



Dover Water Resources Update

May 1, 2024



**Emery &
Garrett**
GROUNDWATER
INVESTIGATIONS
A Division of GZA



Topics

Existing Water Resources

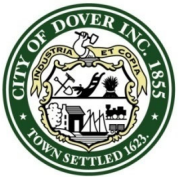
Water Resource Challenges

- Drought Management
- Water Quality
- Yield Capacity

Water Resource Monitoring Projects Overview

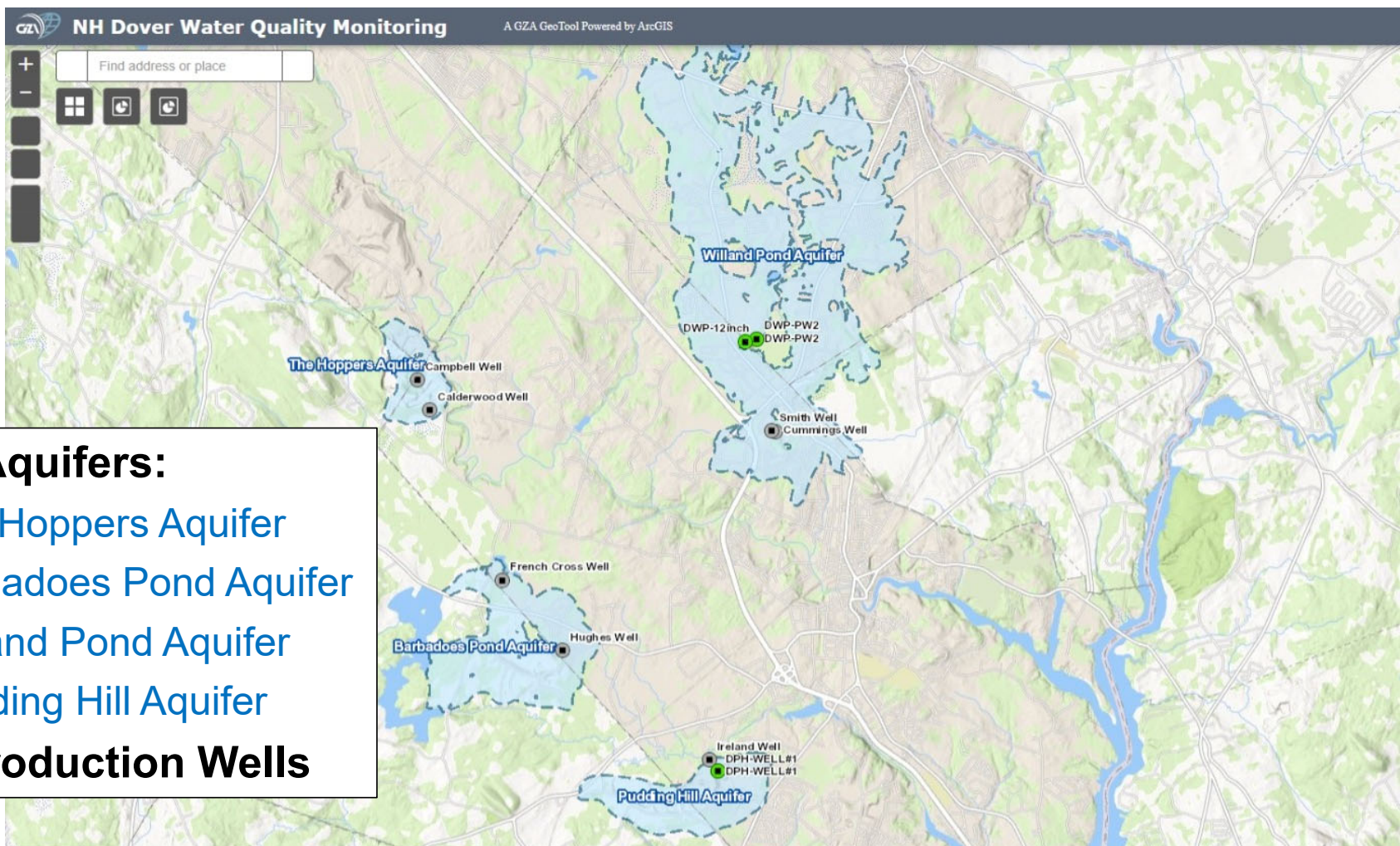
Aquifer Management Planning – Including Artificial Recharge

New Source Exploration



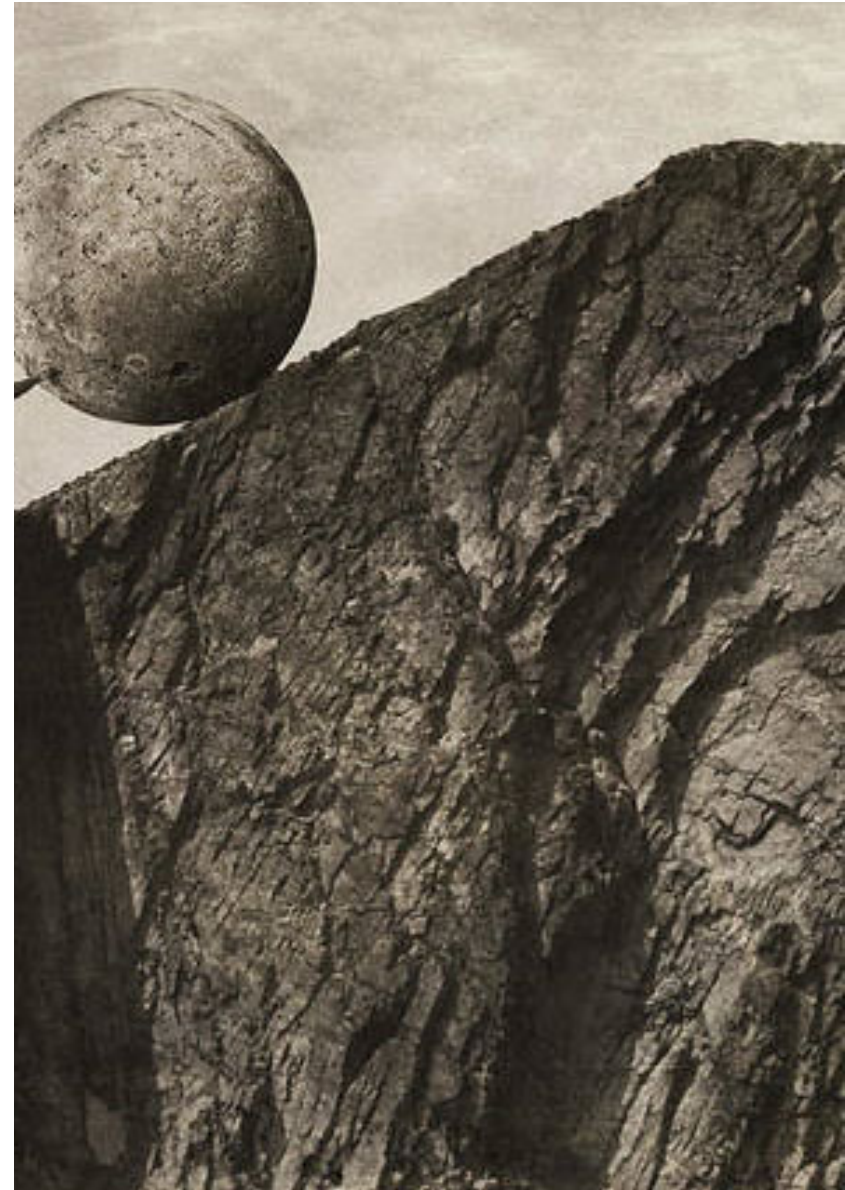


Existing Groundwater Resources



Challenges

- **Climate/Drought**
- **Water Quality/Contamination**
 - **Per- and Polyfluoroalkyl Substances (PFAS)**
 - **Chloride**



Challenges

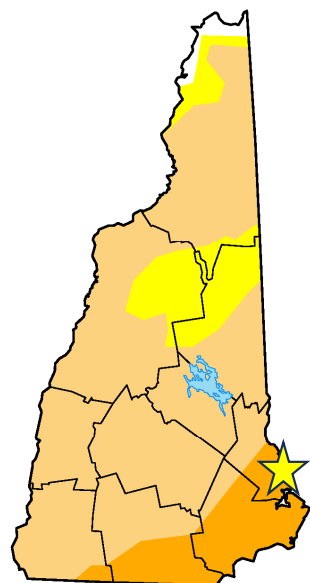
Climate/Drought



Climate/Drought

U.S. Drought Monitor New Hampshire

August 2, 2022
(Released Thursday, Aug. 4, 2022)
Valid 8 a.m. EDT



Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

Author:

Curtis Riganti
National Drought Mitigation Center



droughtmonitor.unl.edu

U.S. Drought Monitor New Hampshire

April 23, 2024
(Released Thursday, Apr. 25, 2024)
Valid 8 a.m. EDT



Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

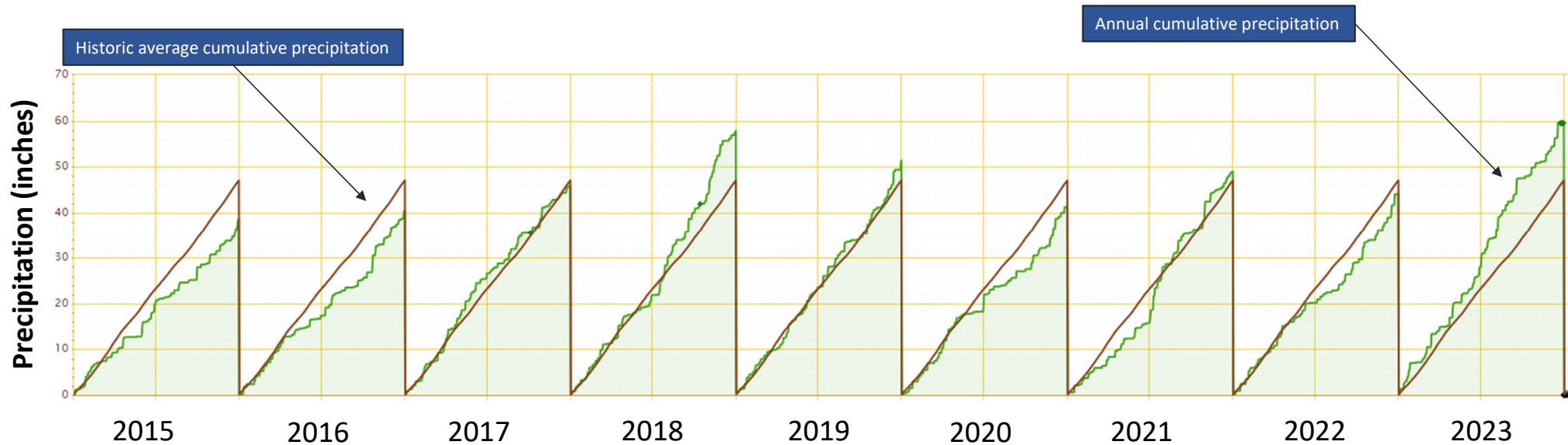
Author:

David Simeral
Western Regional Climate Center



droughtmonitor.unl.edu

Comparison of Annual Accumulated Precipitation to 20-Year Average Accumulated Precipitation for 2015 - 2023

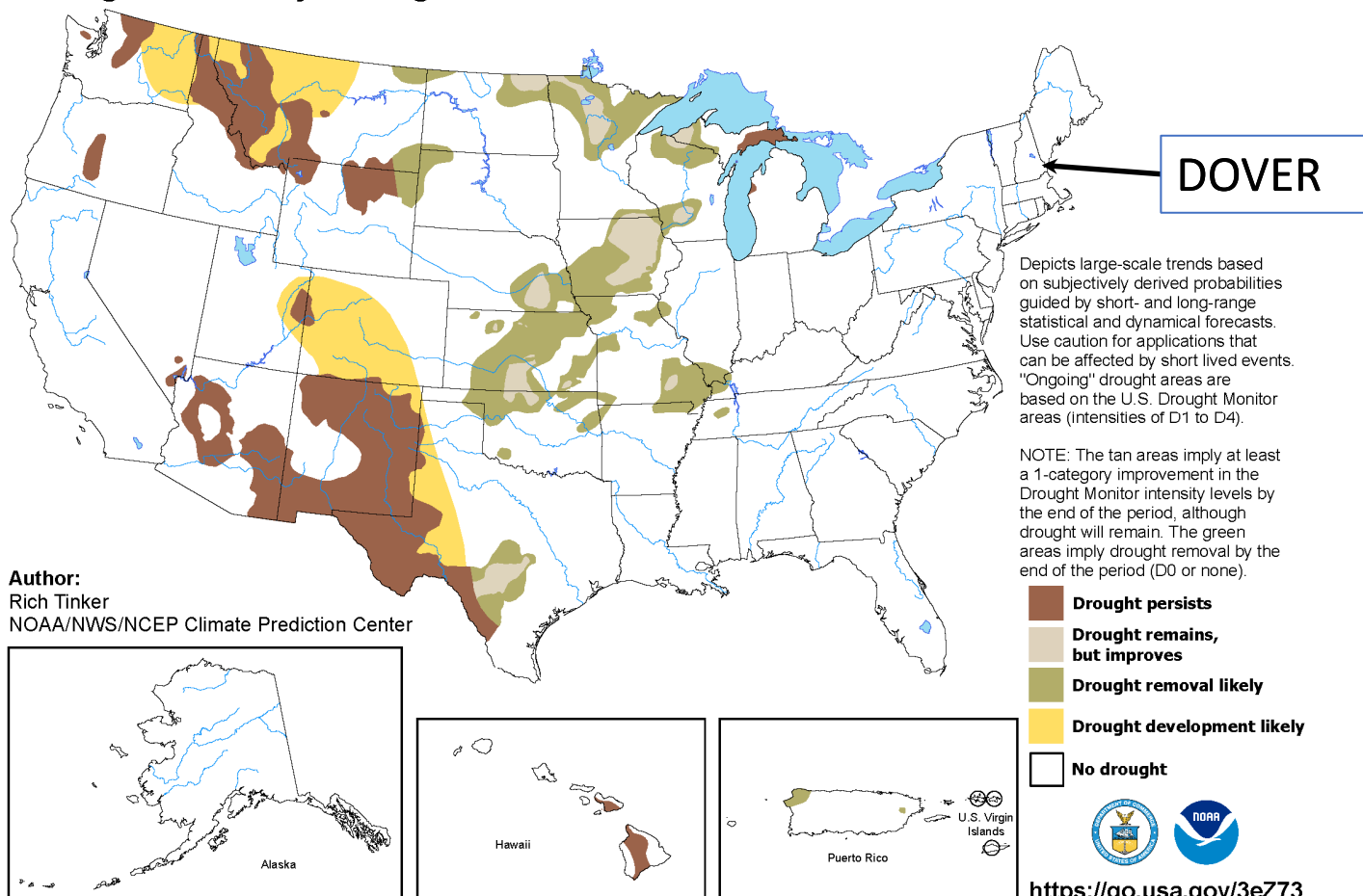


Thompson Farm, Durham, New Hampshire
Data from <http://scacis.rcc-acis.org/>

U.S. Seasonal Drought Outlook

Drought Tendency During the Valid Period

Valid for April 18 - July 31, 2024
Released April 18, 2024



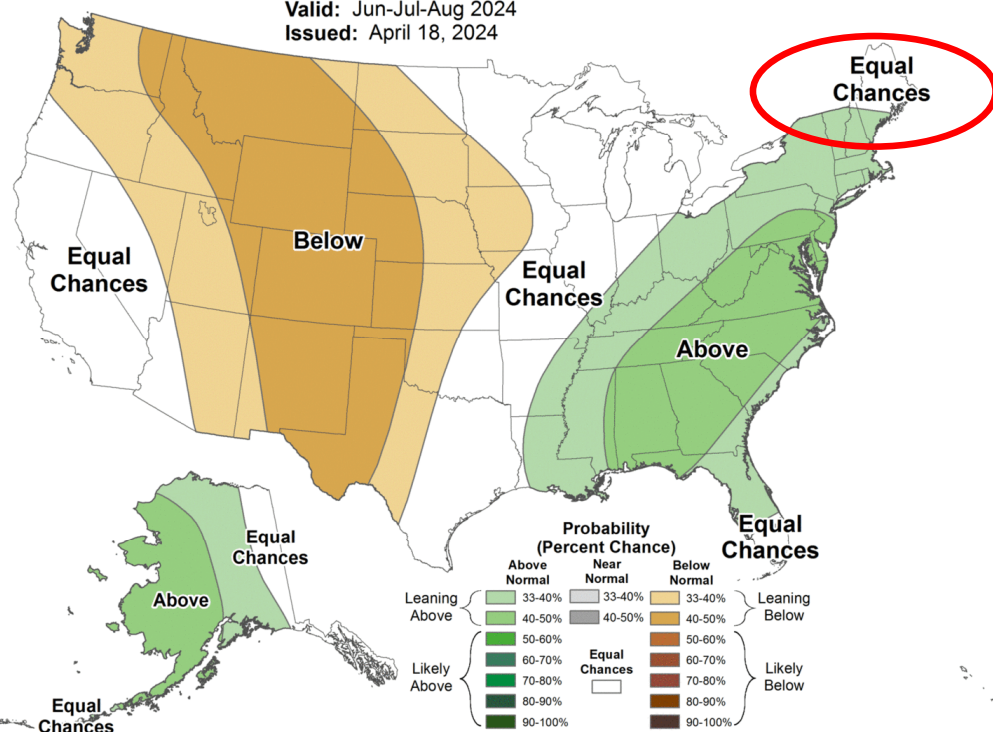
Precipitation Forecast June – September 2024

Jun-Jul-Aug 2024

Seasonal Precipitation Outlook



Valid: Jun-Jul-Aug 2024
Issued: April 18, 2024

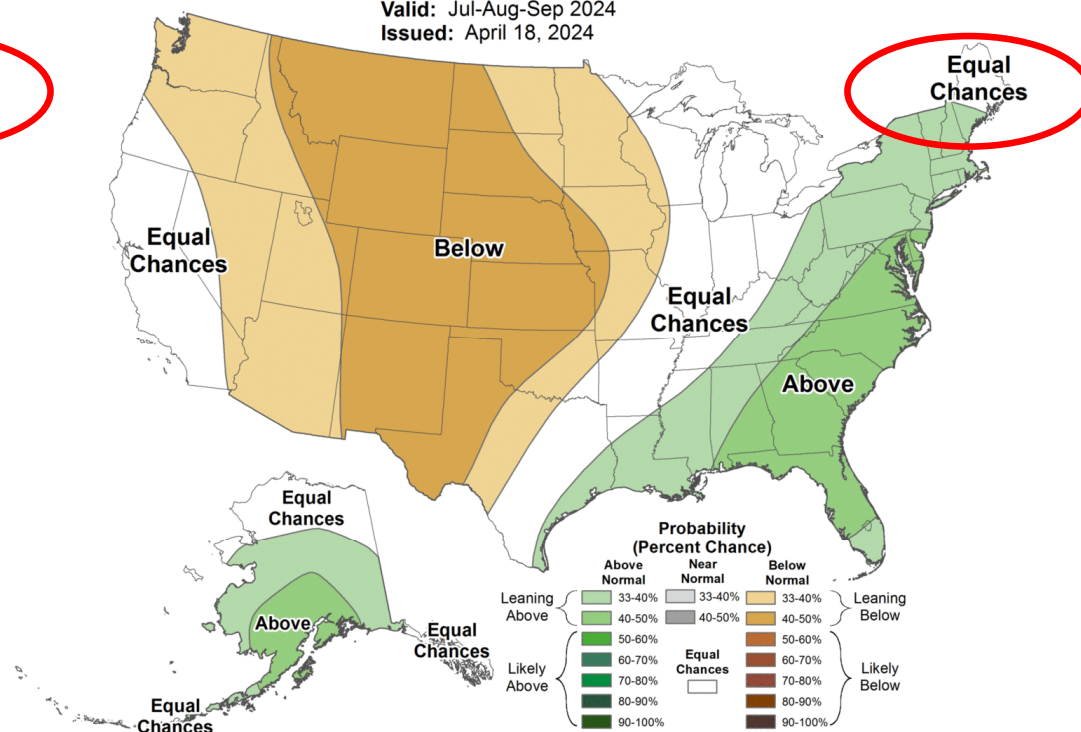


Jul-Aug-Sep 2024

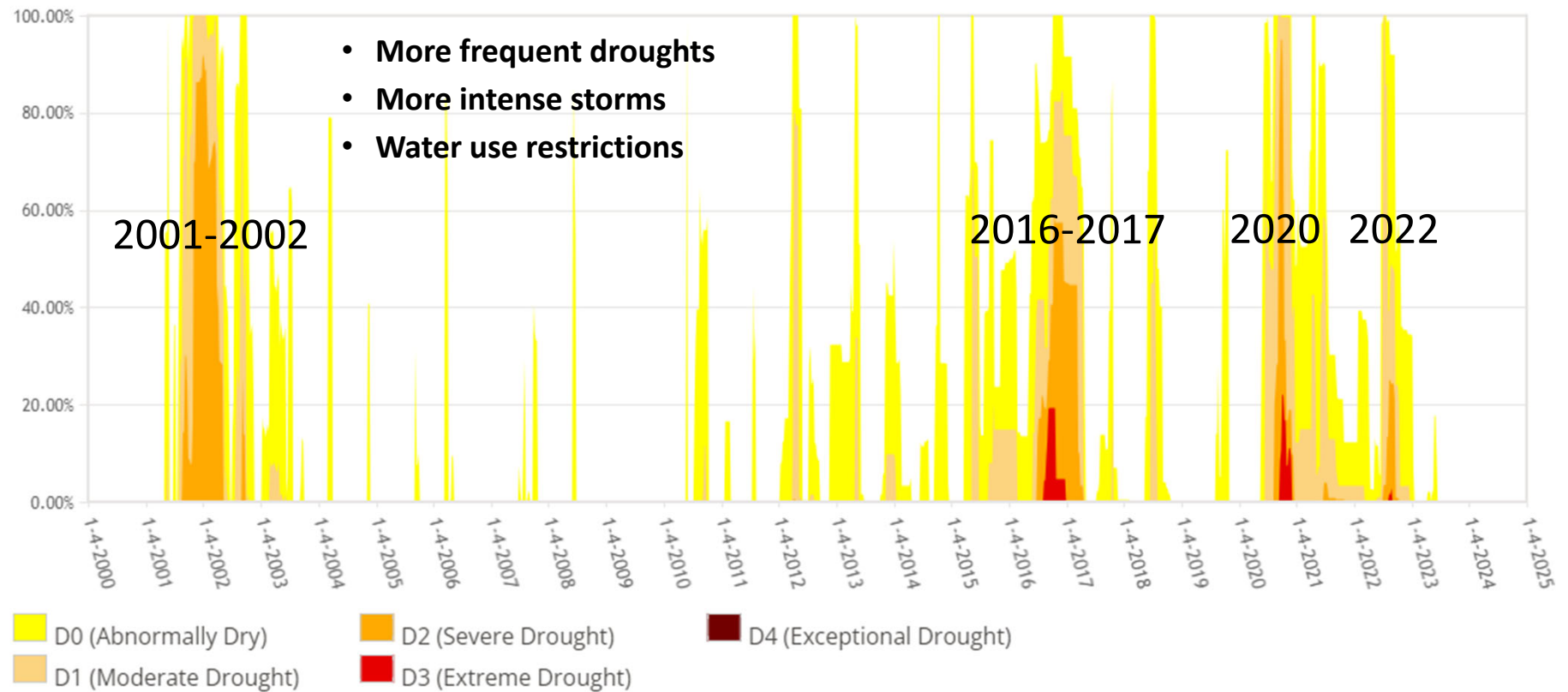
Seasonal Precipitation Outlook



Valid: Jul-Aug-Sep 2024
Issued: April 18, 2024



New Hampshire Percent Area in U.S. Drought Monitor Categories

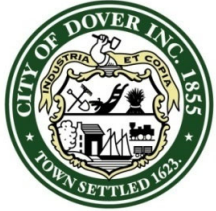


From the U.S. Drought Monitor website, <https://droughtmonitor.unl.edu/DmData/TimeSeries.aspx>, 4-29-2024

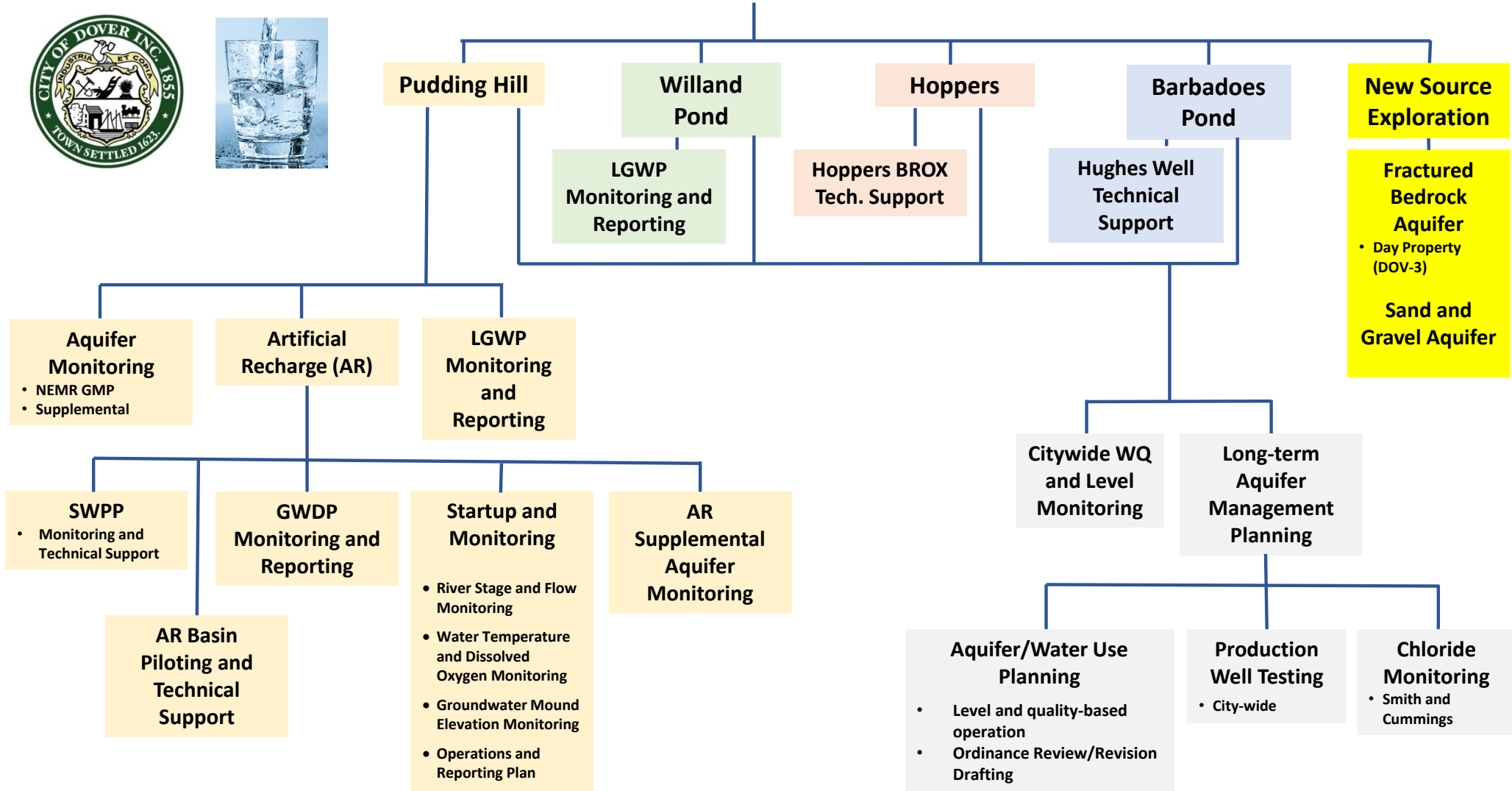


Water Resource Project Overviews





Dover Water Supply – EGGI/GZA Project Relational Diagram



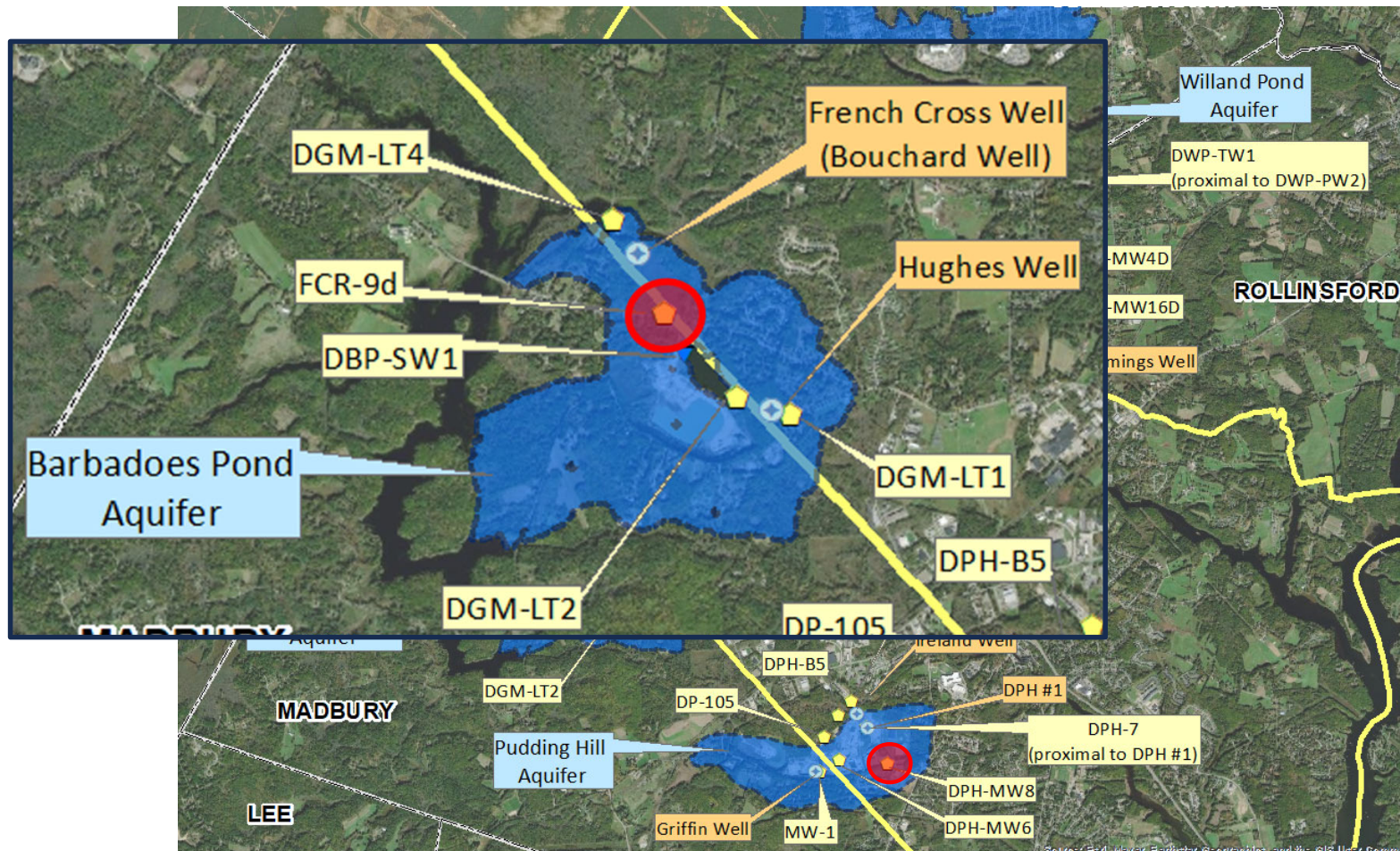
Groundwater Monitoring Programs –

1) City Wide
(24 wells)

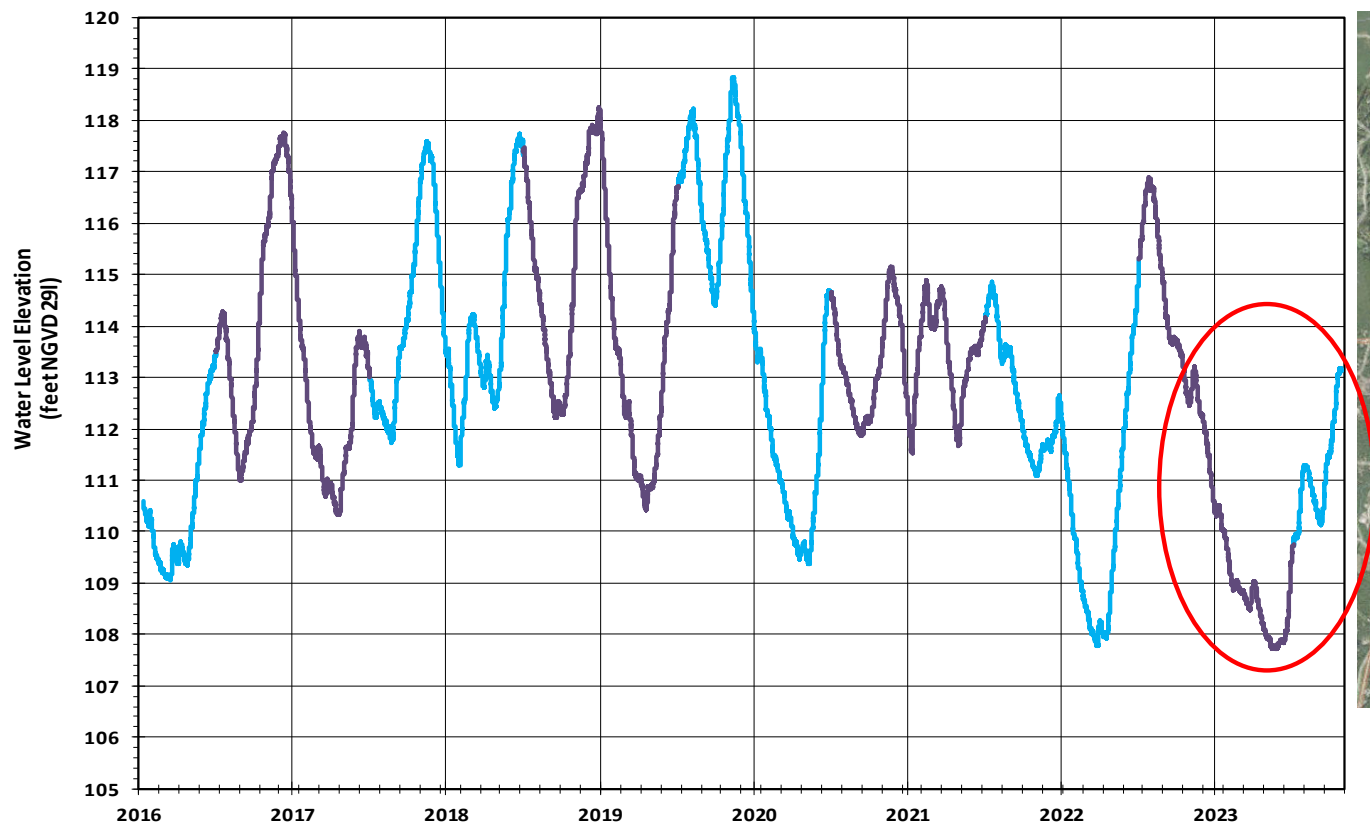
**2) Pudding Hill
Aquifer (50
wells)**



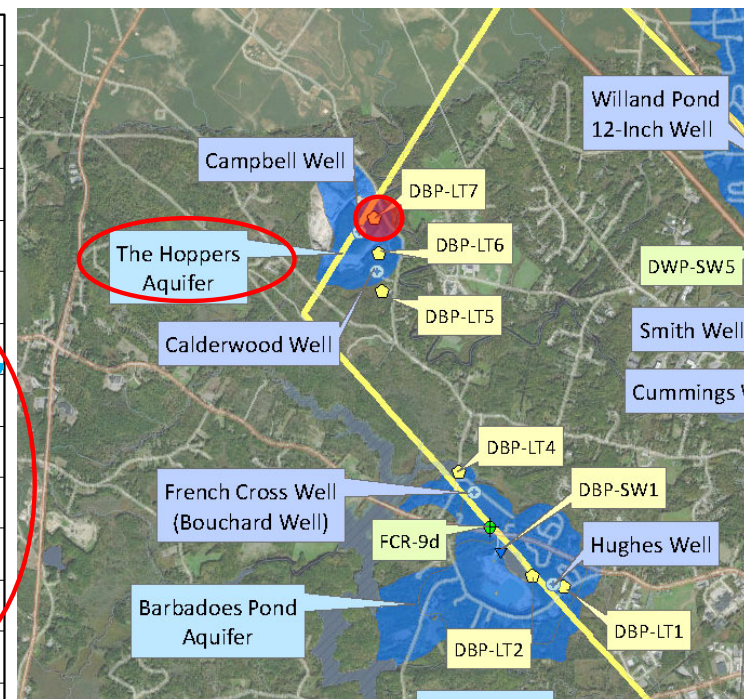
Indicator Water Level Monitoring Locations



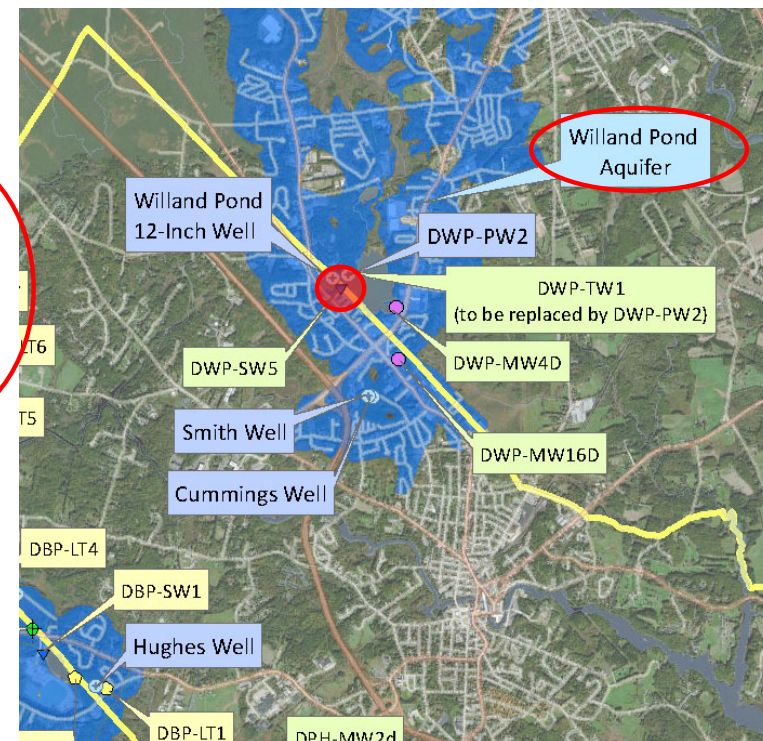
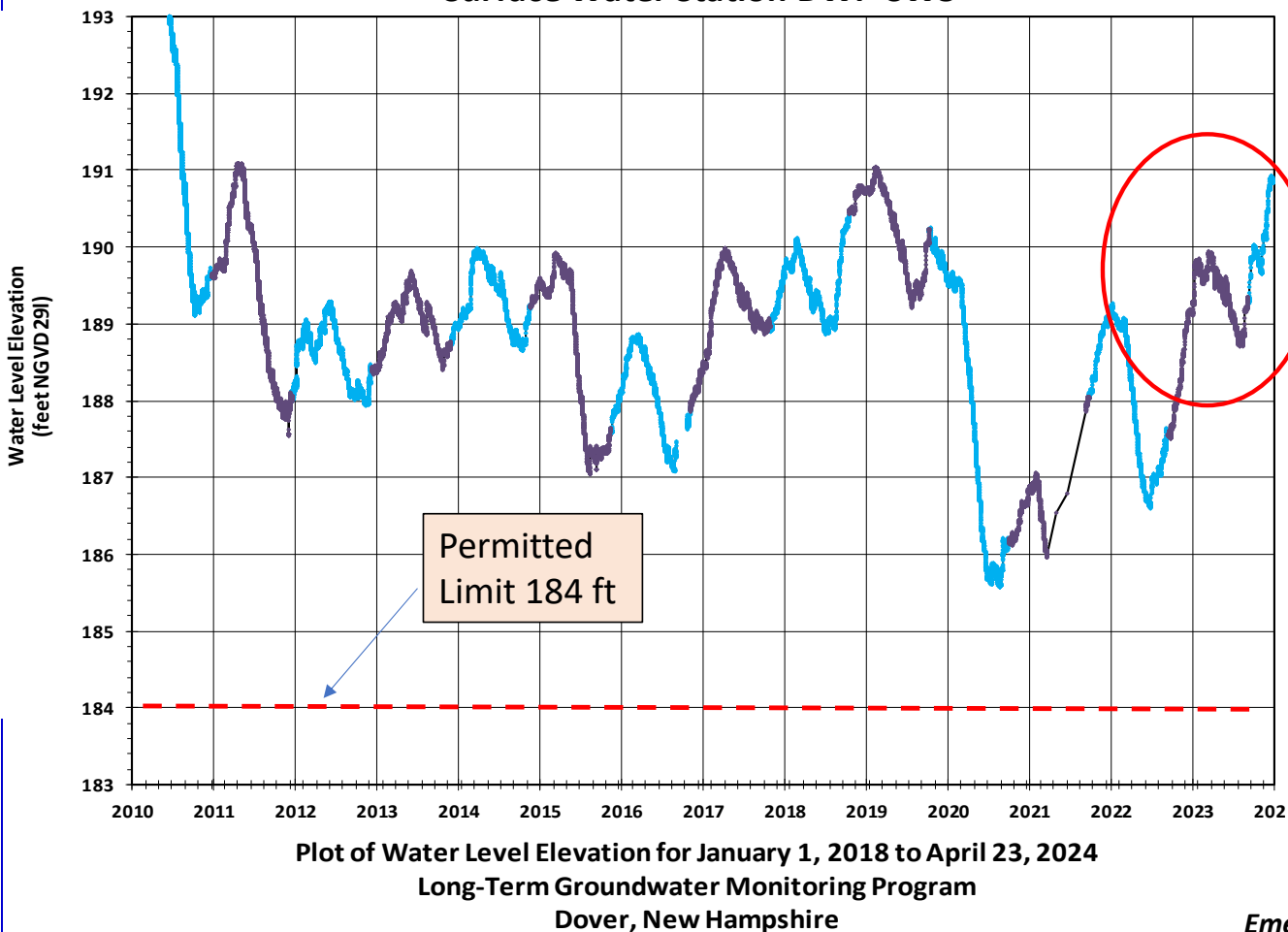
The Hoppers Aquifer Monitoring Well LT7



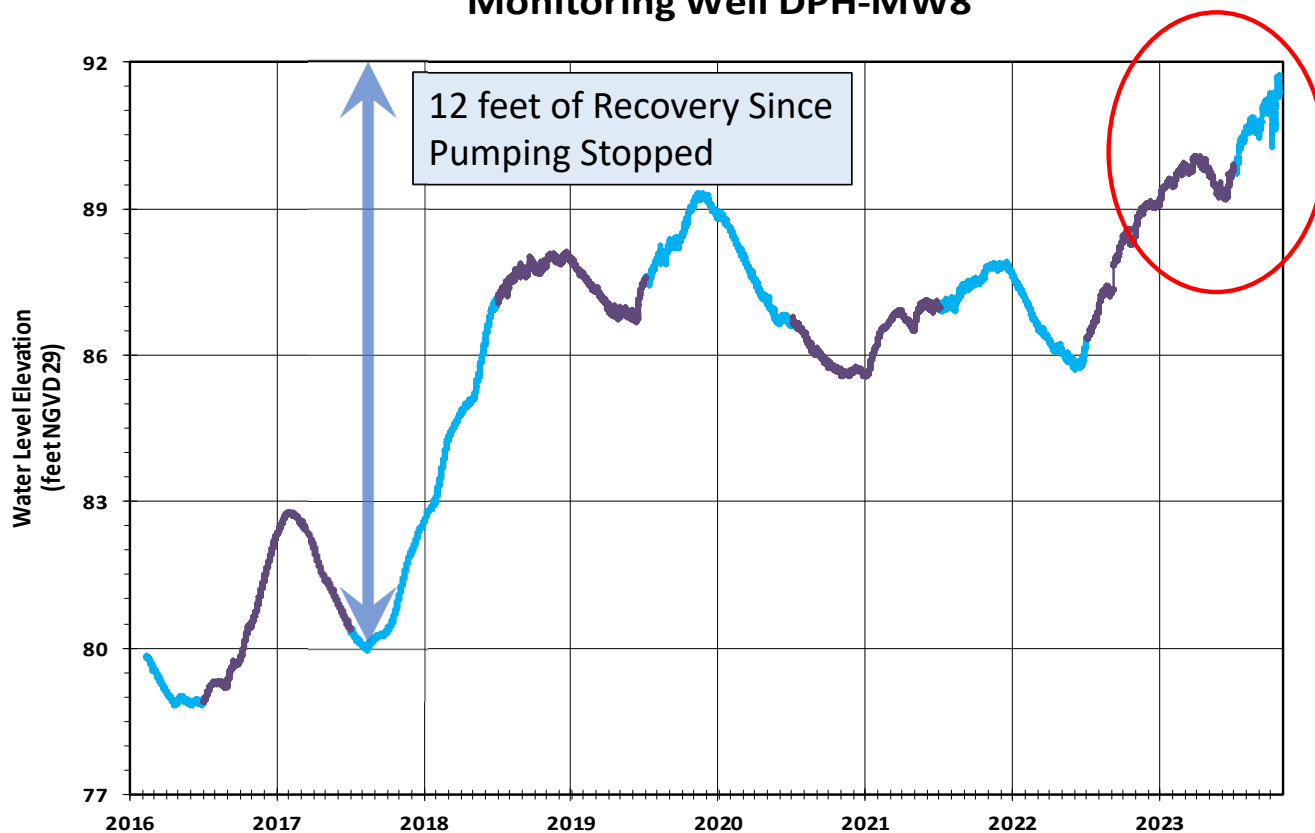
Plot of Water Level Elevation for July 1, 2016 to April 23, 2024
 Long-Term Groundwater Monitoring Program
 Dover, New Hampshire



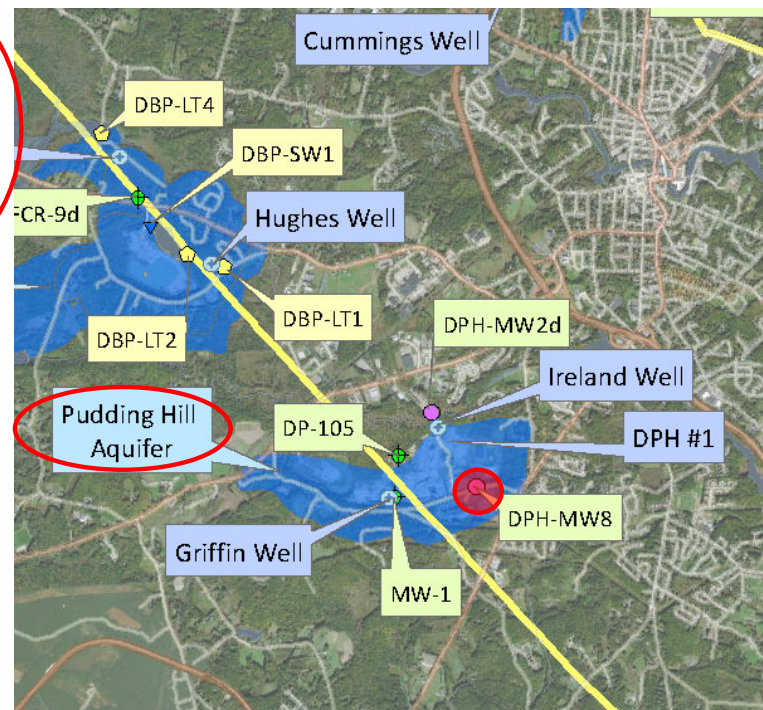
Willand Pond Surface Water Station DWP-SW5



Pudding Hill Aquifer Monitoring Well DPH-MW8



Plot of Water Level Elevation versus Time for August 10, 2016 to April 23, 2024
Long-Term Groundwater Monitoring Program
Dover, New Hampshire



Biannual Monitoring in Support of NEMR Groundwater Management Permit-Contract Pending with Schnitzer/NEMR for 2024

- Monitoring in April and November on City Property Coordinated with Schnitzer's (NEMR) consultants --- Water quality monitoring of up to 15 locations
- Water level monitoring of 29 locations
- Supplemental sampling in support of overall contaminant monitoring (typically in August)
- Large Groundwater Withdrawal Permit Monitoring (DPH #1 and Ireland Well) in April and August

Challenges

Water Quality Contaminants



Emerging Contaminants – PFAS

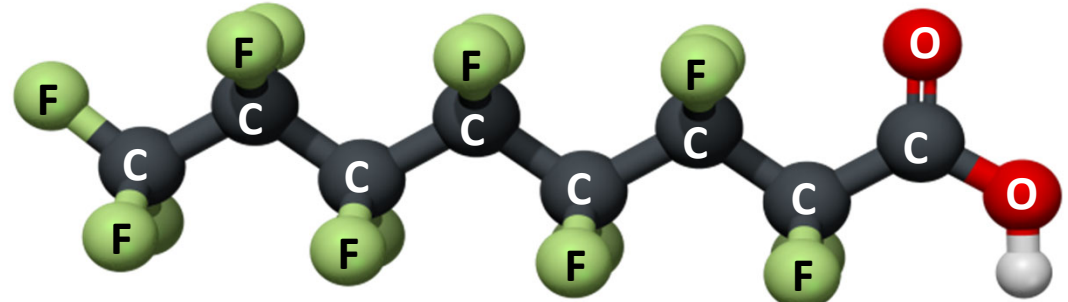
GEOTECHNICAL ENVIRONMENTAL ECOLOGICAL WATER CONSTRUCTION MANAGEMENT

(Per- and Polyfluoroalkyl Substances)

- Very useful properties
 - *Ubiquitous*
- 1000's of compounds
 - *Complex chemistry*

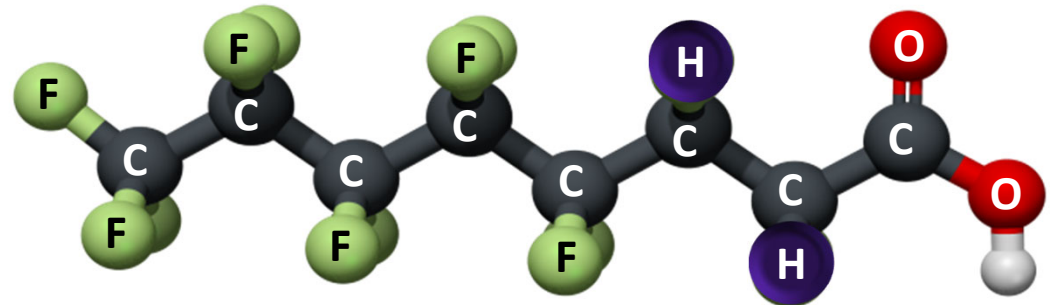


Perfluorinated = Completely Fluorinated



Perfluorooctanoic Acid (PFOA)

Polyfluorinated = Incompletely Fluorinated



5:3 Fluorotelomer Carboxylic Acid (5:3 FTCA)



Figures from Taryn McKnight, Eurofins-TestAmerica

Known for excellence. Built on trust.

PFAS

1,000's of compounds; < 100 can readily be quantified

Persistent: C-F bonds extremely stable in the environment

Bioaccumulative & Toxic

Emerging contaminant of concern (**regulatory goalposts have moved**)

PFAS	Current NH MCL	New Enforceable Federal MCL	Maximum Contaminant Level Goal
PFOA	12	4.0	0
PFOS	15	4.0	0
PFNA	11	10	10
PFHxS	18	10	10
HFPO-DA (GenX)	None	10	10
Mixture of two or more: PFNA, PFHxS, HFPO-DA, and PFBS	None	Hazard Index of 1	Hazard Index of 1

Units are parts per trillion (ng/L)
(Roughly one drop in 20
Olympic-sized swimming pools)

PFAS

Dover Production Well PFAS Data Summary

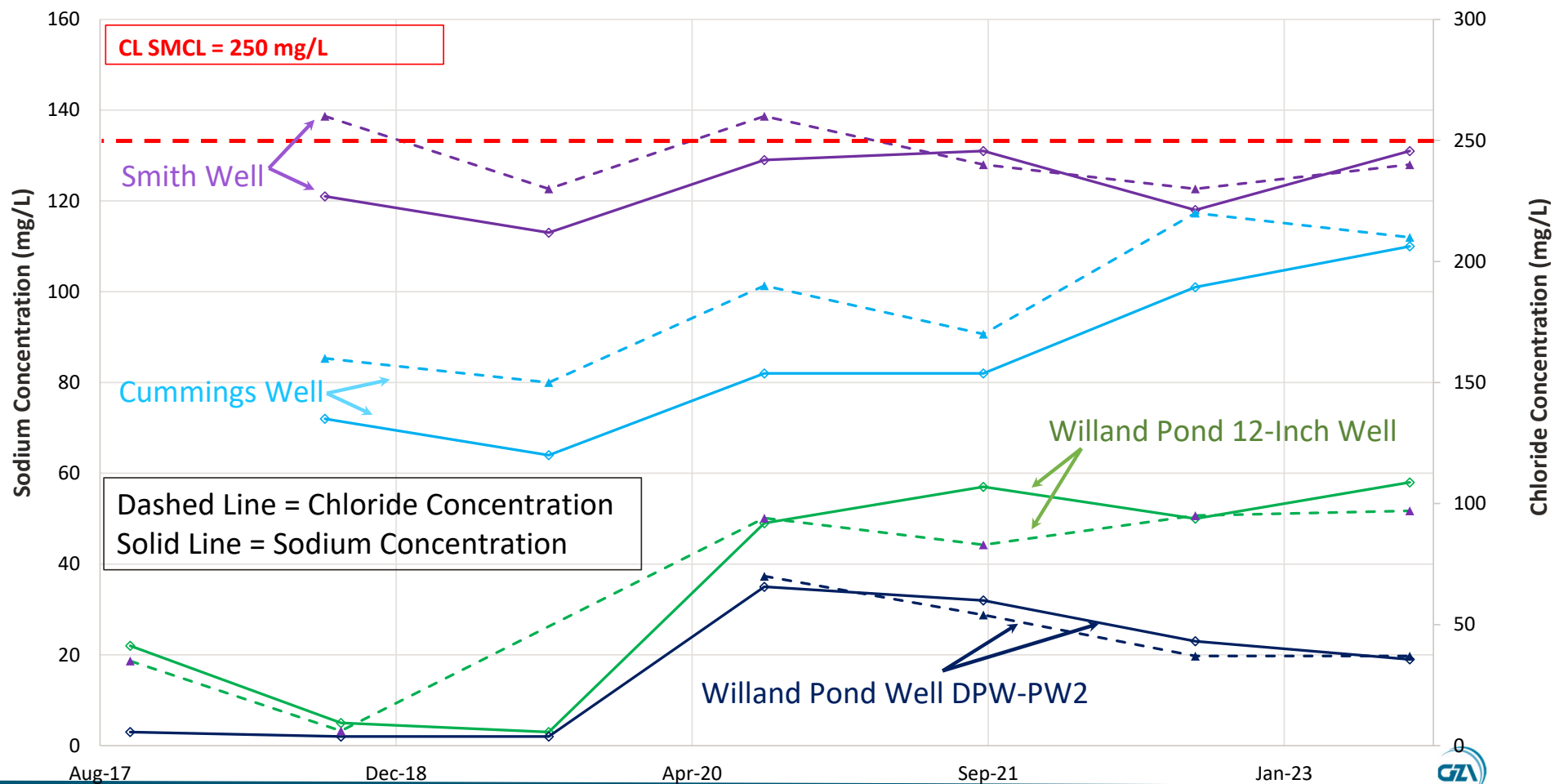
Aquifer	Production Wells	Maximum Per- and Poly Fluoroalkyl Substance (PFAS) Concentration Detected					Number of Sampling Rounds	Number of Rounds PFAS Detected	Monitored Since
		PFOA	PFNA	PFOS	PFHxS	PFBS			
Willand Pond	Smith Well	NON-DETECT	NON-DETECT	NON-DETECT	NON-DETECT	NON-DETECT	6	None	2018
	Cummings Well	2.09	NON-DETECT	NON-DETECT	NON-DETECT	NON-DETECT	6	1	2018
	Well DWP-PW2	NON-DETECT	NON-DETECT	NON-DETECT	NON-DETECT	NON-DETECT	6	None	2017
	12-Inch Well	NON-DETECT	NON-DETECT	NON-DETECT	NON-DETECT	NON-DETECT	6	None	2017
Hoppers	Calderwood Well	NON-DETECT	NON-DETECT	NON-DETECT	NON-DETECT	NON-DETECT	6	None	2018
	Campbell Well	2.71	NON-DETECT	NON-DETECT	NON-DETECT	NON-DETECT	6	3	2018
Barbadoes Pond	Hughes Well	NON-DETECT	NON-DETECT	NON-DETECT	NON-DETECT	NON-DETECT	6	None	2018
	Bouchard Well	NON-DETECT	NON-DETECT	NON-DETECT	NON-DETECT	NON-DETECT	5	None	2018
Pudding Hill	Well DPH#1	16.8	4.08	6.28	14.4	2.96	72	46	2017
	Ireland Well	106	NON-DETECT	173	50.7	13.8	42	30	2016

Boldface concentrations exceed newly established federal MCL.



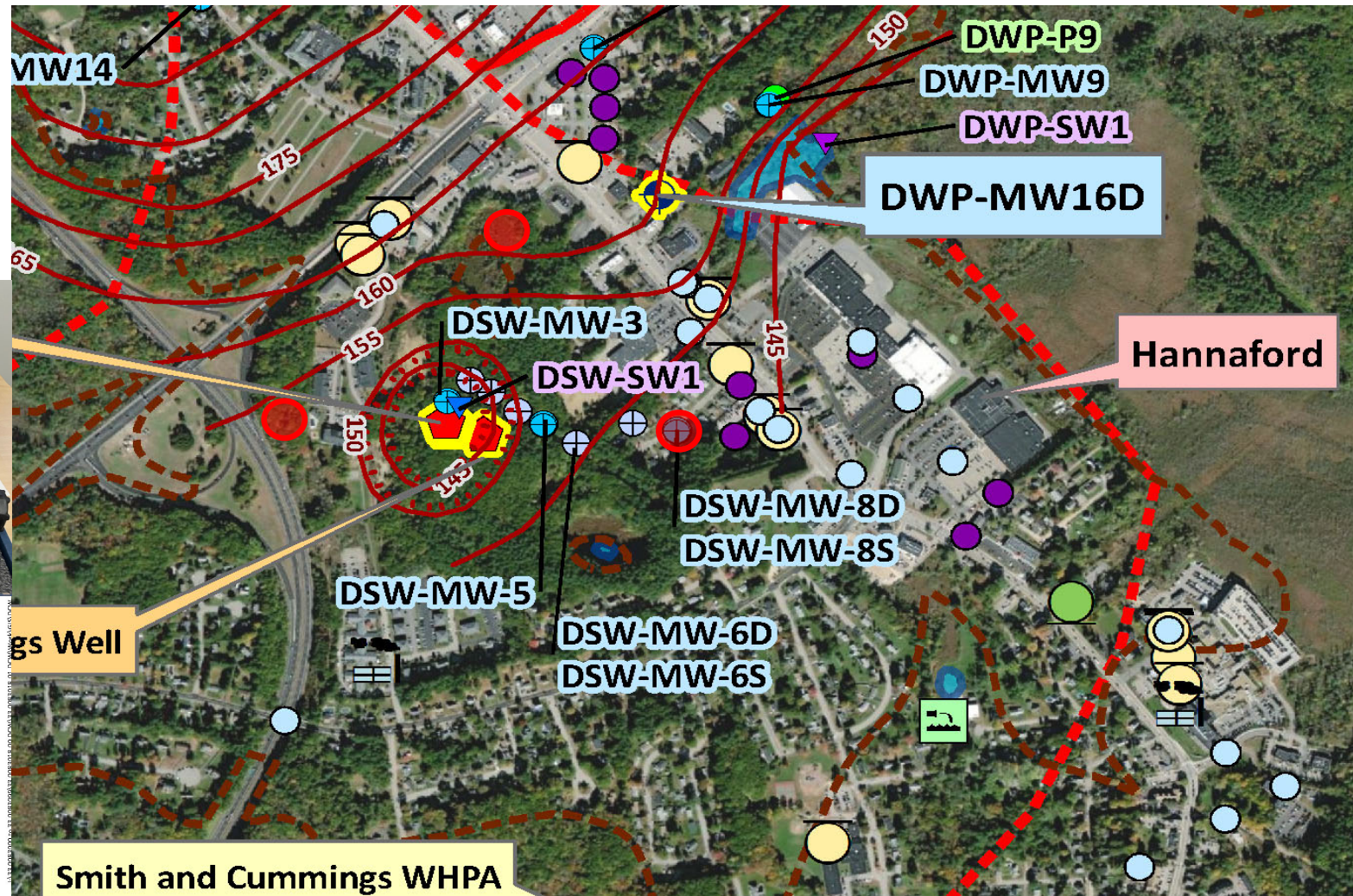
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Pudding Hill	Well DPH#1	16.8	4.08	6.28	14.4	2.96
	Ireland Well	106	NON-DETECT	173	50.7	13.8

Sodium (Na) and Chloride (Cl) Monitoring



Sonde Locations

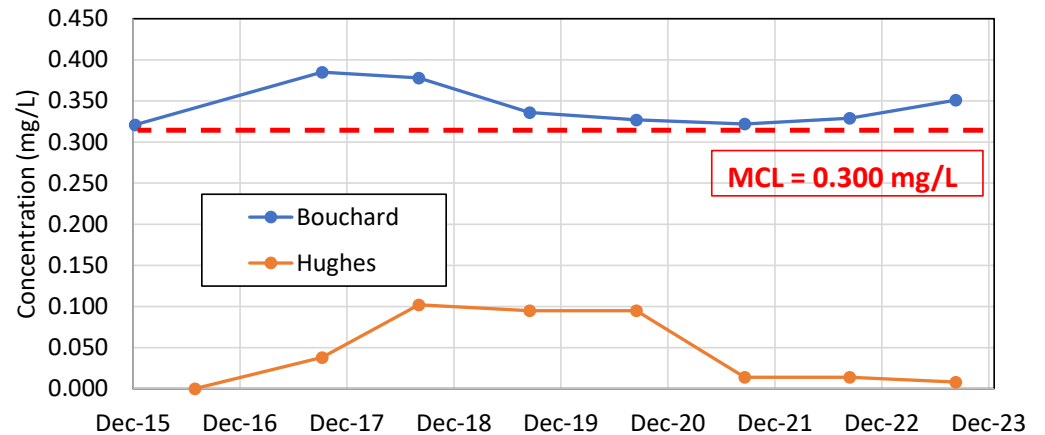
Deploy three sondes
(One existing and two proposed
MWs)



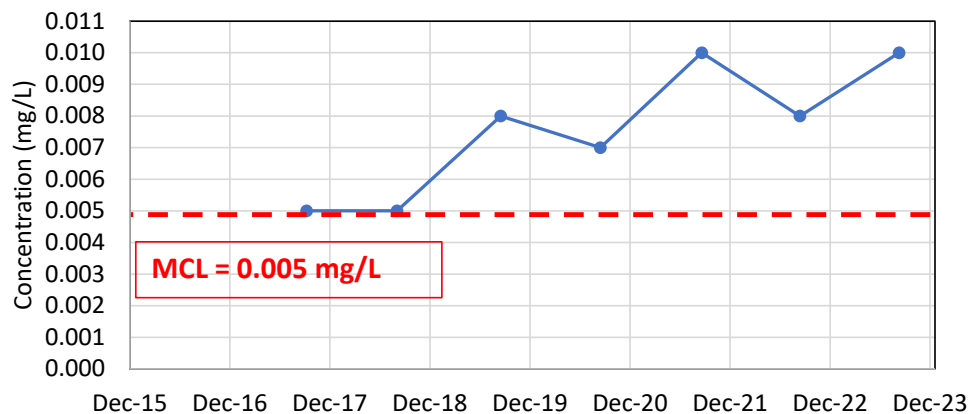
Barbadoes Pond Aquifer

- Iron, manganese, and arsenic (Bouchard)
- Pike Excavation near Hughes Well
- Connect Hughes, add treatment at Hughes, drill new well closer to French Cross?

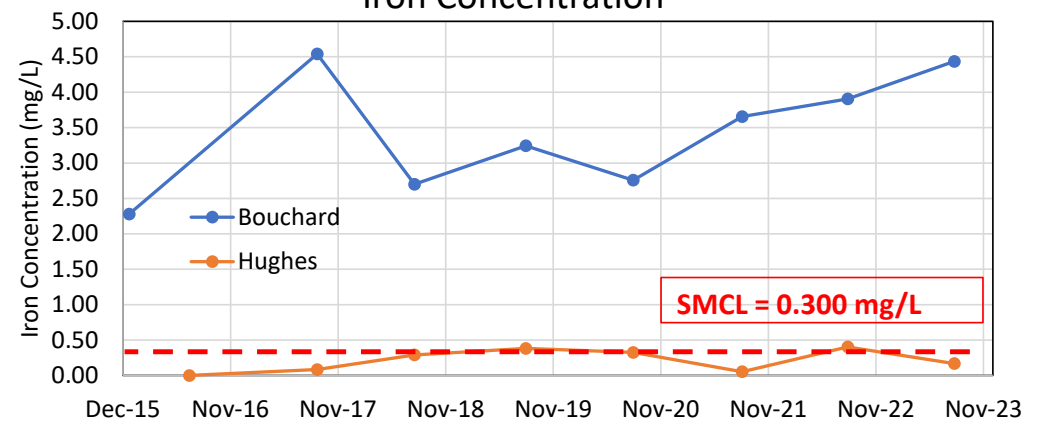
Manganese Concentration



Arsenic Concentration



Iron Concentration



Artificial Recharge



Pudding Hill Aquifer – Artificial Recharge Update

- ✓ 401 Certification approved
- ✓ Aquifer Recharge facility constructed
- ✓ Groundwater Discharge Permit (GDP) application submitted and GDP issued

401 Certification-related plans and permits (*Comments received*)

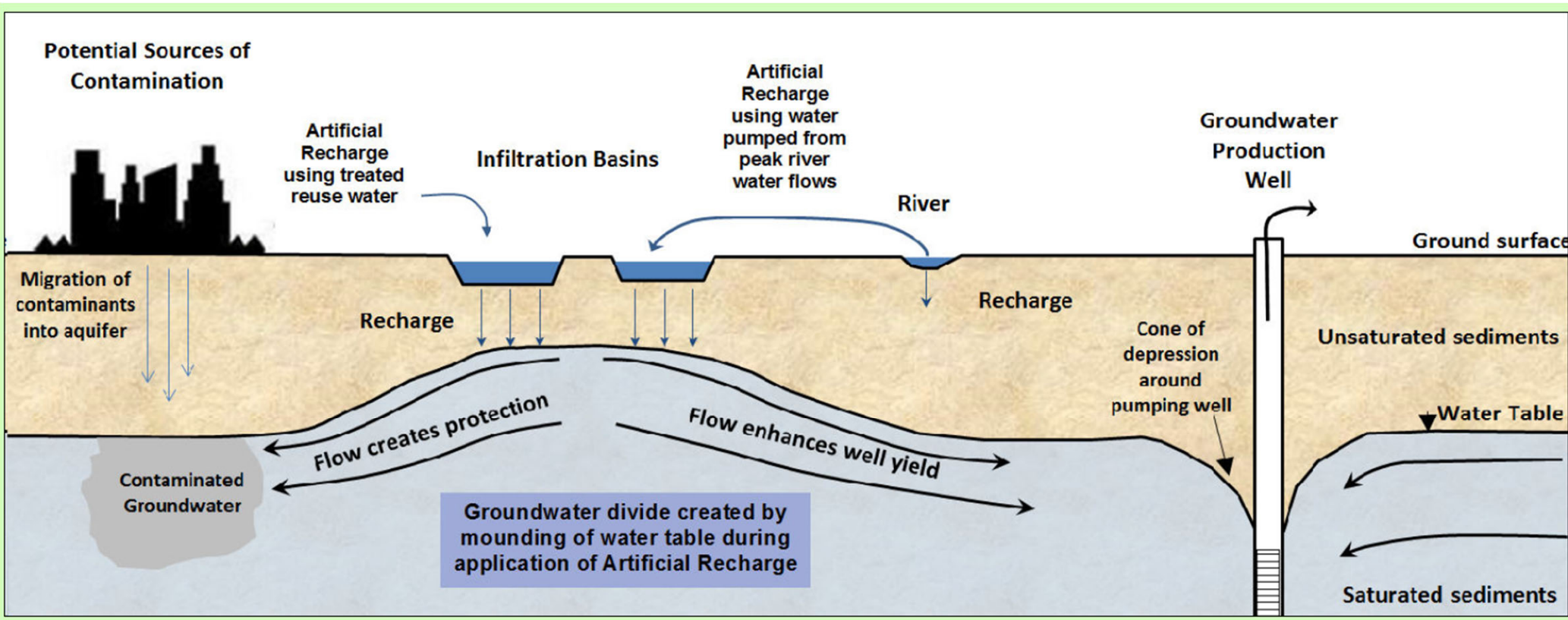
Condition E-10 - River stage and flow monitoring

Condition E-11 - Water temperature and dissolved oxygen (DO) monitoring

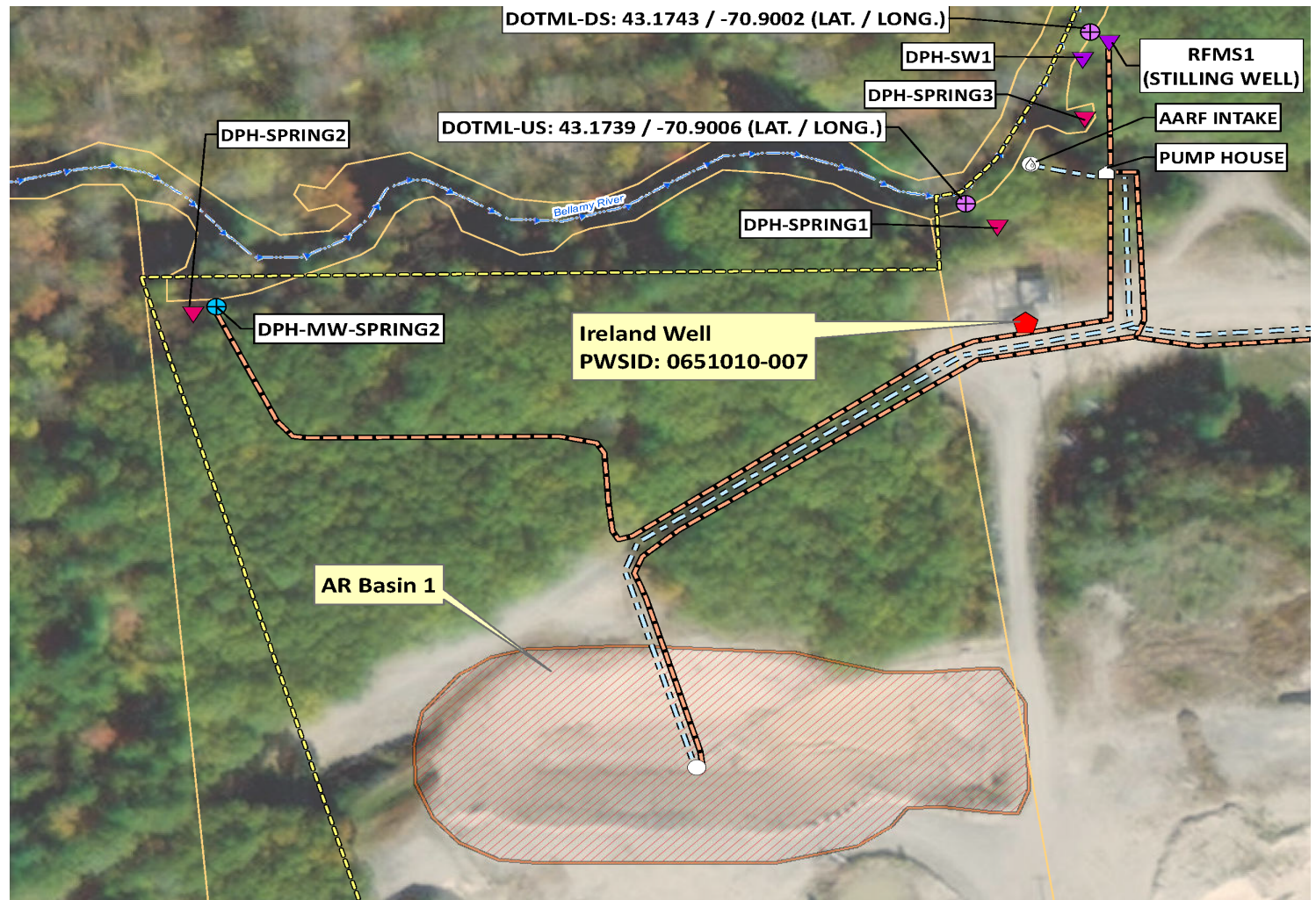
Condition E-12 - Groundwater mound elevation monitoring

Condition E-16 - Operations and reporting plan

Schematic of Artificial Recharge Process

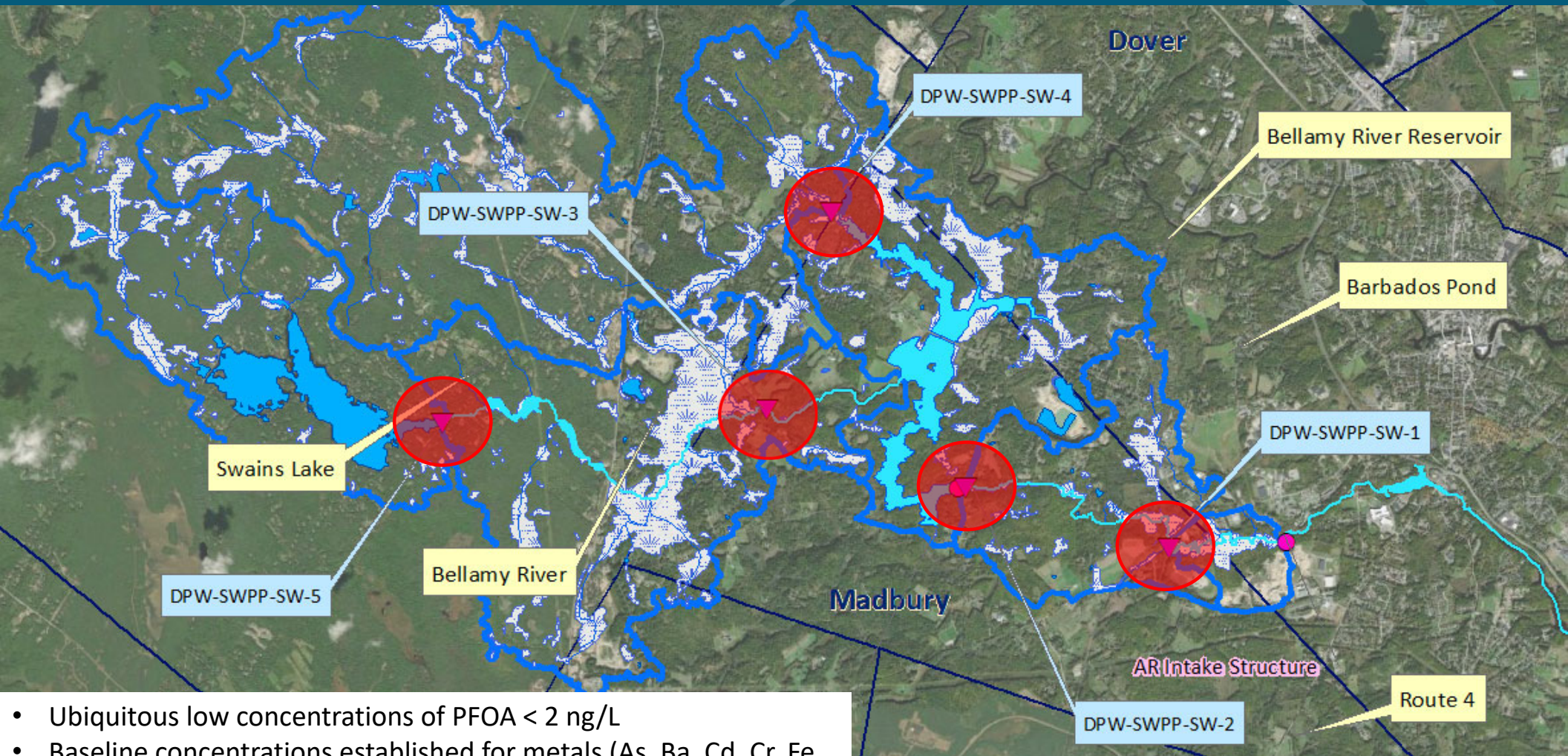


Artificial Recharge



SWPP Surface Water Quality Monitoring

GEOTECHNICAL ENVIRONMENTAL ECOLOGICAL WATER CONSTRUCTION MANAGEMENT



- Ubiquitous low concentrations of PFOA < 2 ng/L
- Baseline concentrations established for metals (As, Ba, Cd, Cr, Fe, Mn, Hg, Se, Ag, and Na) and chloride

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BROX QUARRY



Hoppers Aquifer Discussion

- Brox Quarry Excavation

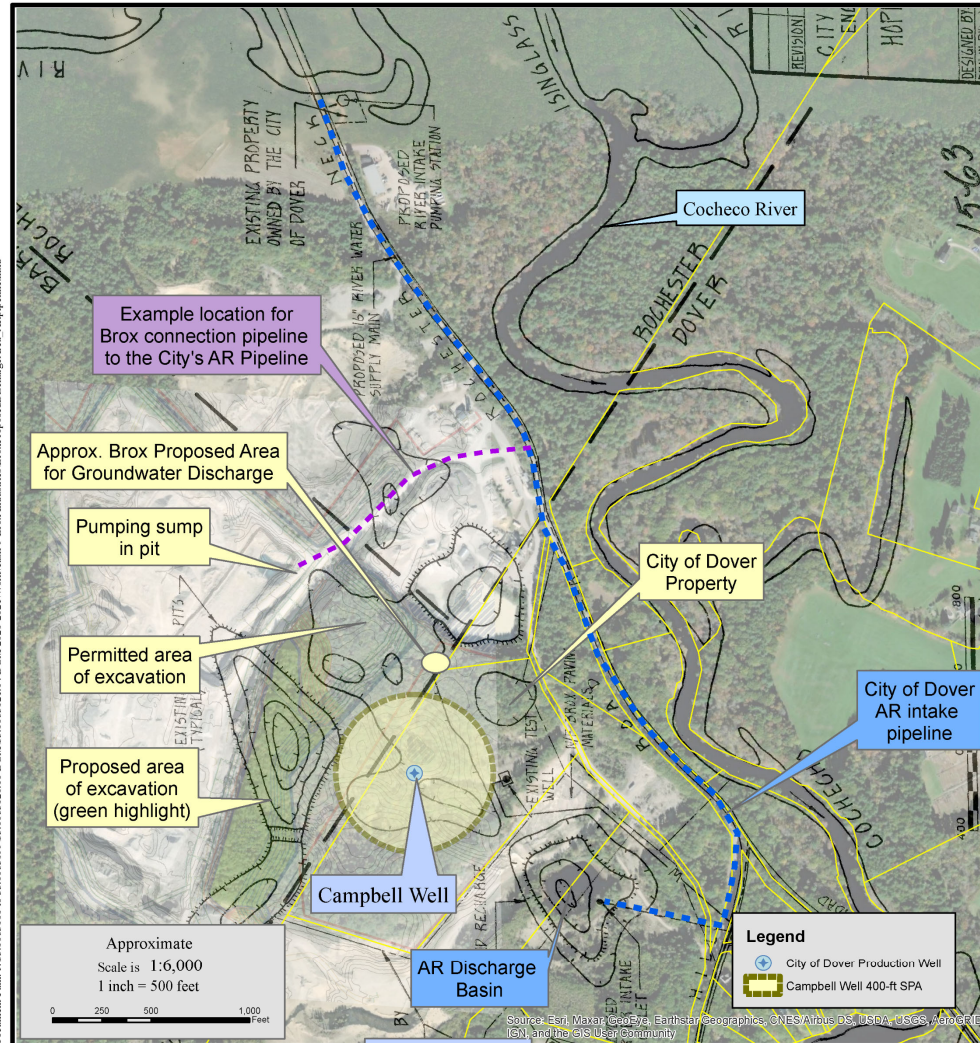
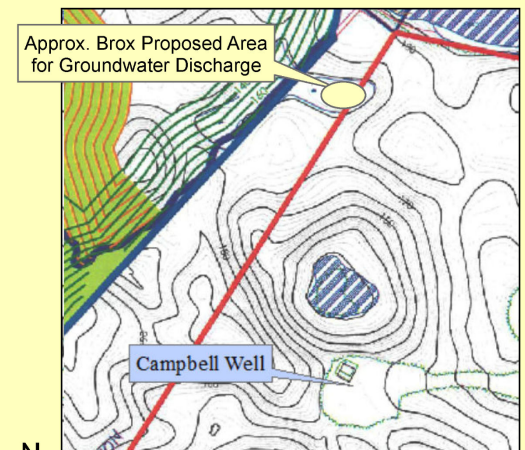


FIGURE 1

Brox Industries, Inc's Proposed Location for Future Groundwater Discharge, Location of City of Dover's Artificial Recharge Pipeline, and Potential Connection Pipeline from Brox Quarry

City of Dover Existing Monitoring and Production Wells

Proposed Area of Discharge



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FIGURE 1

Brox Pit Discussion

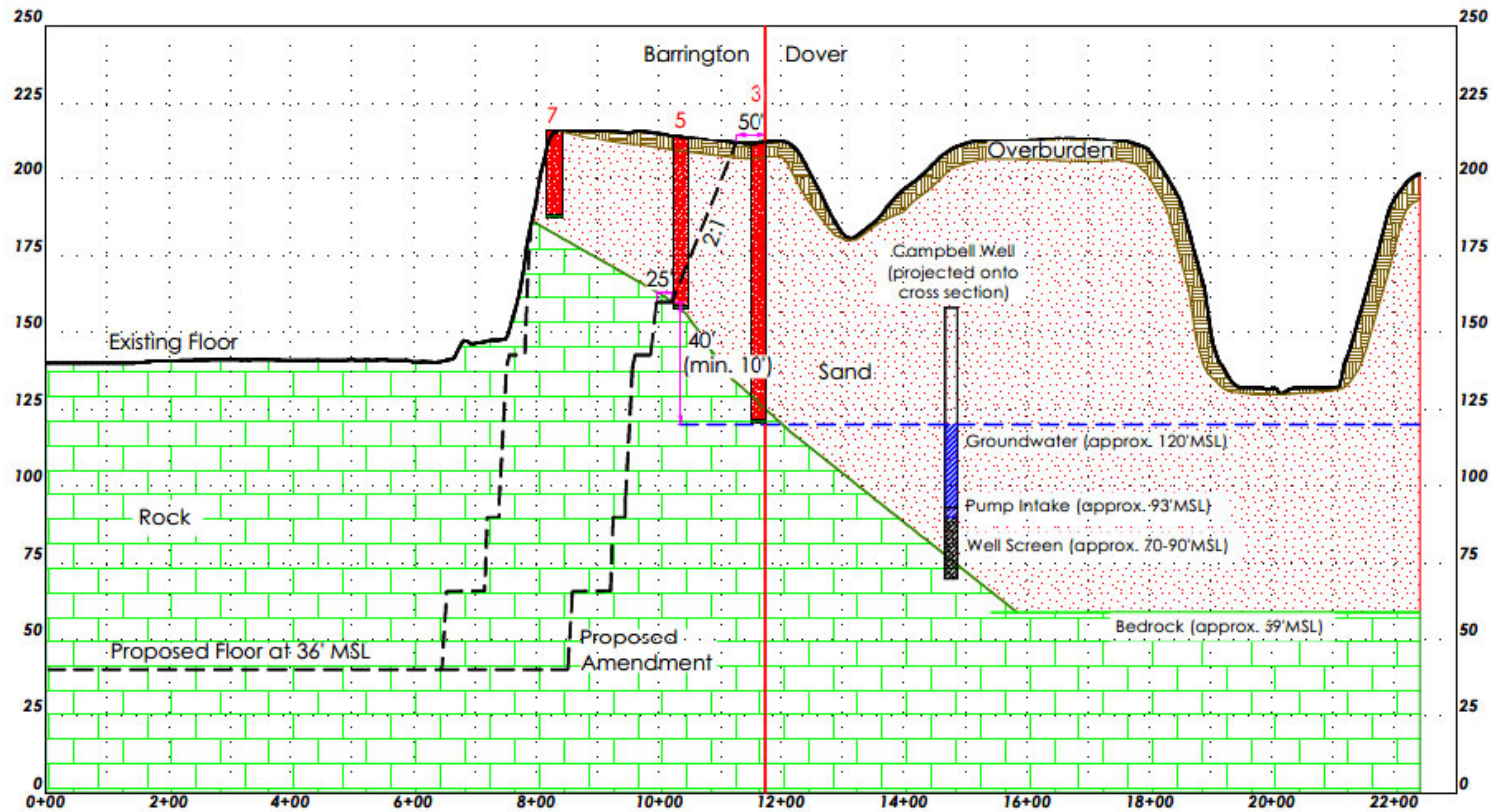


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Hoppers Aquifer Discussion

GEOLOGIC CROSS SECTION

VERT. SCALE 5X



A

GEOLOGIC LEGEND:



Overburden



Sand



Concord Granite

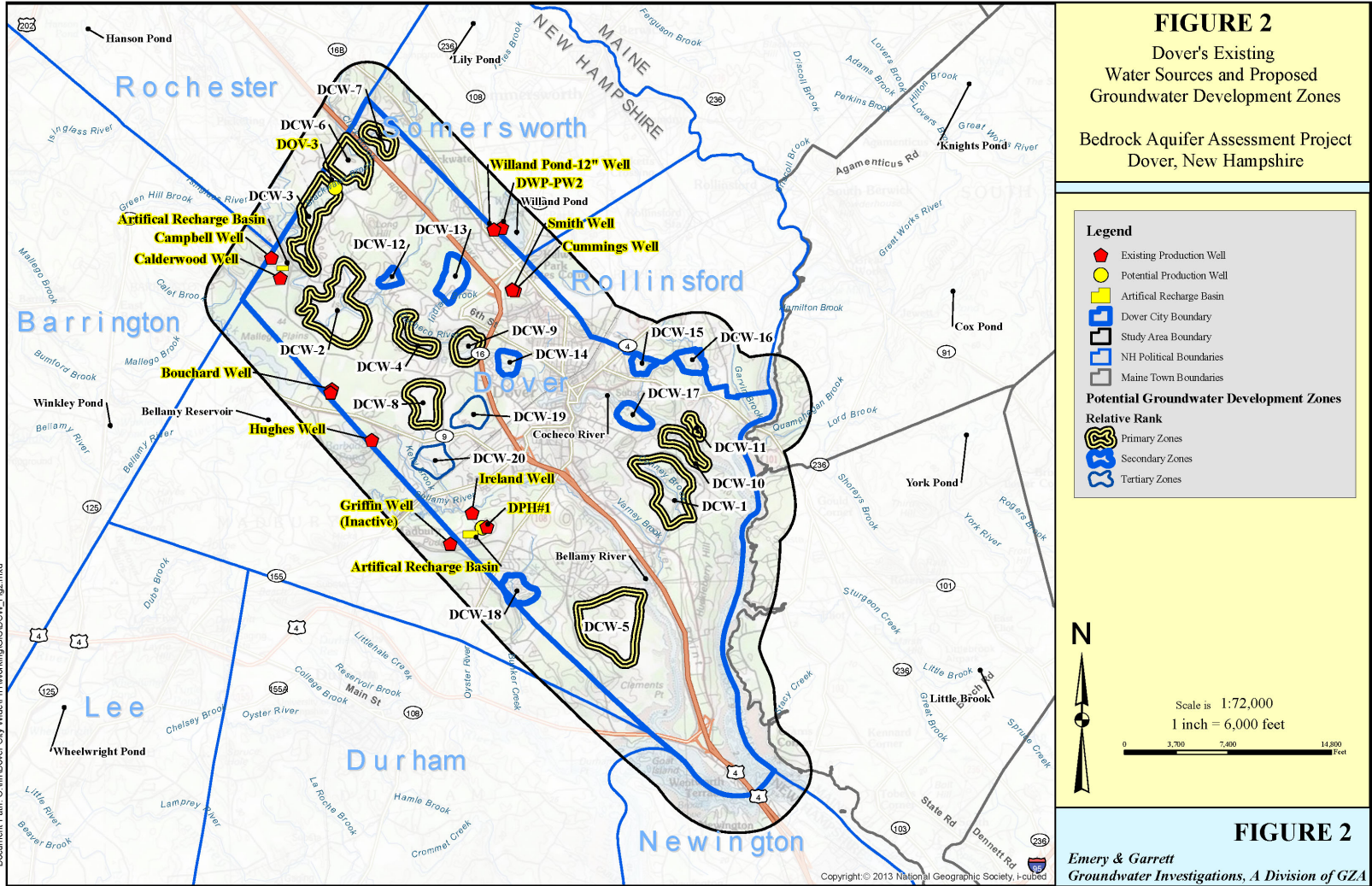
A'

- Completion and Implementation of Aquifer Management Plan
 - Operations – Critical Water Levels
 - Standard Operating Procedures
- New Groundwater Source Exploration and Development
- Pudding Hill Treatment and Start up of Artificial Recharge
- Re-Permit Griffin Well for use as an emergency backup well
- Continuation of monitoring with Schnitzer once PFAS Treatment Plant is in operation

New Source Exploration



New Source Exploration – DOV-3

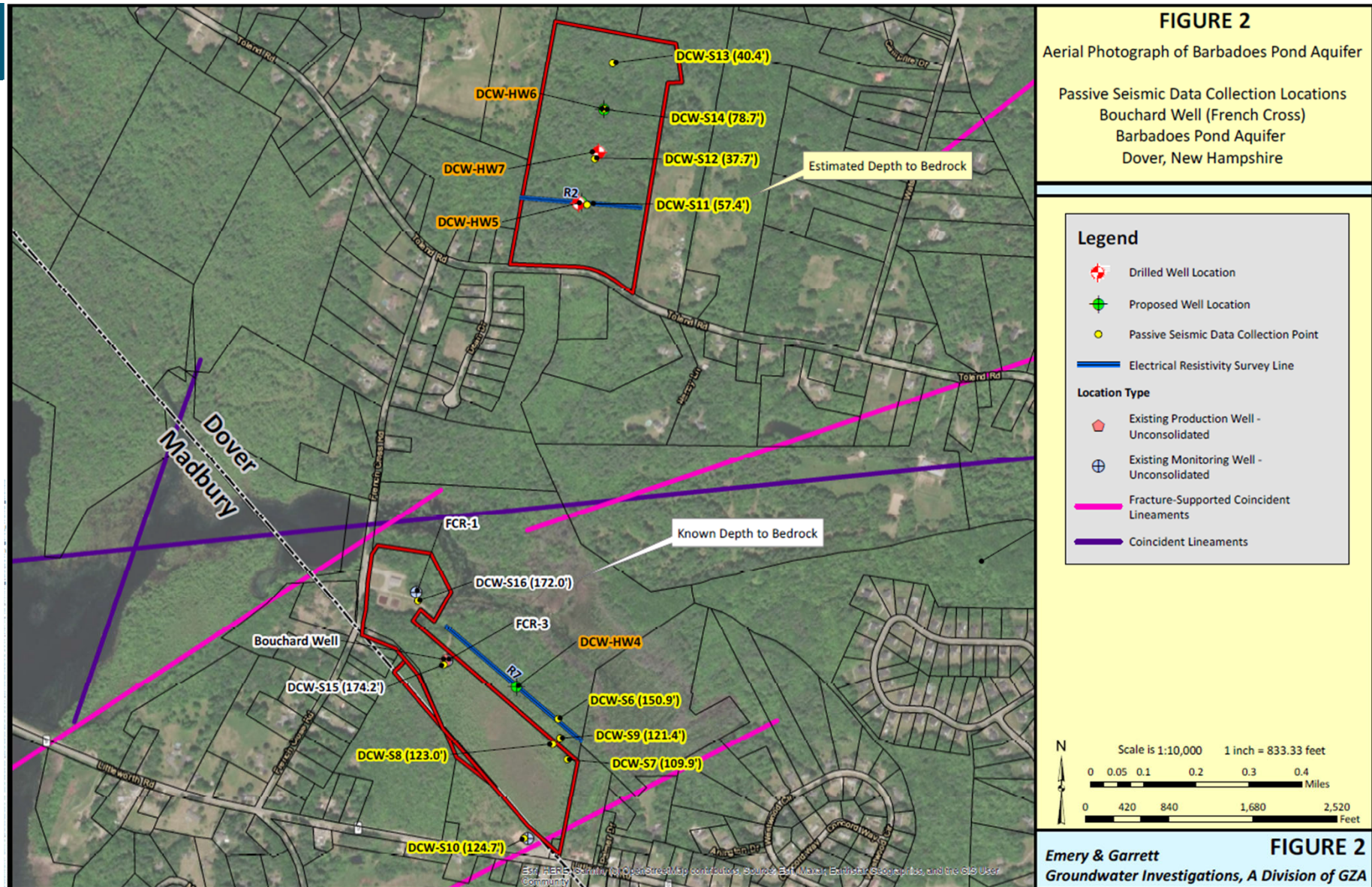


Document Path: C:\n\ Dover City Wide\p1\Working\GIS\DCW_Fig2.mxd

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GEOTECHNICAL ENVIRONMENTAL ECOLOGICAL WATER CONSTRUCTION MANAGEMENT





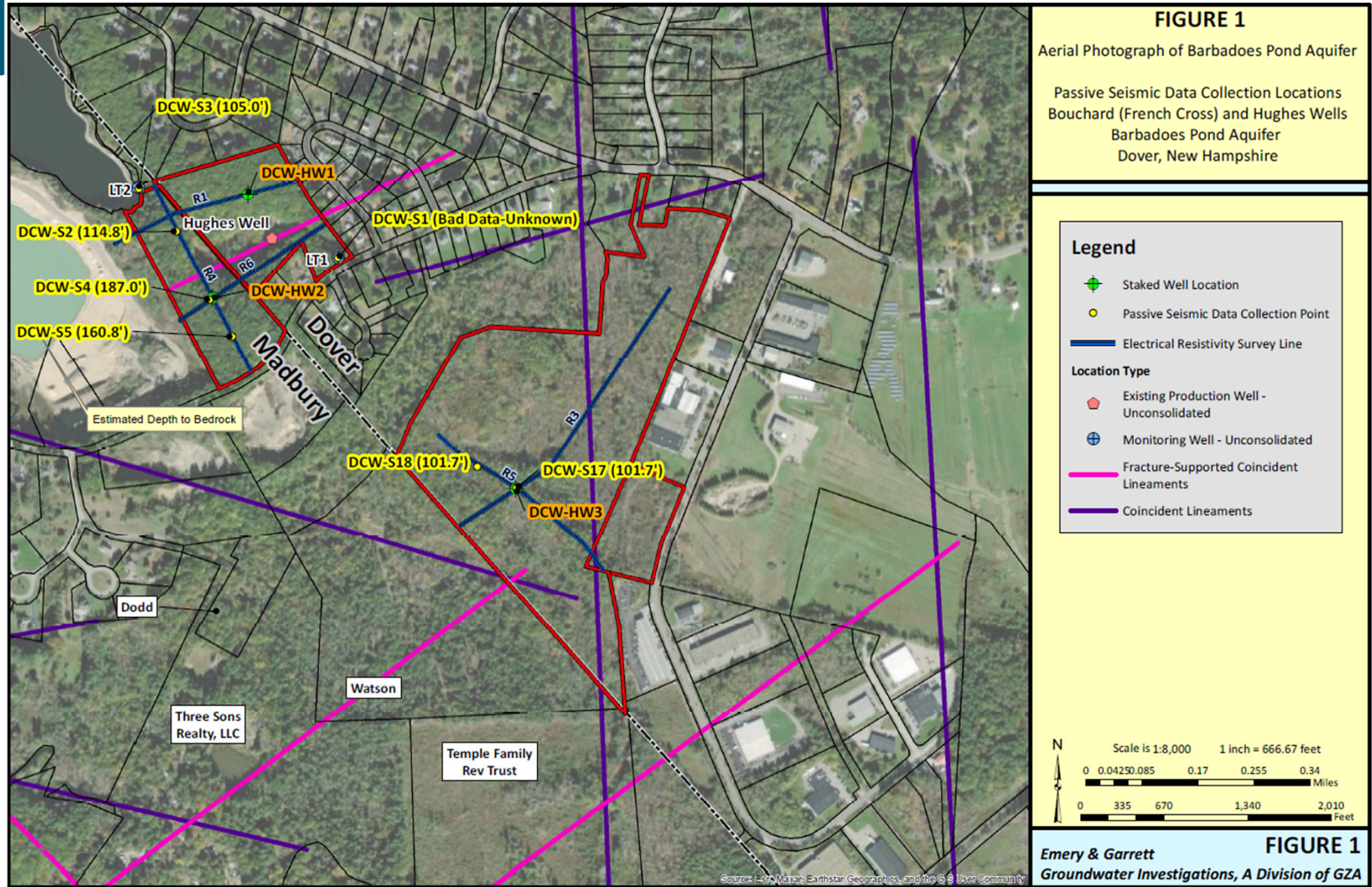
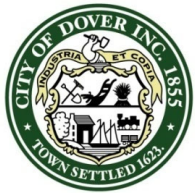


TABLE II
Drilling Summary Table
Exploratory Test Wells Installed
Dover, New Hampshire

Exploratory Test Well ID	Well Construction Type	Total Depth of Borehole (feet)	Depth to Bedrock (feet)	Well Screen Information			Specific Capacity (gpm/ft)
				Top (feet)	Bottom (feet)	Slot Size (inches)	
DCW-HW1	3" PVC	122.0	N/A	100	120	0.010"	24
DCW-HW5	3" PVC	55.0	N/A	35	55	0.010"	0.2
DCW-HW6	N/A	43.0	38	N/A	N/A	N/A	N/A
DCW-HW7	3" PVC	35.0	33.5	20	30	0.010"	2.73



Steps/Action Items



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Aquifer Management Plan Key Elements

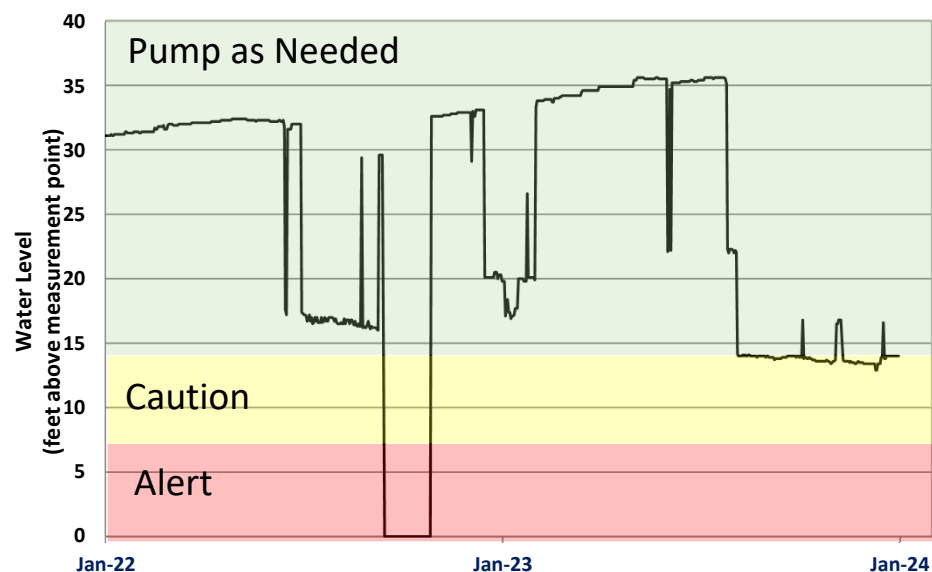
1. Production Well Testing and Data Summary
2. Citywide contaminant threat inventory
3. Proposed amendments to Groundwater Protection Ordinance (170-28.3) and “Groundwater Protection Zones” map
4. Water level-based and water quality-based action levels



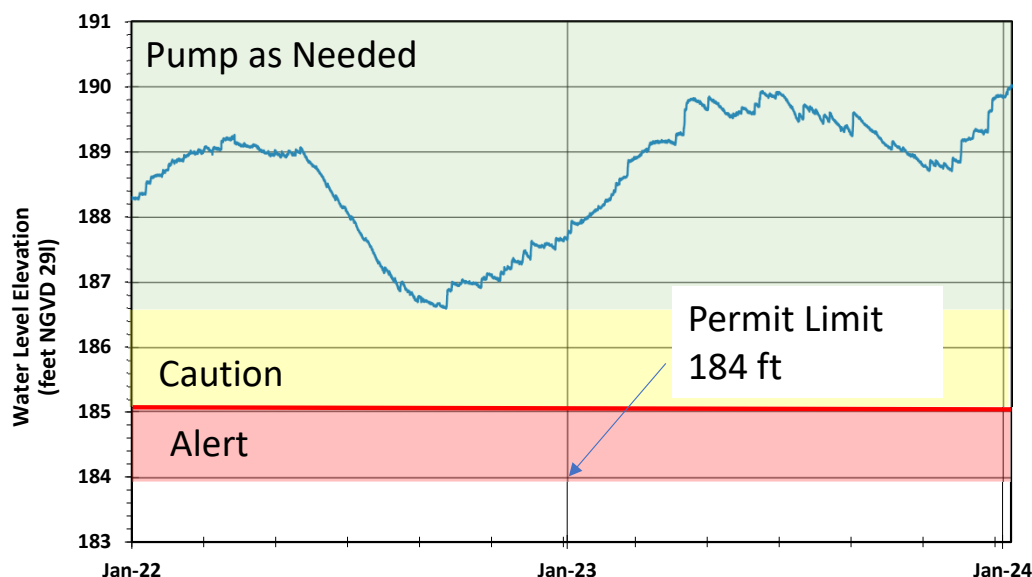
Water Level Elevation (ft)	Water Elevation (7/1/22)	5-Year Average	Elevation Trigger Point
Barbadoes Pond			
DGM-SW1	127.7	128.1	125.0
FCR-9D	129.7	130.5	129.0
DGM-LT1	127.5	127.4	125.0
DGM-LT2	127.8	127.9	126.0
DGM-LT4	124.6	125.7	123.0
Pudding Hill			
DP-105	93.7	92.5	80.0
DPH-7	84.2	81.3	60.0
DPH-B5	82.5	82.2	70.0
DPH-MW-1	95.3	94.2	80.0
DPH-MW2D	81.8	81.5	75.0
DPH-MW6	93.7	92.8	80.0
DPH-MW8	87.6	86.5	85.0
The Hoppers Aquifer			
DGM-LT5	106.7	108.0	106.0
DGM-LT6	110.0	111.1	110.0
DGM-LT7	112.2	114.0	112.0
Willand Pond Aquifer			
DWP-MW4D	174.7	174.2	171.0
DWP-MW16D	132.3	138.5	136.0
DWP-SW5*	189.9	189.6	184.0
DWP-TW1	188.3	189.3	185.0

Aquifer Management Planning

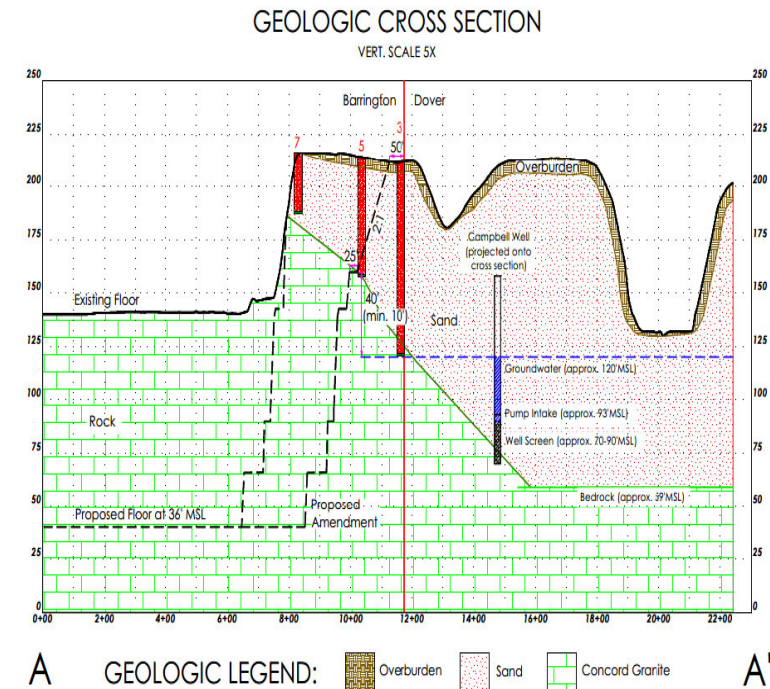
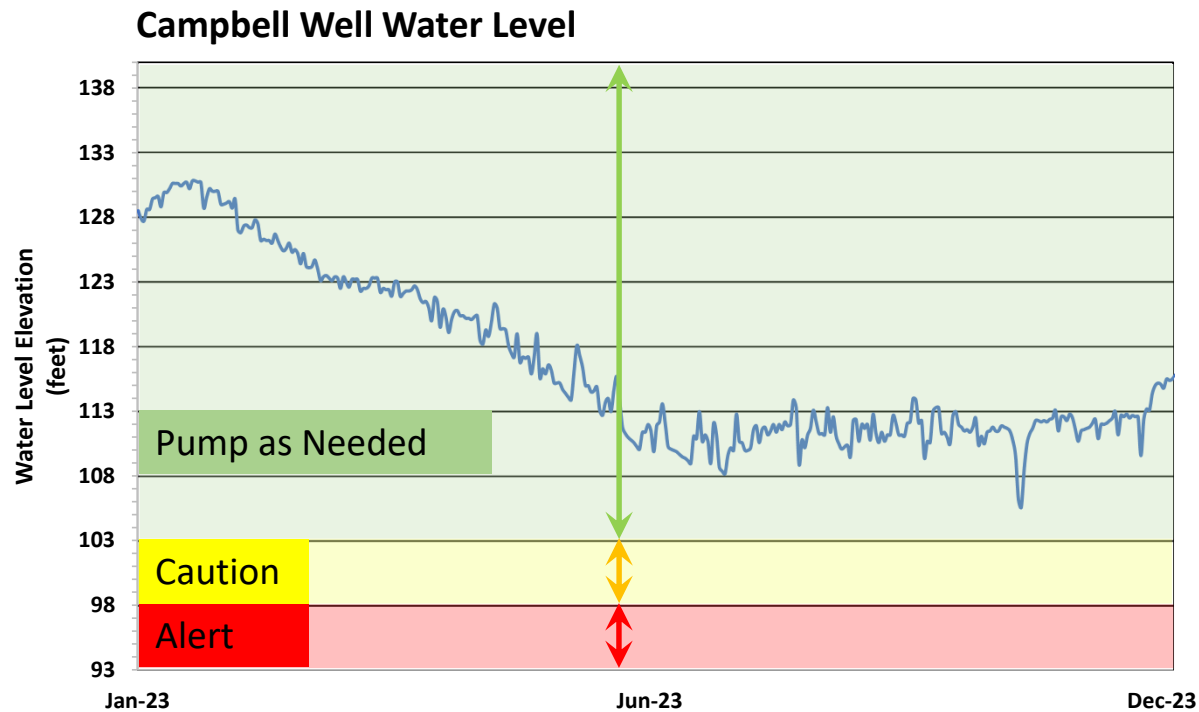
Willand Pond 12" Well

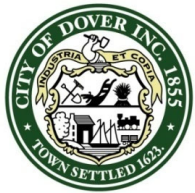


Surface Water Station DWP-SW5



Aquifer Management Planning





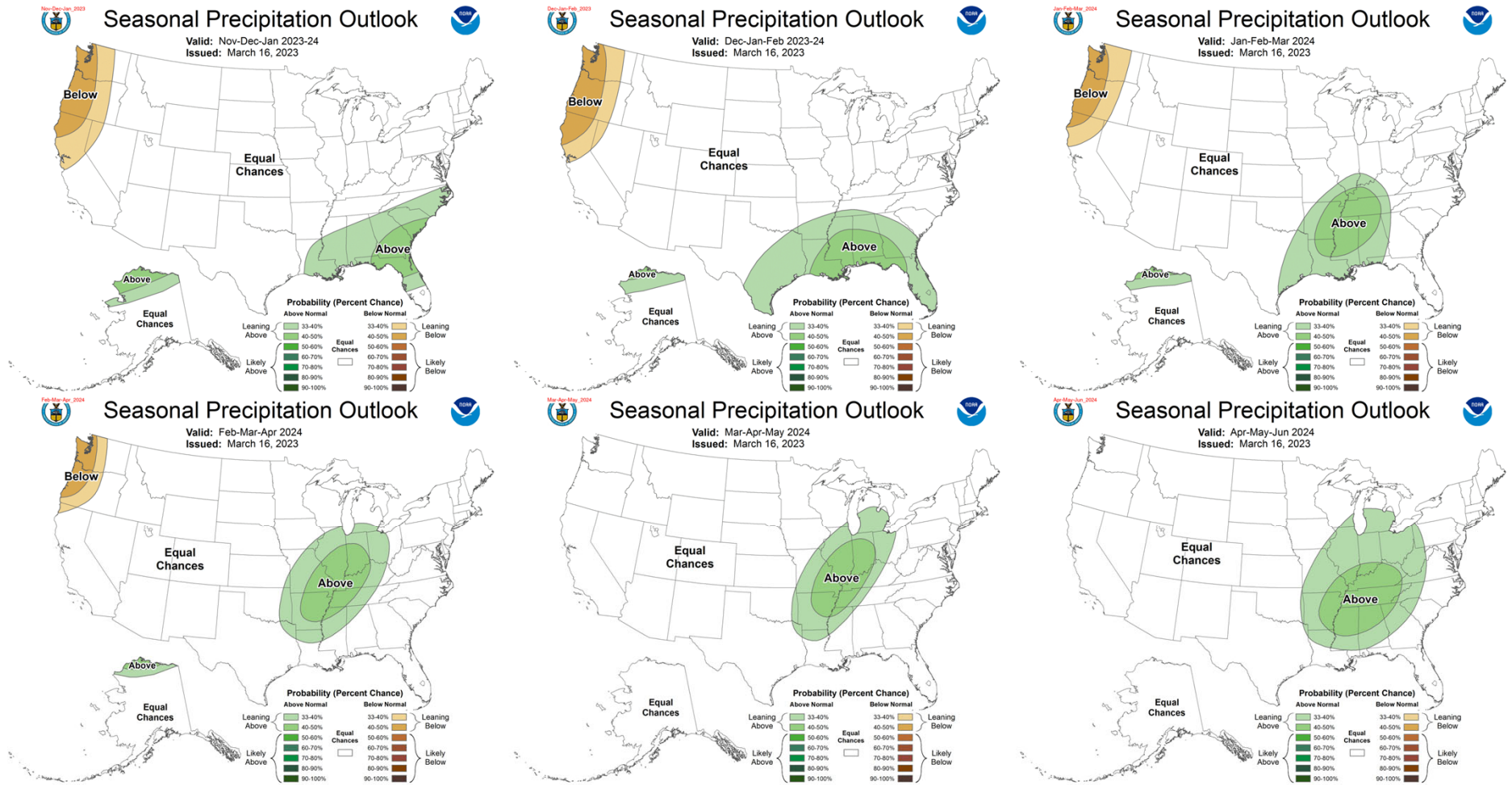
Further Discussion?



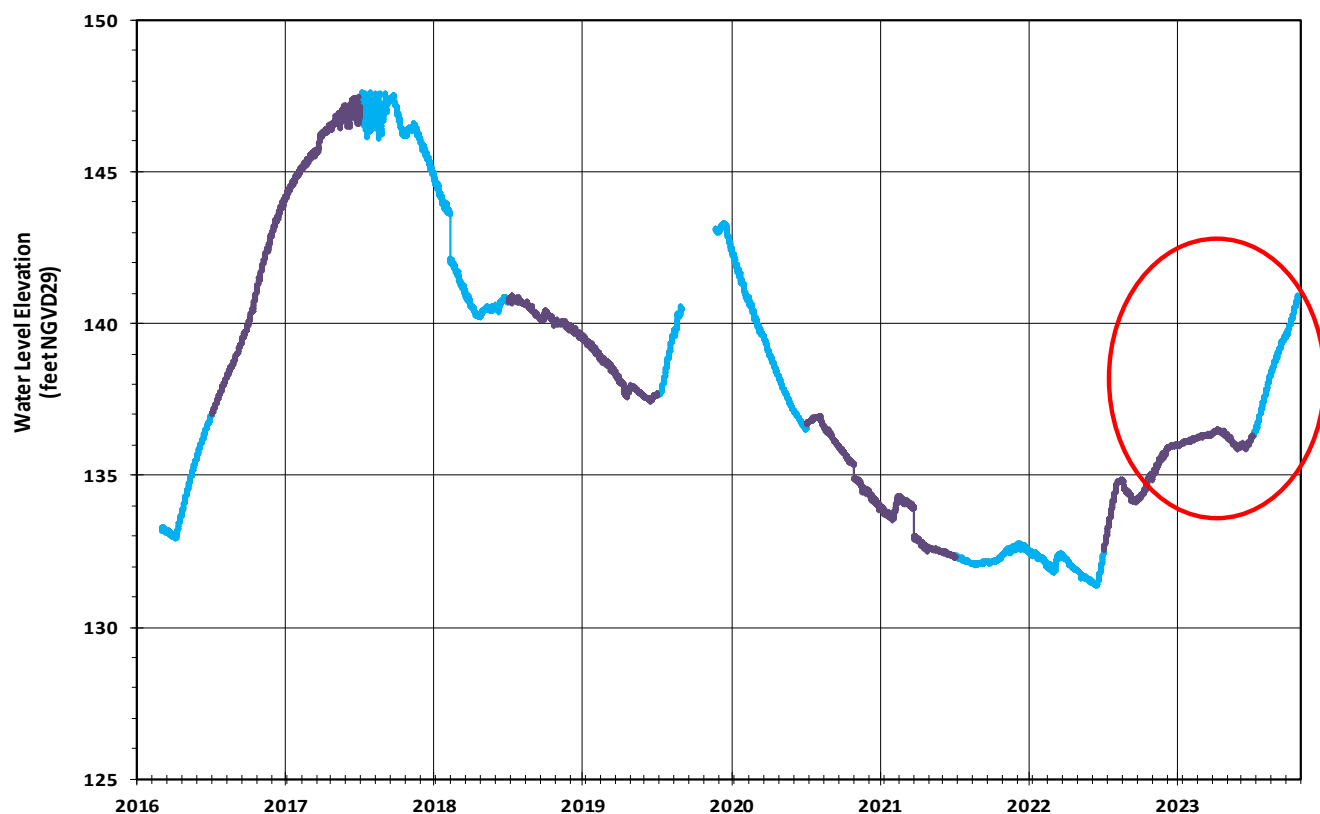
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Precipitation Forecast November 2023 – June 2024



Willand Pond Aquifer Monitoring Well DWP-MW16D



Plot of Water Level for July 1, 2016 to April 23, 2024
 Long-Term Groundwater Monitoring Program
 Dover, New Hampshire



Dover Water Supply Recent Data Summary

PFAS Detected - Pudding Hill Aquifer

Monitoring Wells

(maximum concentrations of regulated PFAS detected 2022)

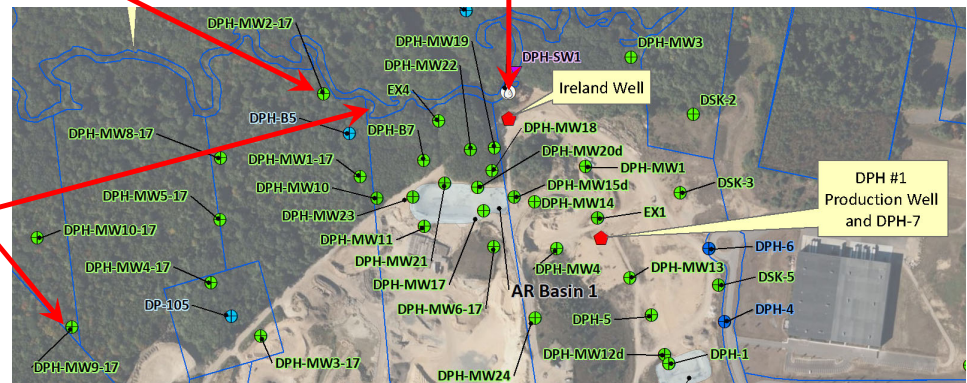
- PFOA – 257 ng/L (MW2-17, Feb)
- PFOS – 305 ng/L (MW2-17, Feb)
- PFNA – 6.30 ng/L (MW9-17, April)
- PFHxS – 92.3 ng/L (MW2-17, Feb)

Artificial Recharge Intake Nov

- PFOA – 3.2 ng/L
- PFOS – 3.59 ng/L

Spring 2 (DPH-MW-Spring 2) Nov

- PFOA – 75 ng/L
- PFOS – 71 ng/L
- PFHxS – 36.3 ng/L



Willand Pond Aquifer Discussion

- Iron and manganese concentrations
- Willand Pond depth in drought
- Chloride Intrusion monitoring
- Lowell Ave PFAS source
- Zoning Ordinance Changes/Aquifer Protection Zoning
 - Recommend same changes in Somersworth?
- Conservation/protection of Land?

