond Vlg
Maher Rd
Ma Pond Marsh
Little Sandy Pond
Horse Pond
Big Sandy Pond
Flint Rock Pond
Israel Pond
Feet (U.S. Survey)
0 500 1000 1500 2000 2500 3000

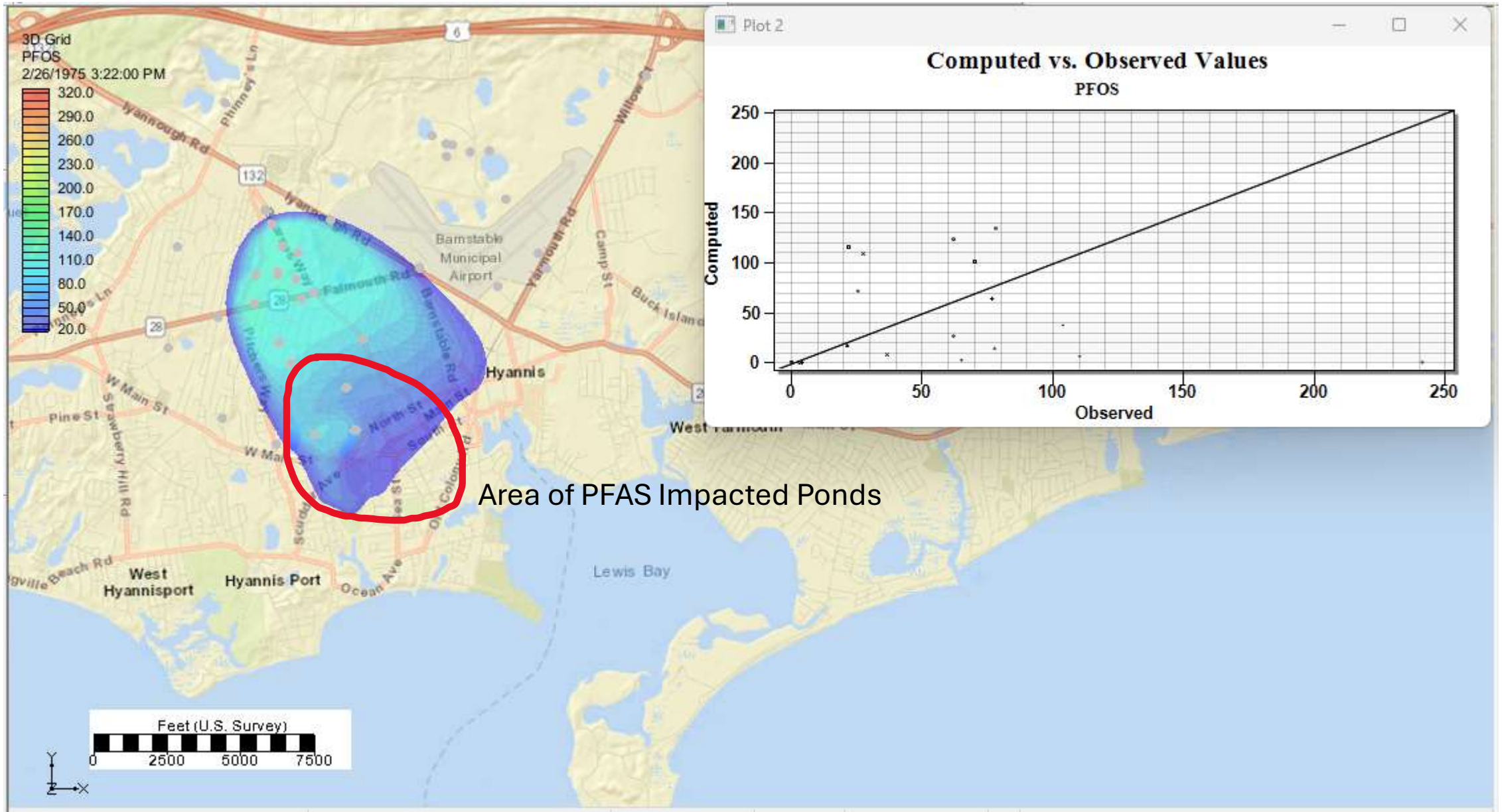

PRELIMINARY SIMULATION OF
COMINGLED AIRPORT PLUMES
One Month Activity Every 3-5 Years
2002 to 2022
Hyannis Park

Hyannis Water Supply Distribution Area

Septic Discharge (Yellow) and Wastewater Collection (Green)

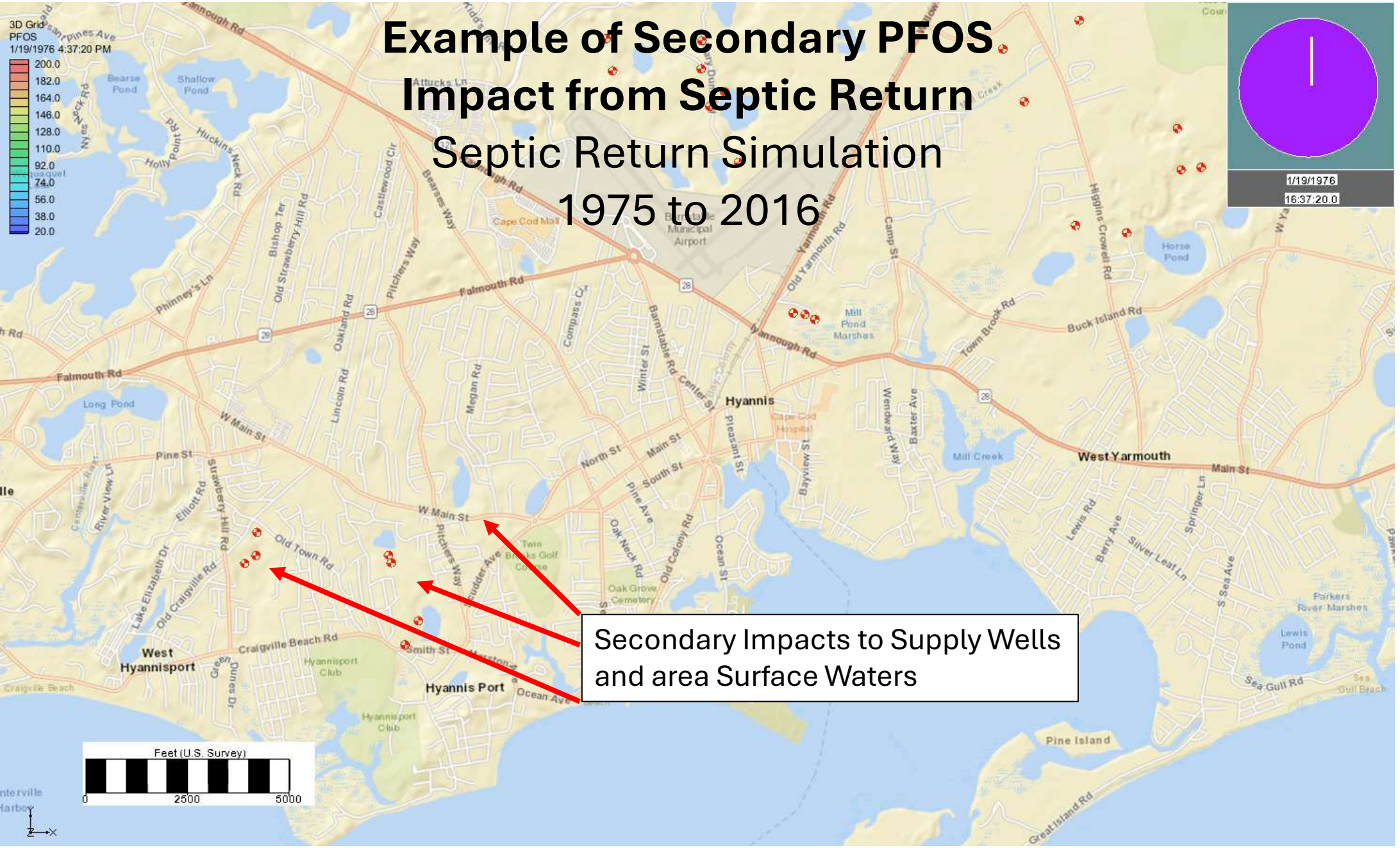


Example of Secondary PFOS Impact From Wastewater Discharge



Example of Secondary PFOS Impact from Septic Return

Septic Return Simulation 1975 to 2016



Take Aways

- Present data sets and modeling are applied to historic activities to hindcast past concentrations and exposures.
- Reconstruction requires attention to detail, intimate local knowledge, and accessible data and information.
- Septic systems and wastewater infiltration beds can distribute PFAS from local sources into groundwater over much larger areas.
- Work in progress to model the collective point and secondary source impact and concentrations in the distribution system.

- PFAS Investigation of multi-source and multi-receptors transcends single party assessment.

End

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