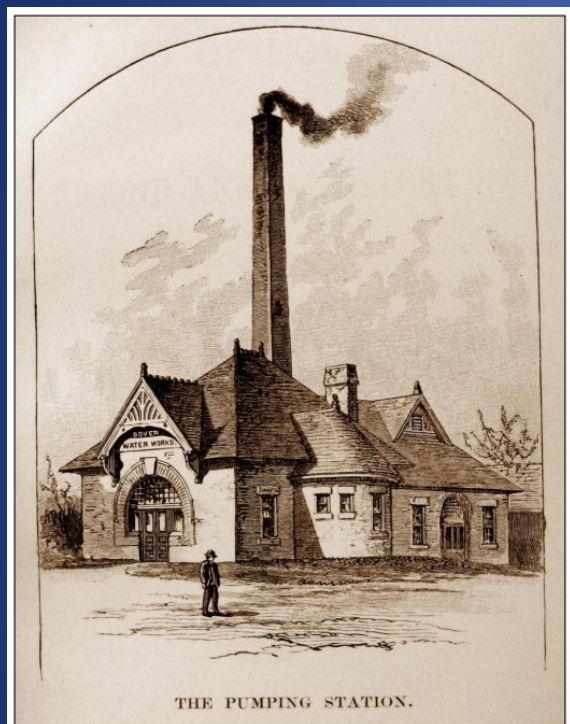


Dover Water Facility Improvements



City Council Workshop June 14, 2023

Joint Presentation

- Underwood Engineers – Infrastructure
 - Keith Pratt, President
- EGGI/GZA – Supply and Well Monitoring
 - James Wieck, Associate Principal



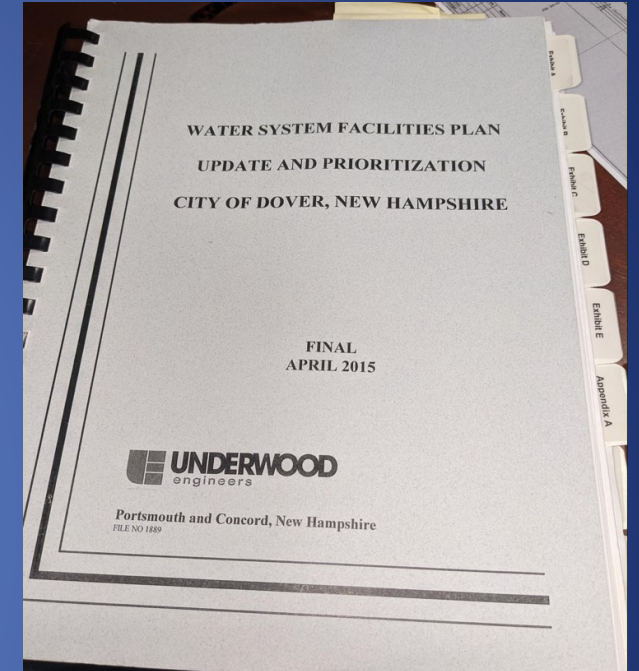
Water System Improvements 400 More Years!

AGENDA

- Dover System Overview
- Projects Completed and in Process
- Future Projects
- Supply and Demand
- EGGI/GZA... Supply and Well Monitoring

2015 Facilities Plan

- Renew Vertical Assets (Supply and Treatment)
- Invest in the most valuable supplies
- Address most critical facilities first
- Prioritize cost-effective sources: \$/GPD
- Develop a Phased Priority Program

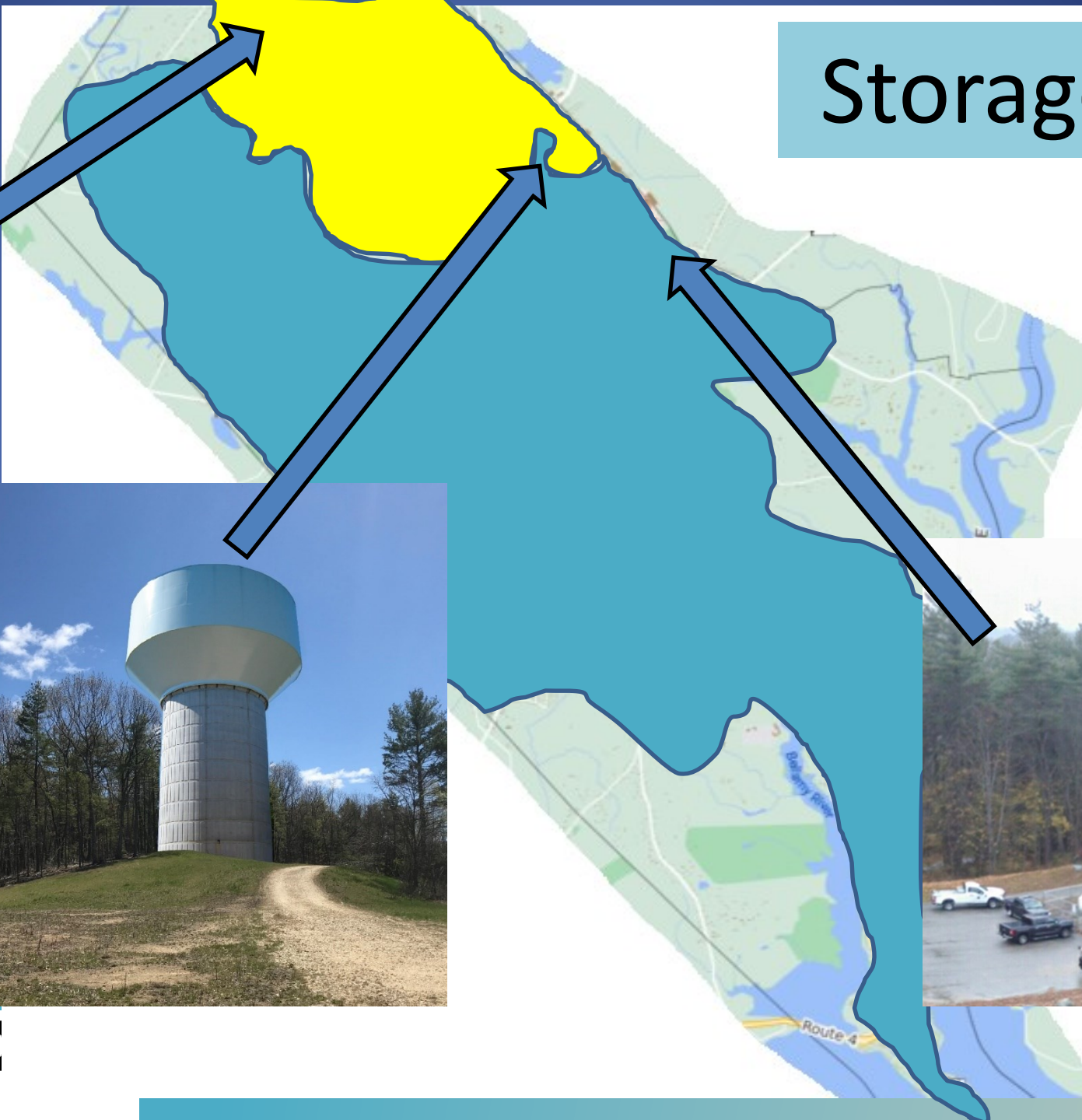


**Significant Amount of
Work Completed to Date!**

City of Dover Water System

- 28,000 people served
- 2.0 million gallons annual average demand
- 11 wells (not all active) in four aquifers
- 3 water treatment facilities (a 4th being abandoned)
- 2 artificial recharge facilities
- 2 active water storage tanks (a 3rd tank in construction)
- 1 booster pumping station
- 1 Emergency Interconnection (another one to be installed soon)

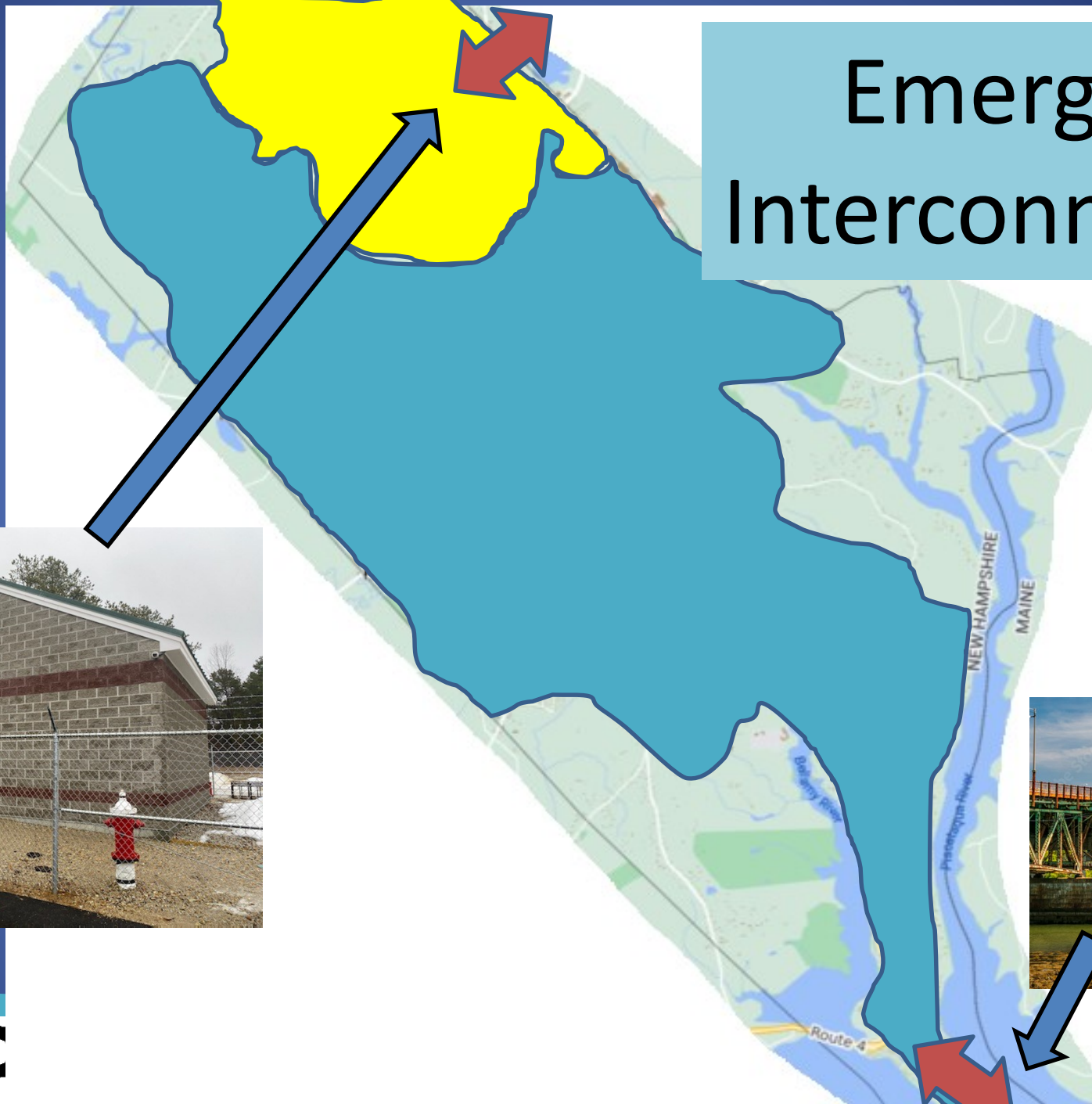
Storage Tanks



Rendering
Online in 2024



Emergency Interconnections



Pending ~2027

4 Aquifers 11 Wells

Hoppers - 2 Wells
Campbell
Calderwood

Barbados - 2 Wells
Bouchard
Hughes

Pudding Hill - 3 Wells
Ireland
DPH-1
Griffin

Willand Pond - 4 Wells
Willand 1
Willand 2
Smith
Cummings

4 Aquifers 11 Wells

Hoppers - 2 Wells
Campbell
Calderwood

Barbados - 2 Wells
Bouchard
Hughes

Pudding Hill - 3 Wells
Ireland
DPH-1
Griffin

Willand Pond - 4 Wells
Willand 1
Willand 2
Smith
Cummings

Treatment Facilities



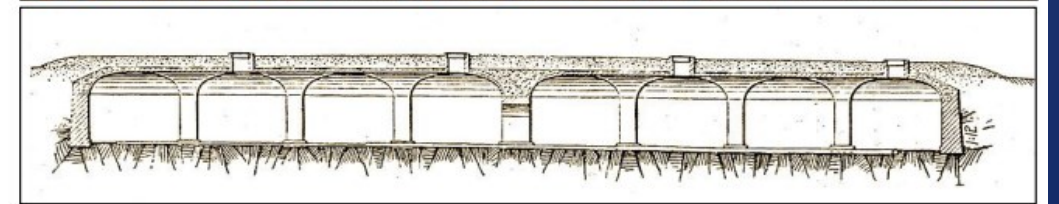
Rendering
Online in 2024



Willand Pond Aquifer

- Willand Pond Wells
- Smith and Cummings Wells
- Lowell Avenue Water Treatment Plant

Historical facilities at Lowell Avenue



Smith and Cummings Wells 1930's



Smith and Cummings Well House



Today

Willand Pond Wells and Control Building



Today

Operate wells to control Willand Pond level



Lowell Avenue Water Treatment Facility

Complete 2018



Hoppers Aquifer

- Campbell Well
- Calderwood Well
- Calderwood Chemical Treatment Facility
- Isinglass River Recharge Station

Calderwood/Campbell Wells and Treatment



Today



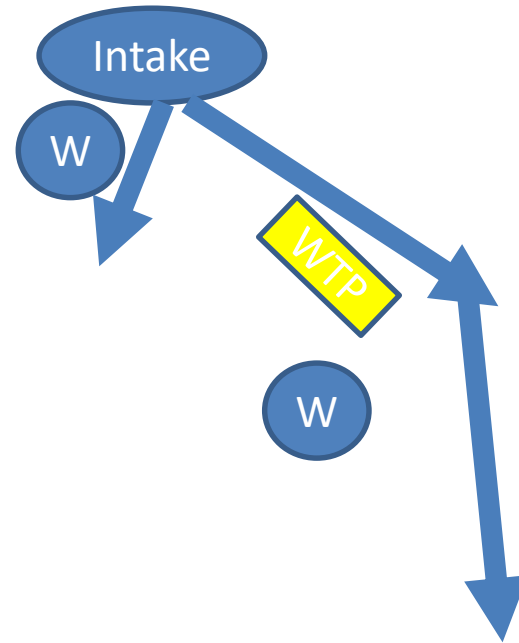
Isinglass Recharge



Today

Pudding Hill Aquifer

- Griffin Well
- Ireland Well (replacement)
- Well DPH-1
- Pudding Hill Water Treatment Facility
- Bellamy River Artificial Recharge Station



Pudding Hill Aquifer

- 3 Wells and Griffin WTP
- Bellamy River Intake
- 2 Recharge Basins and
- Pudding Hill WTP

W

Community Services

Artificial Recharge Pump Station and Intake



Today



Rendering
View from
Driveway

DOVER WATER TREATMENT

Dover Water Pudding Hill

January 26, 2021

Tennant Goucher Architects PA



Today

Pudding Hill Water Treatment Plant

Treatment Process – 3 Major Parts

To Clearwell and
Distribution

Raw water
From wells

NHDES
“Most Advanced Water
Treatment Facility in New
Hampshire”

GAC Vessels for PFAS Removal



June 14, 2023 (9:00 A.M.)



Barbados Aquifer

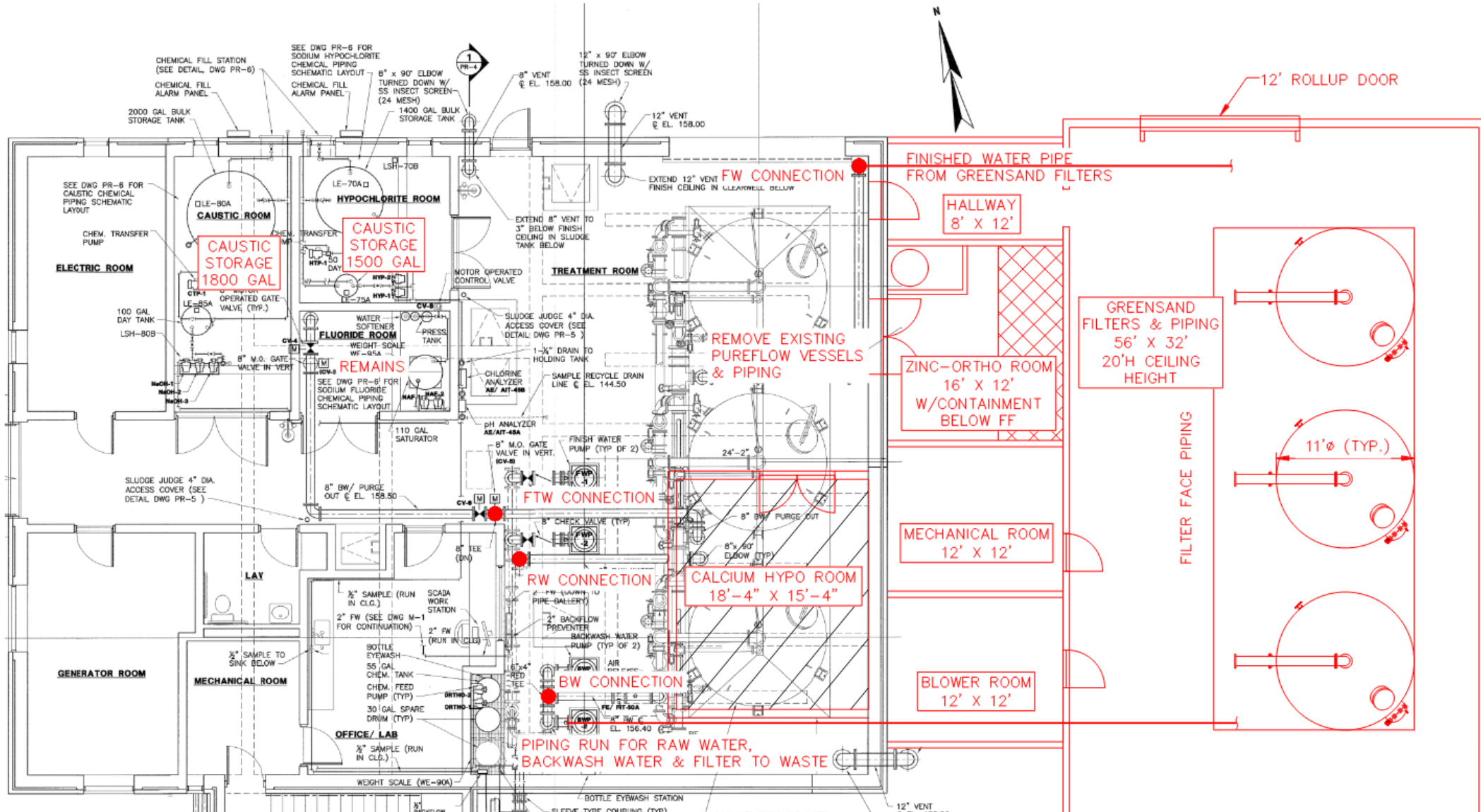
- Bouchard Well
- French Cross Road Water Treatment Facility
- Hughes Well

French Cross Road WTP



Today





Hughes Well



Today

Water Storage Facilities



Today

New 1 MG Tank – In Construction

Rendering



Today



Garrison Hill Reservoir

- Located near Abbey Sawyer Memorial Drive
- 4 Million Gallons
- Built in 1968 – Only tank in the main pressure zone
- Needs to be taken offline for maintenance – Need alternative storage



Dover Water System Vertical Asset Summary

- Prior to 2016
 - 18 Vertical Assets
- Today –
 - 24 Vertical Assets
 - 19 Renewed (79%)

What's Next – Construction

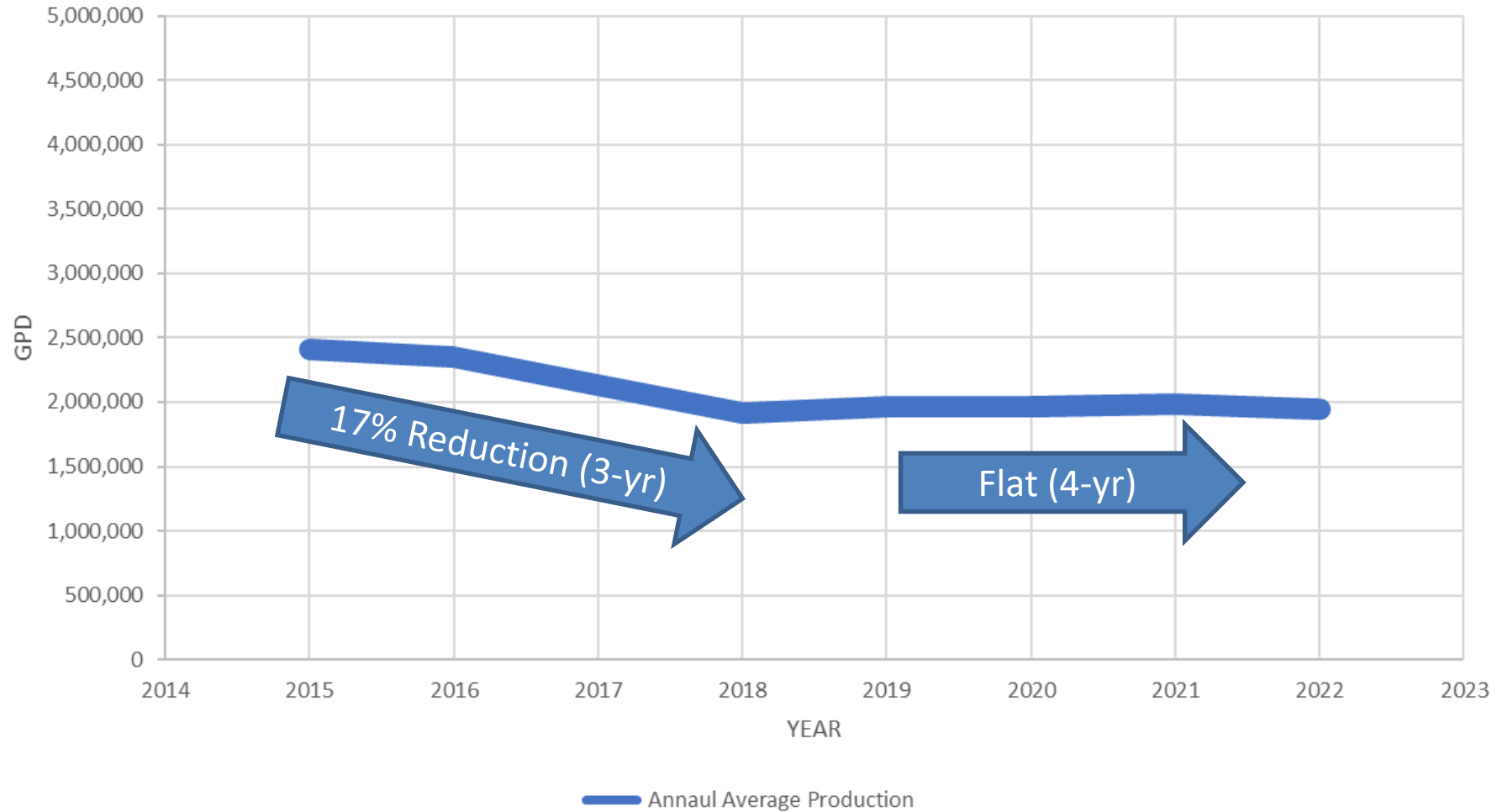
- Garrison Hill Reservoir Rehabilitation
- Dover Portsmouth Interconnect – General Sullivan Bridge
- Distribution Projects – Central Avenue etc.

What's Next – Planning/Design

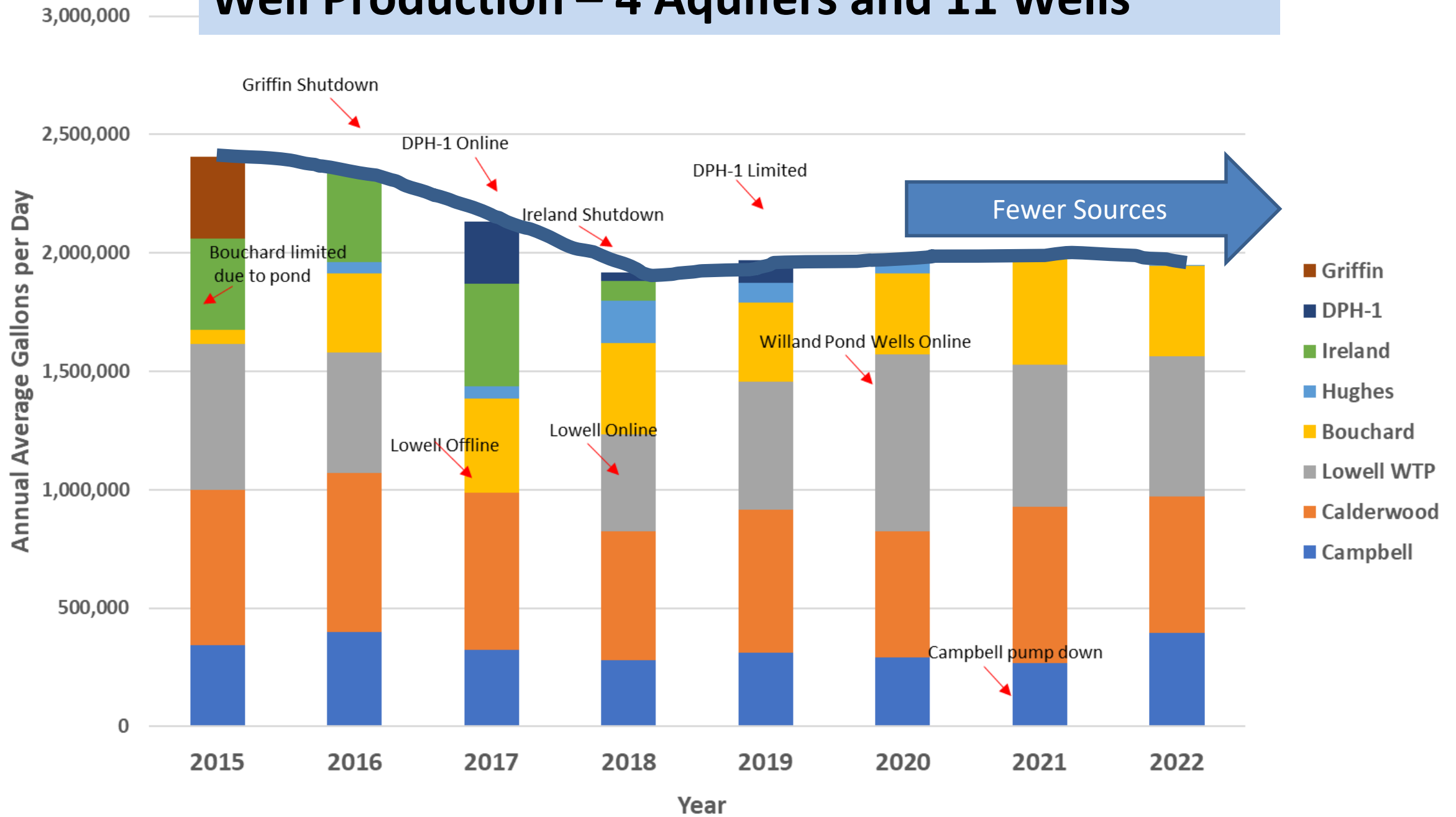
- French Cross Road Water Treatment Plant Upgrade
- Hughes Well Improvements
- Isinglass River Recharge Station Upgrade
- Booster Pump Station at Elevated Tank
- Update the Facility Plan
- SOP's and O&M
- New Supply – Increased Demands and Redundancy/Resiliency.

Supply and Demand

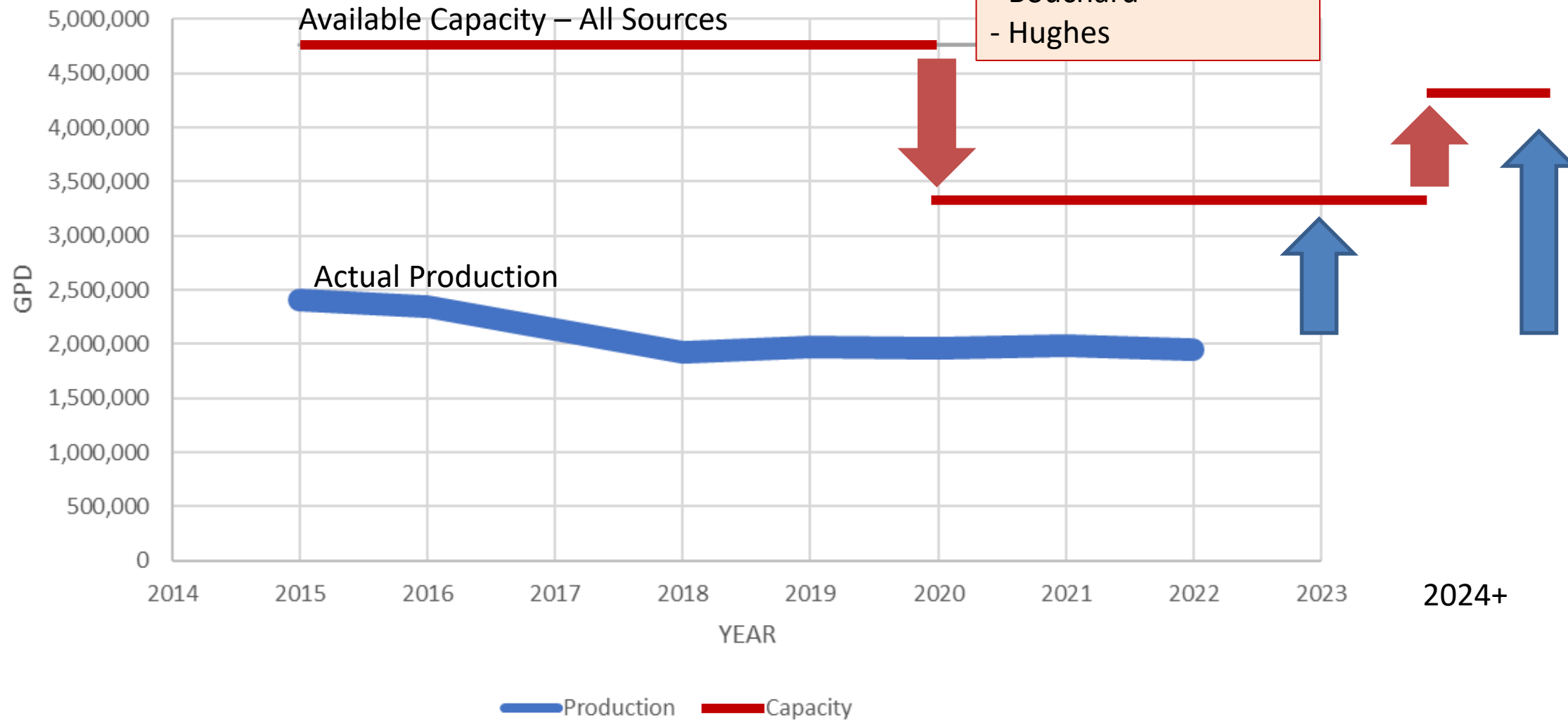
Annual Average Production All Sources Dover, NH



Well Production – 4 Aquifers and 11 Wells



Annual Average Production vs. Capacity Dover, NH

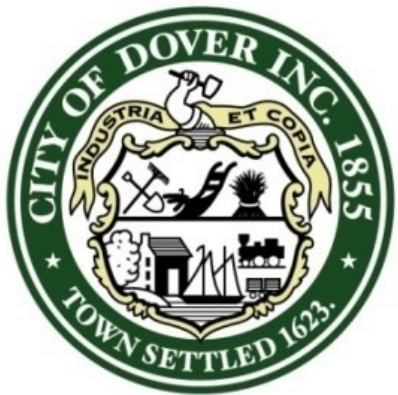


Supply Goals

- Advance Existing Supply Improvements
 - Improve/Replace Hughes Well
 - Upgrade French Cross Road Water Treatment Facility
 - Upgrade Isinglass Recharge Facility
- Add Supply Sources to Meet Demands and Provide Redundancy
 - New Source Investigations

Supply Monitoring and Exploration

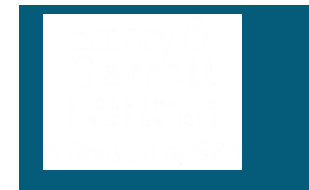
EGGI/GZA



Dover Water Workshop

Water Resources Update

June 14, 2023



Topics

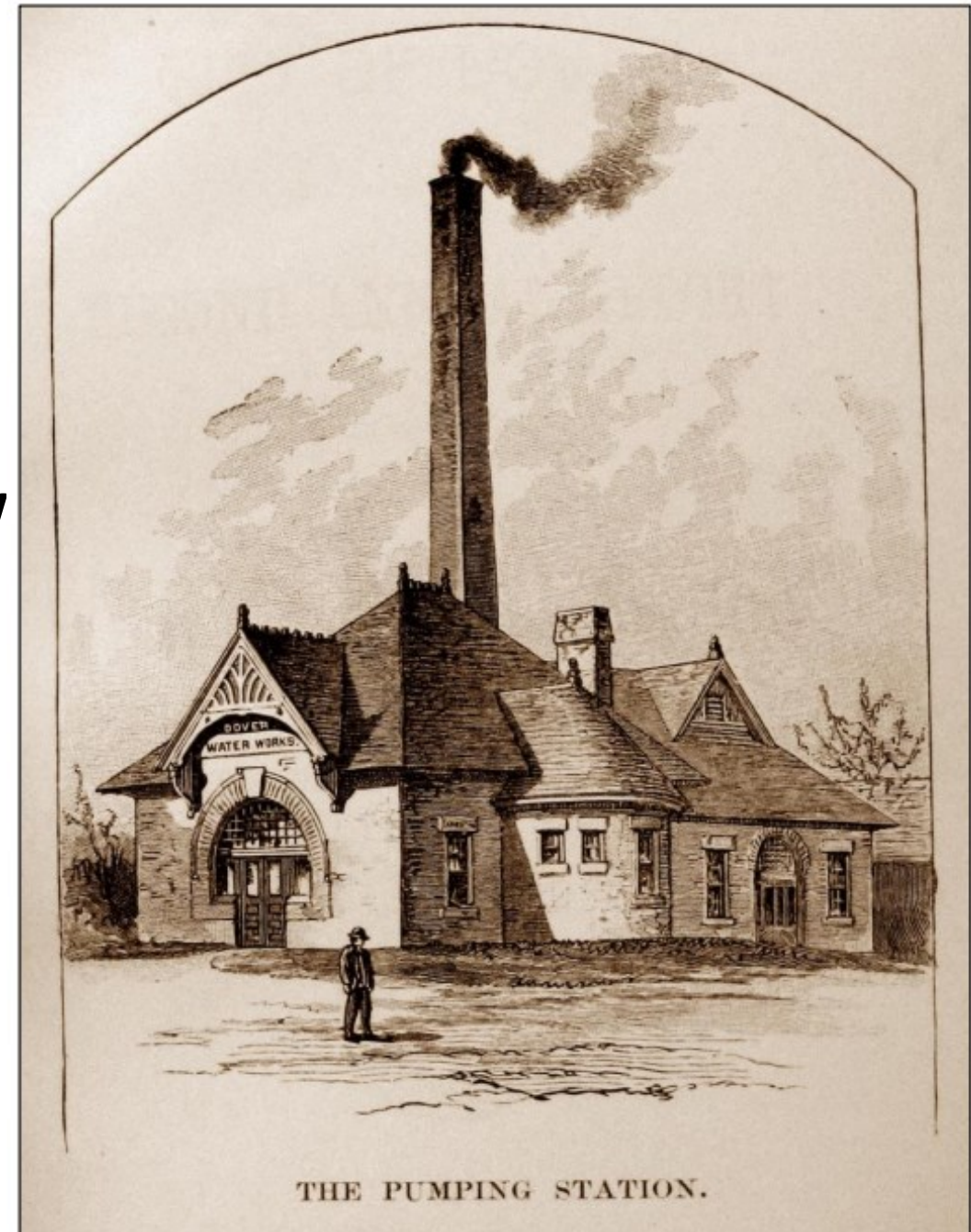
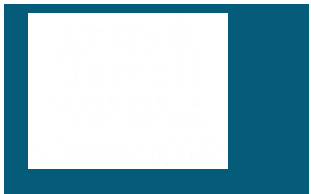
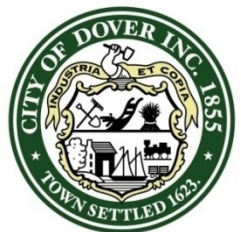
Existing water resources

Water resource challenges

Water resource monitoring projects overview

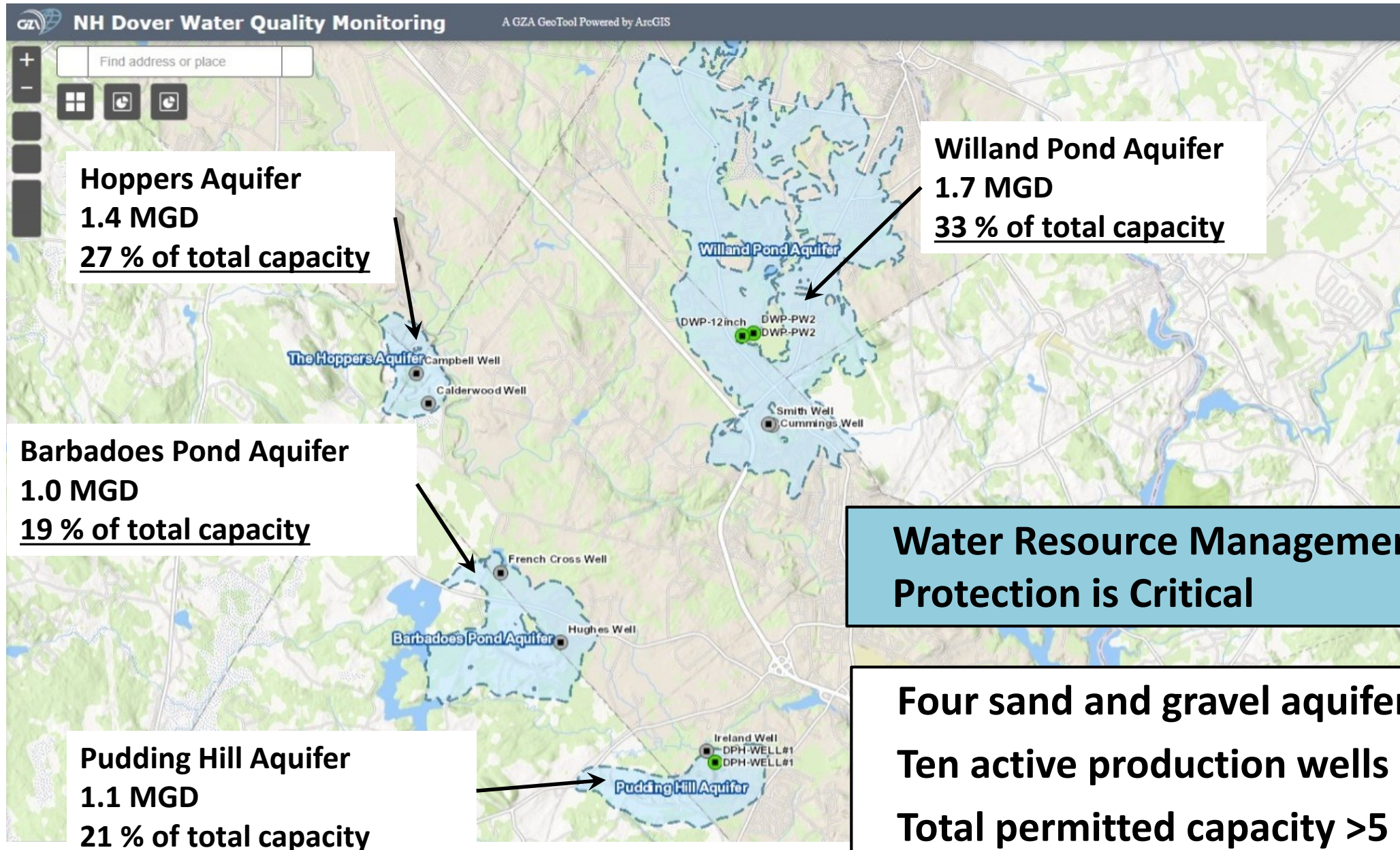
Next Steps/Aquifer management planning

New source exploration





Dover's Existing Water Resources

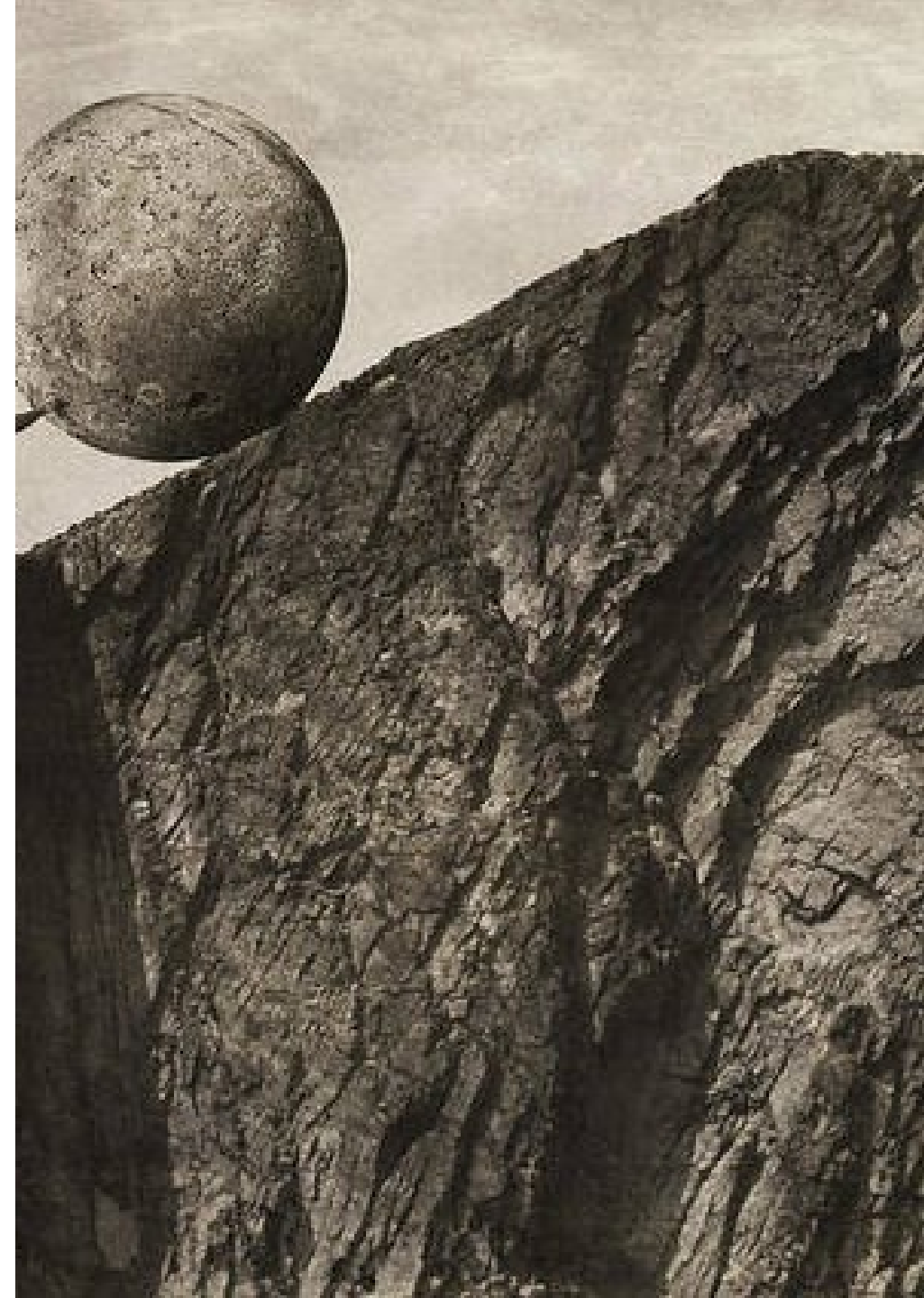


Challenges

Climate/Drought Contamination

- Emerging contaminants (e.g., PFAS)
- Chloride

Land Use



Challenges

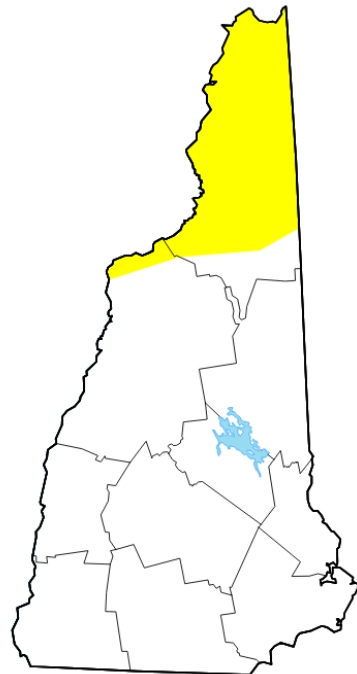
Climate/Drought



Climate/Drought

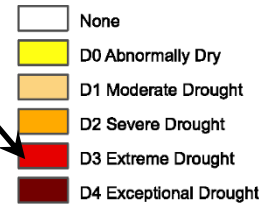
U.S. Drought Monitor New Hampshire

Today



Severe
Drought

Intensity:



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>

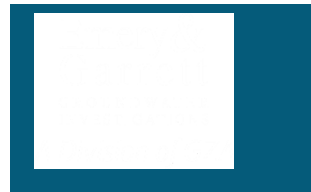
Author:

Curtis Riganti
National Drought Mitigation Center



droughtmonitor.unl.edu

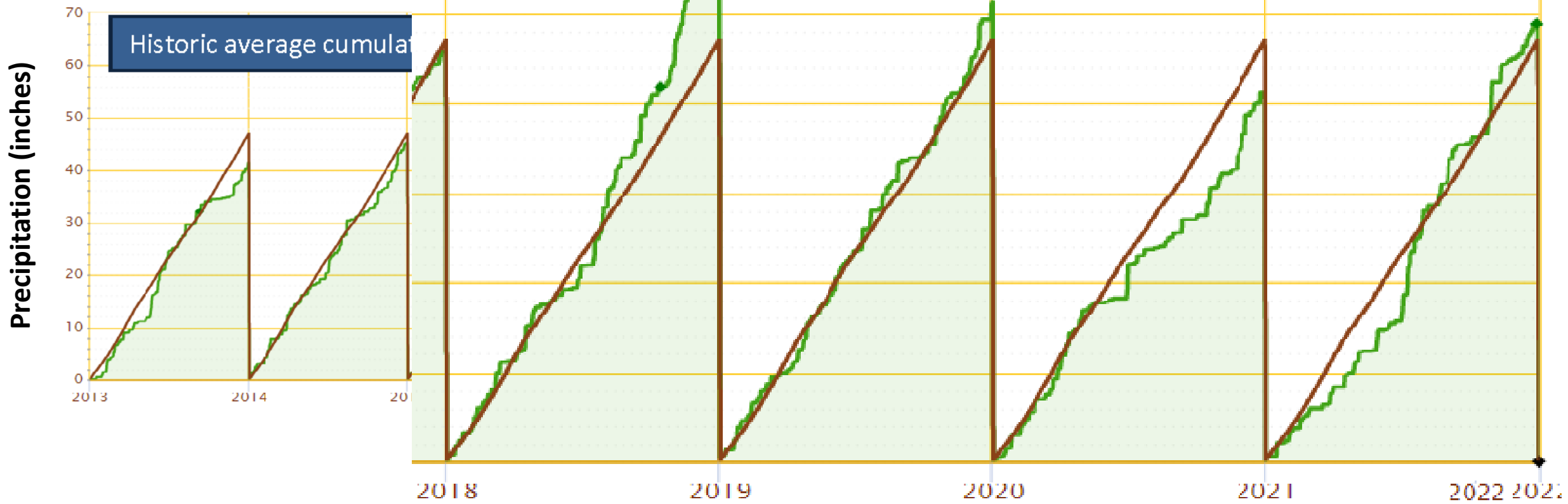
- More frequent droughts
- More intense storms
- Water use restrictions



Comparison of Annual Accumulated Precipitation to 20-Year

rcc-acis.org/

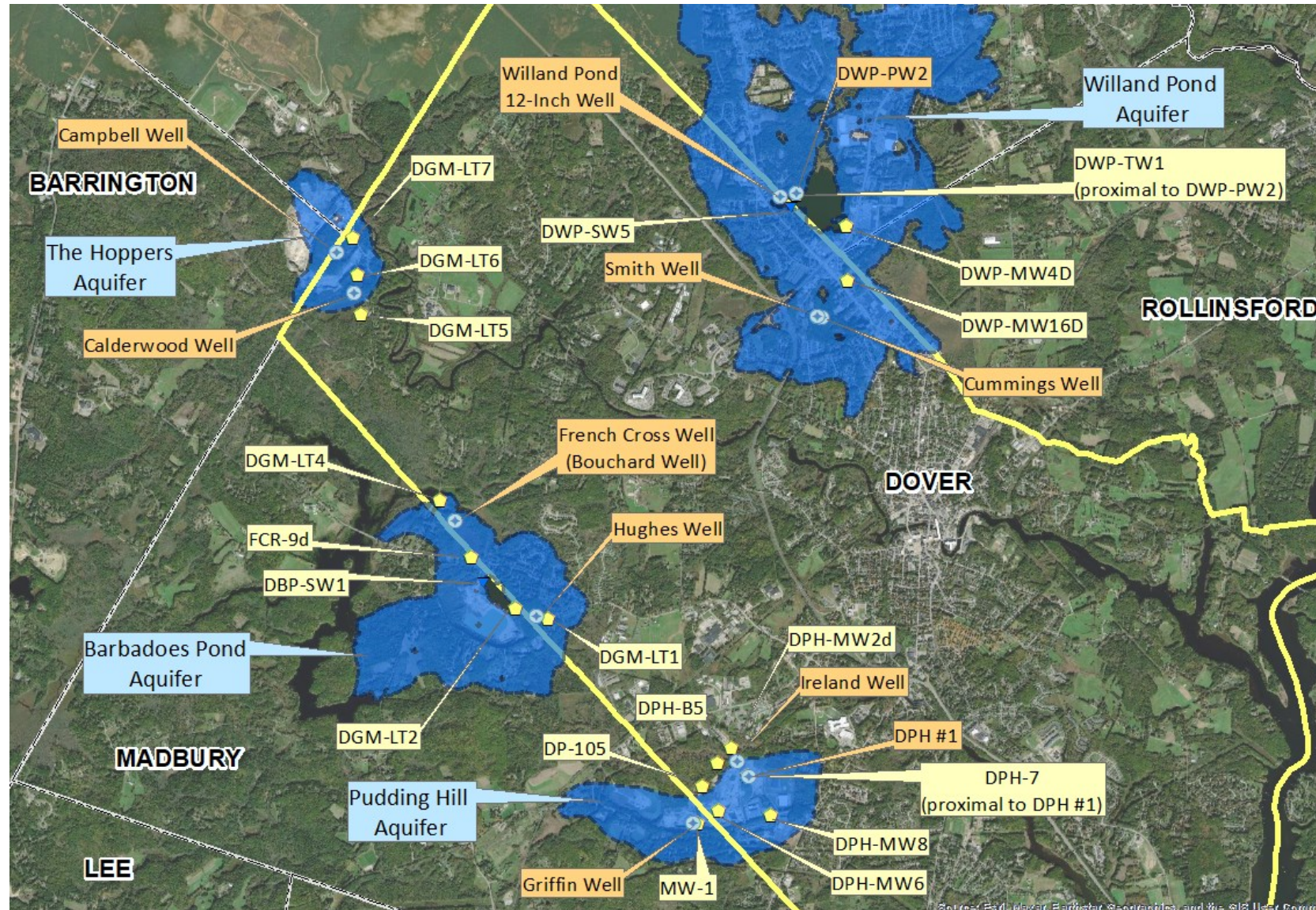
Annual cumulative precipitation



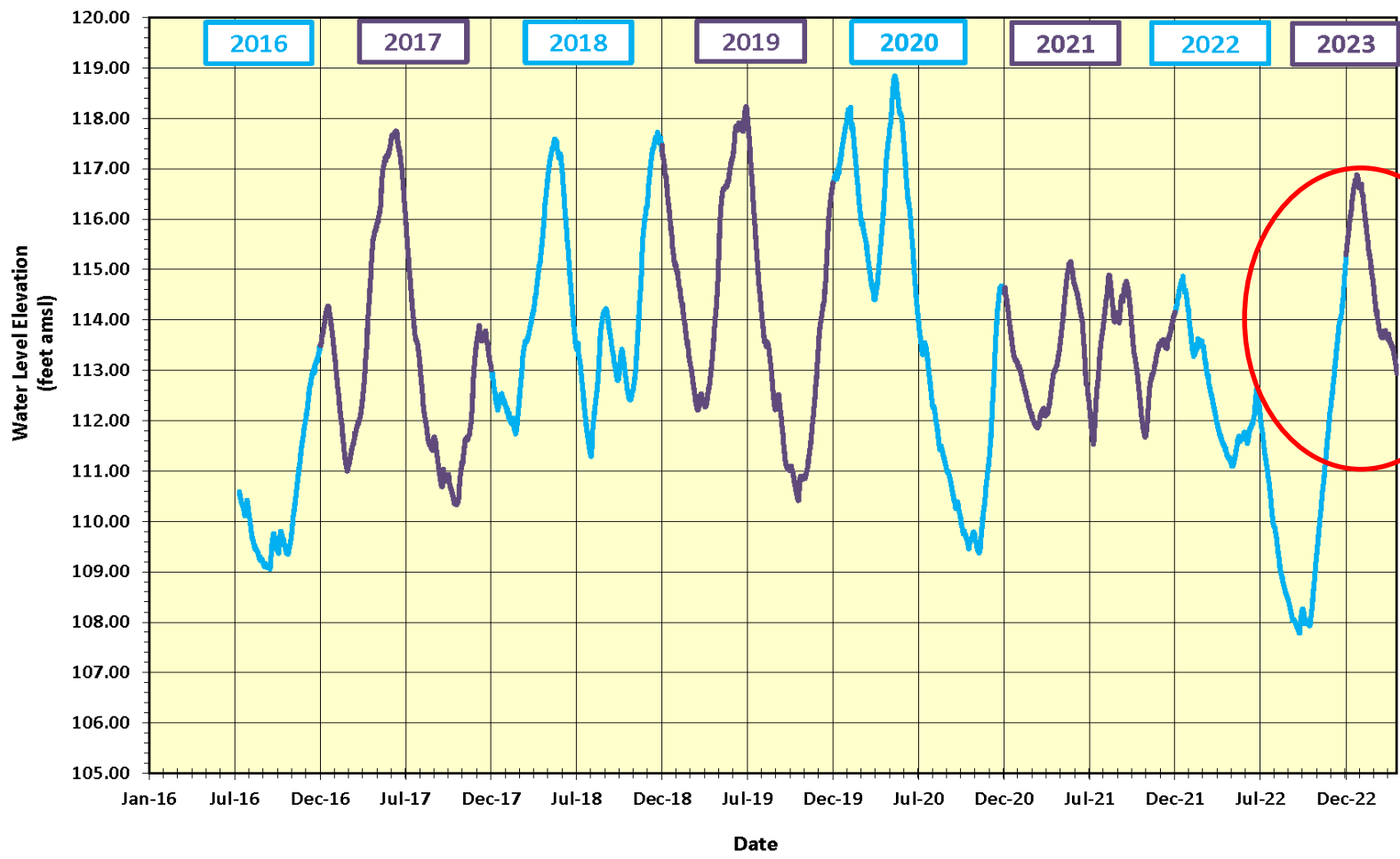
Indicator Water Level Monitoring Locations

17 Groundwater Monitoring Wells

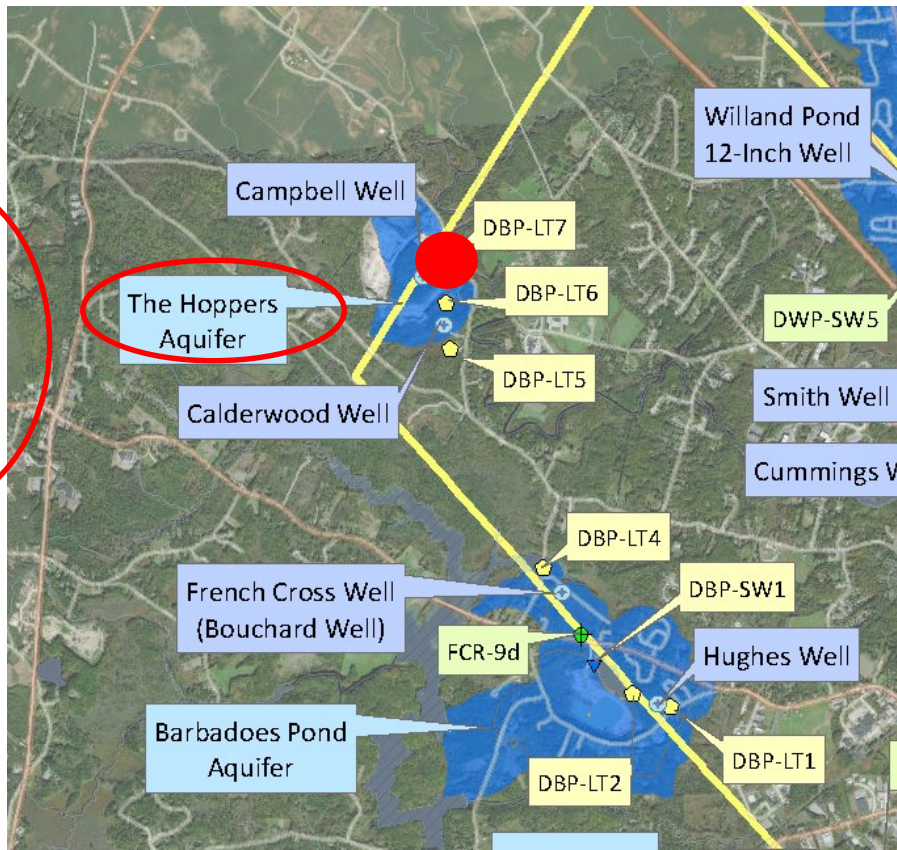
2 Surface Water Stations



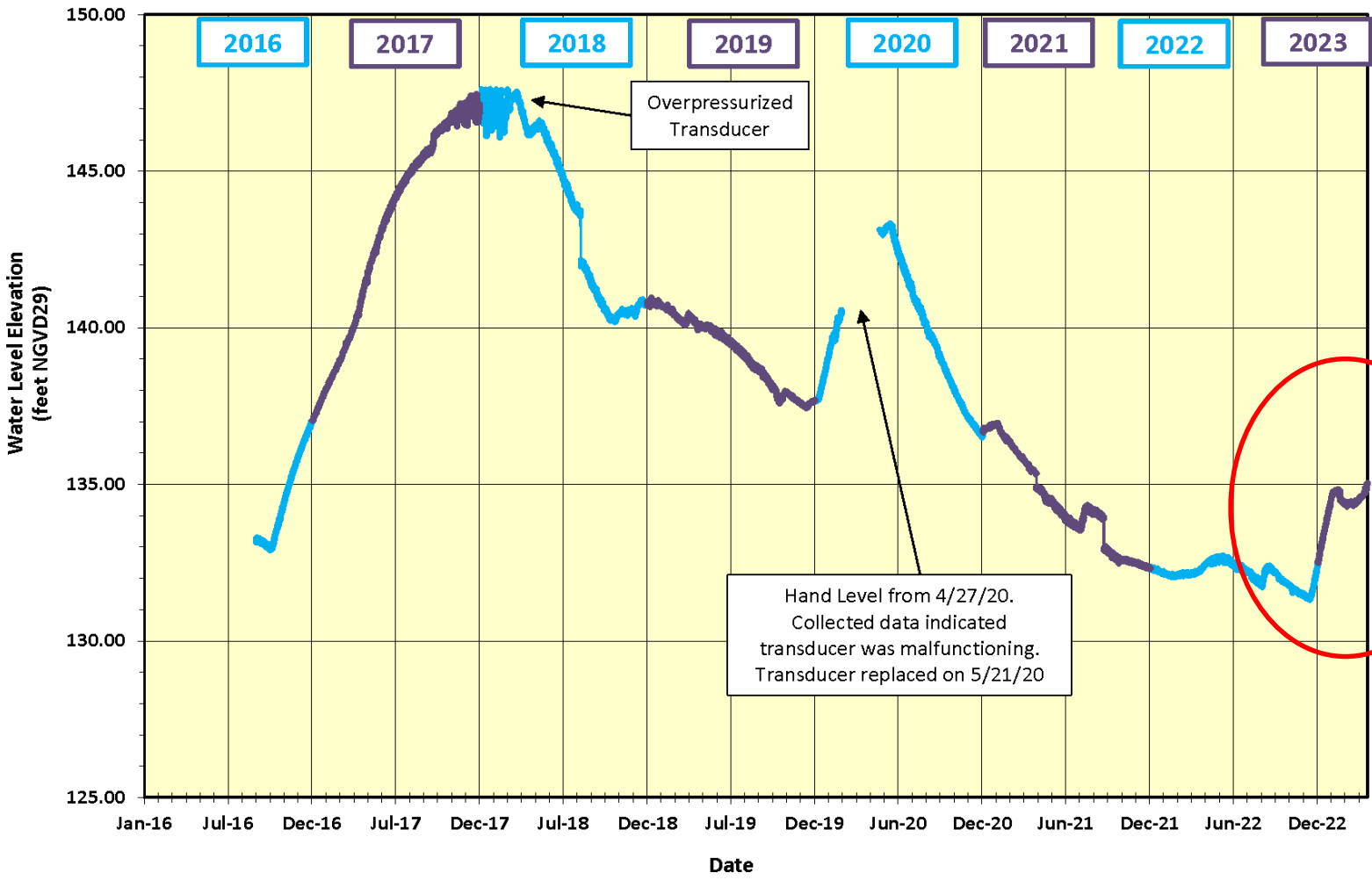
The Hoppers Aquifer Monitoring Well LT7



Plot of Water Level Elevation for January 1, 2016 to April 19, 2023
Long-Term Groundwater Monitoring Program
Dover, New Hampshire



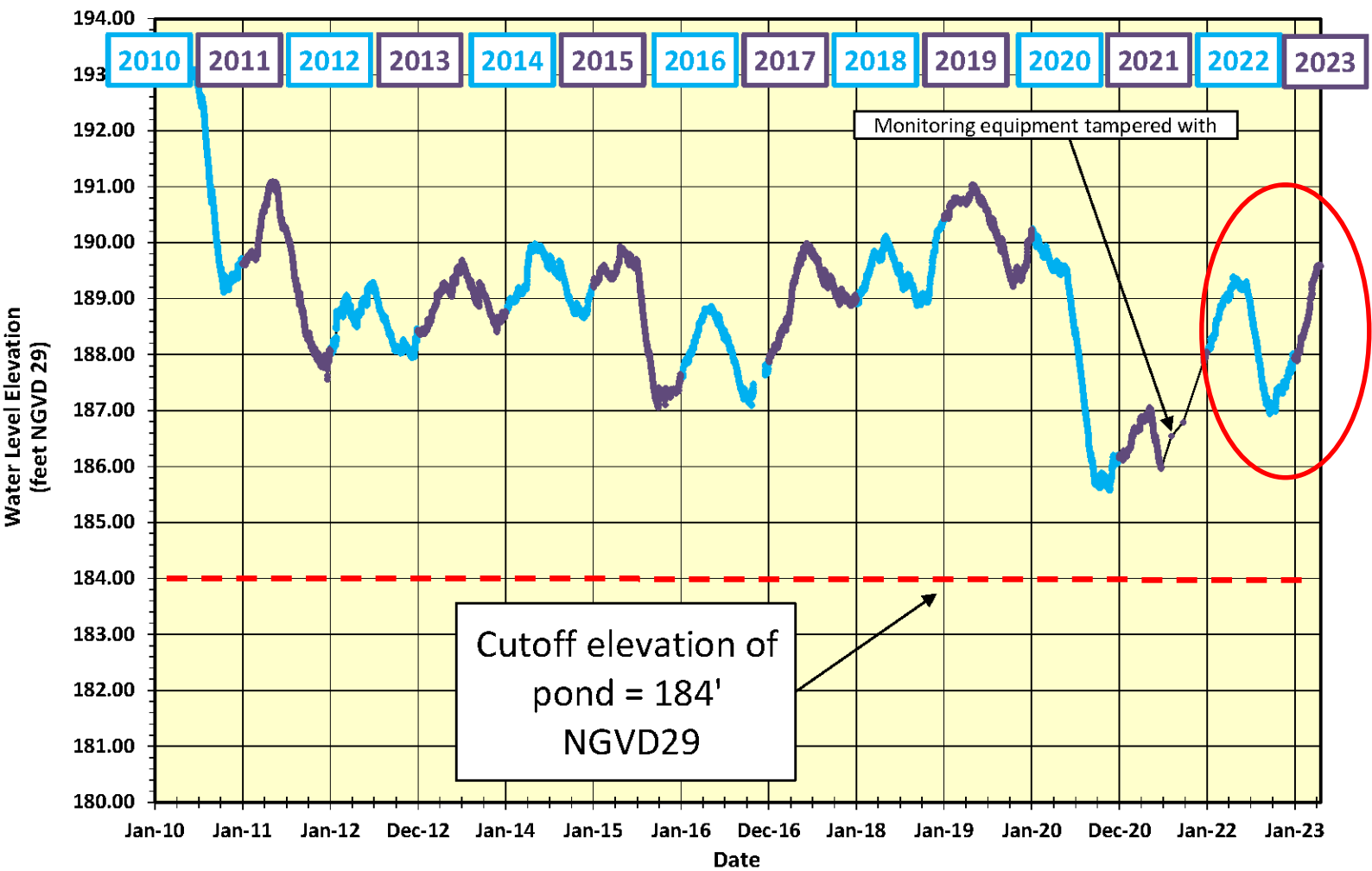
Willand Pond Aquifer Monitoring Well DWP-MW16D



Plot of Water Level for January 1, 2016 to April 19, 2023
Long-Term Groundwater Monitoring Program
Dover, New Hampshire



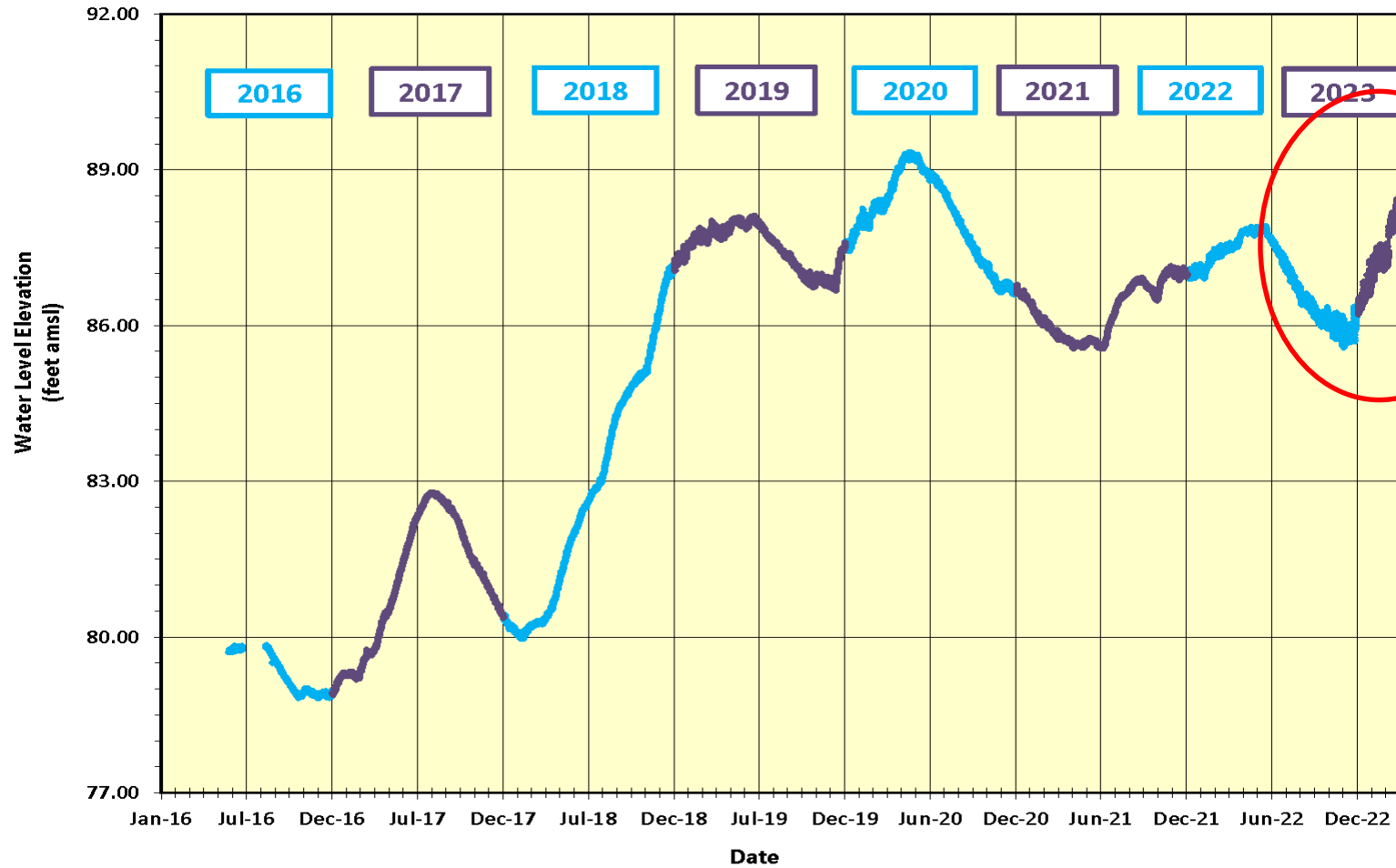
Willand Pond Aquifer Surface Water Station DWP-SW5



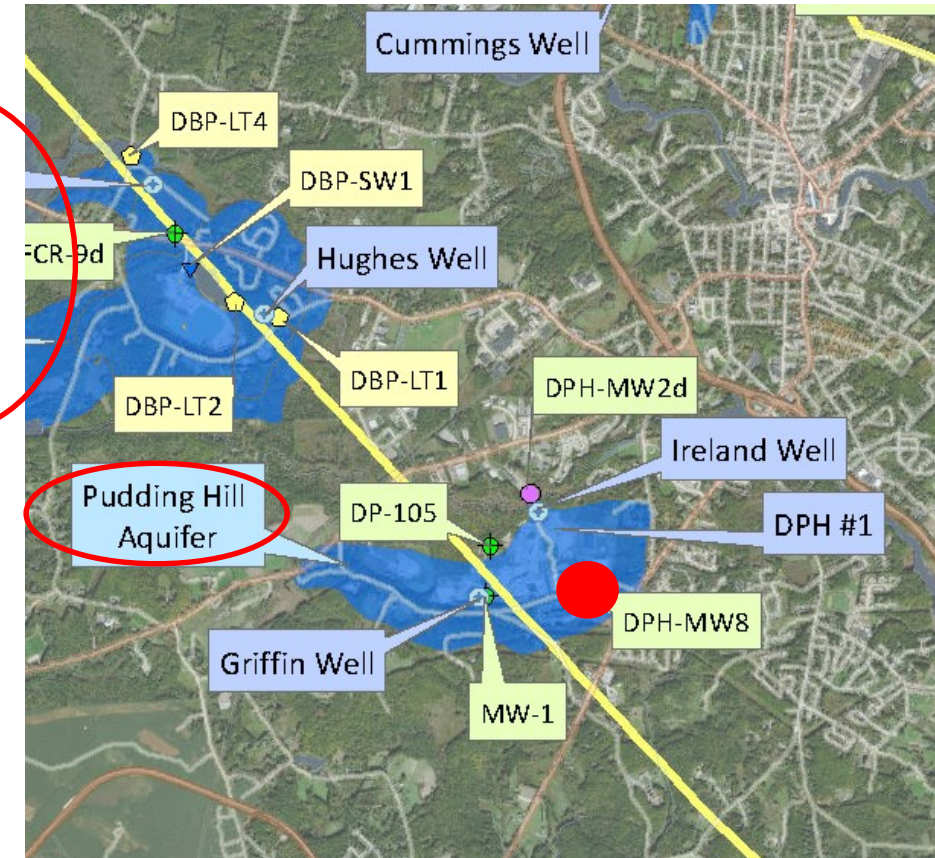
Plot of Water Level versus Time for January 1, 2010 to April 19, 2023
Long-Term Groundwater Monitoring Program
Dover, New Hampshire



Pudding Hill Aquifer Monitoring Well DPH-MW8



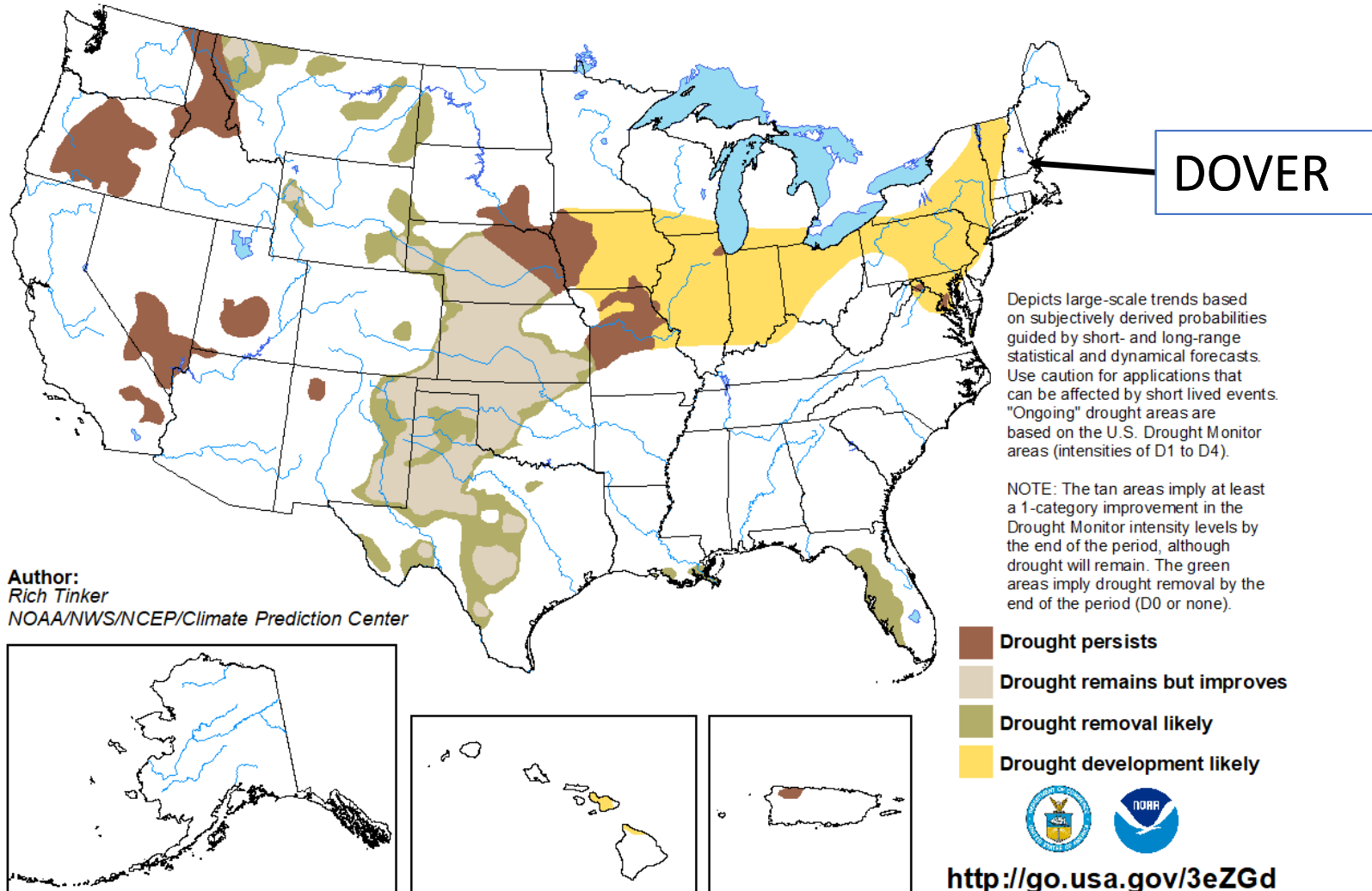
Plot of Water Level Elevation for January 1, 2016 to April 17, 2023
Long-Term Groundwater Monitoring Program
Dover, New Hampshire



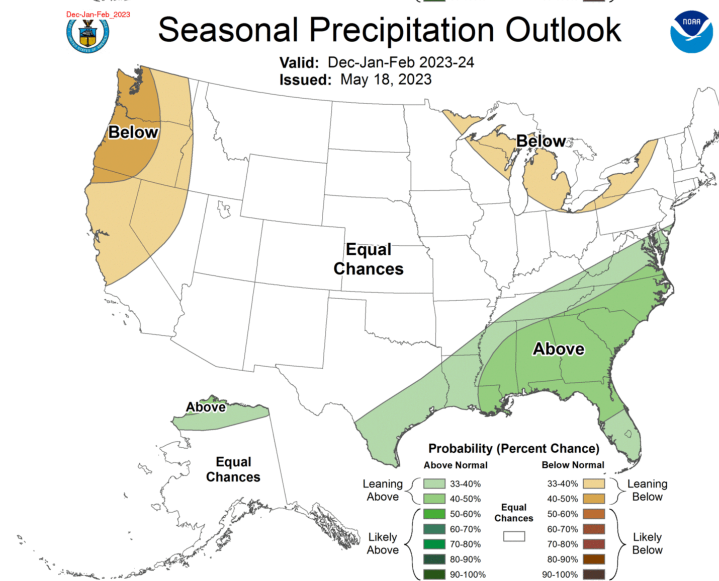
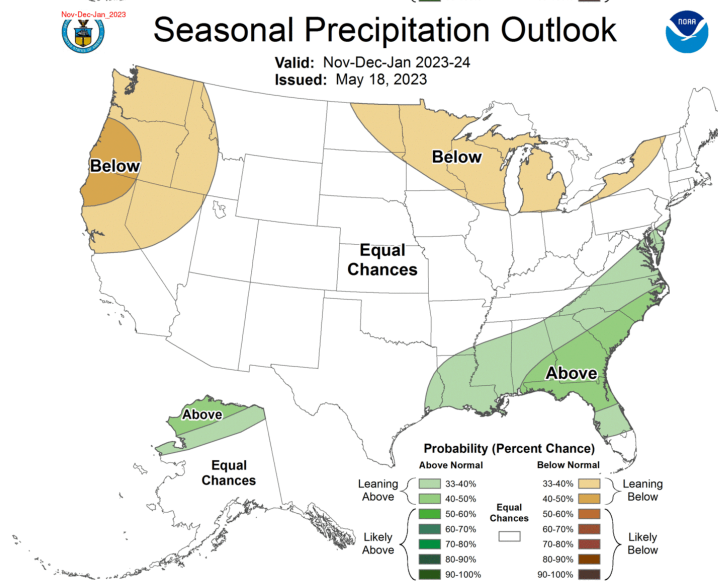
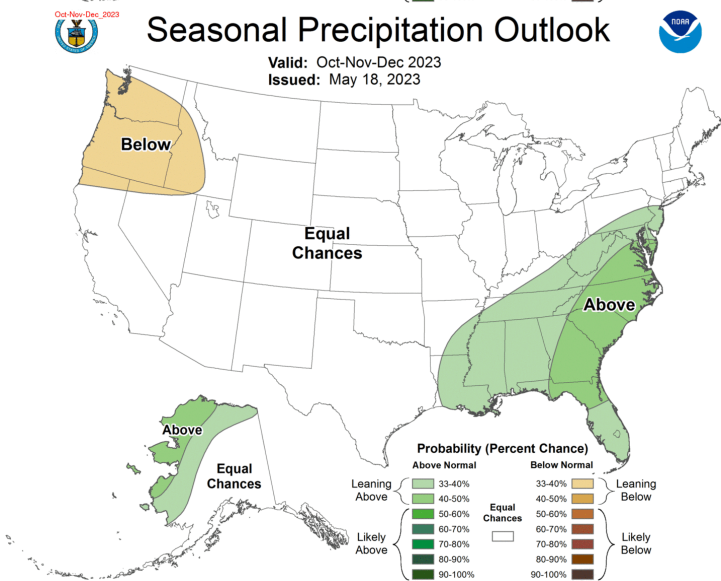
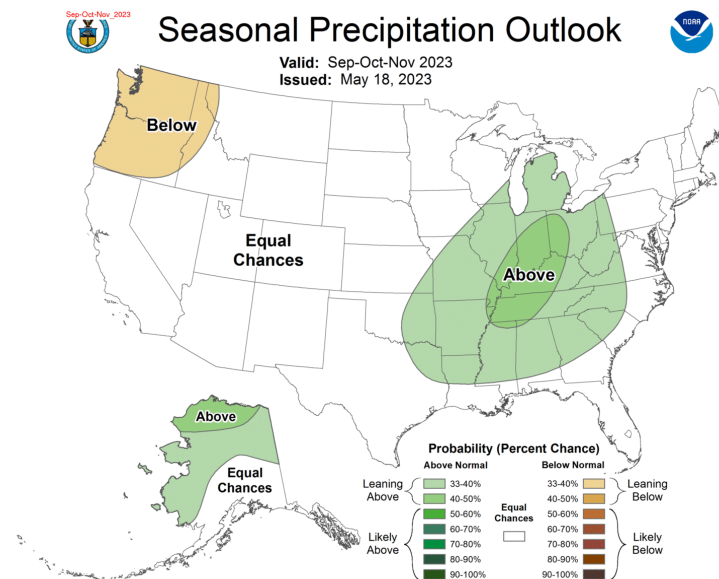
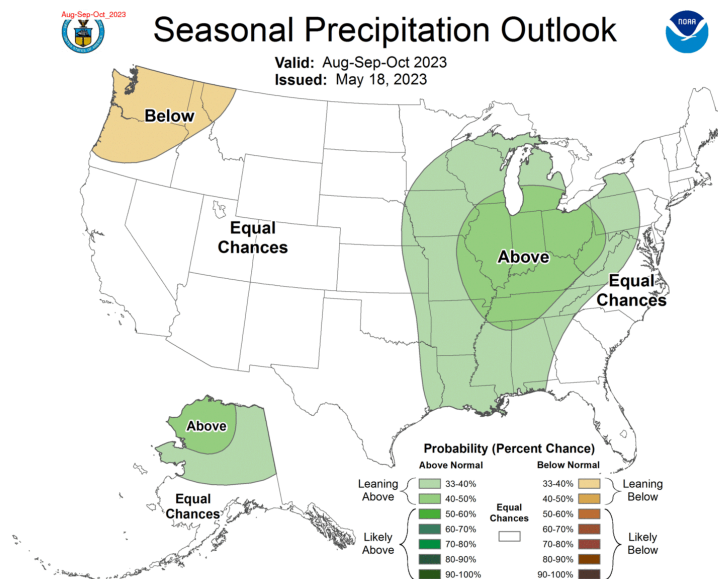
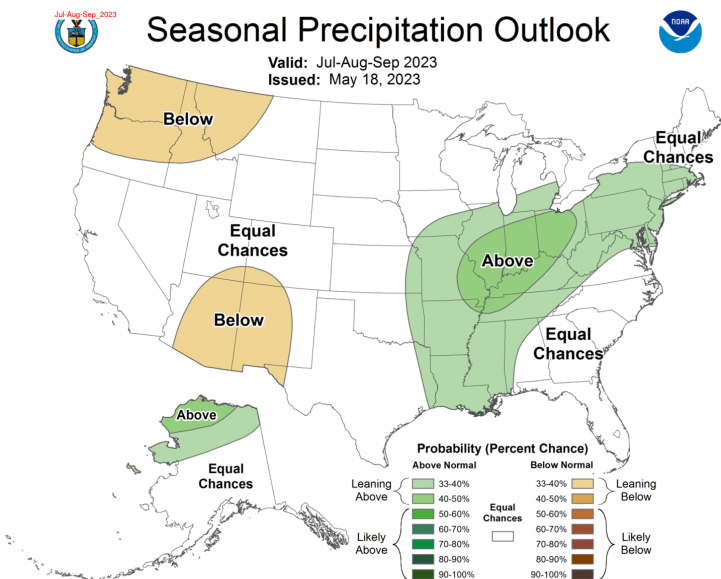
Forecast

U.S. Monthly Drought Outlook Drought Tendency During the Valid Period

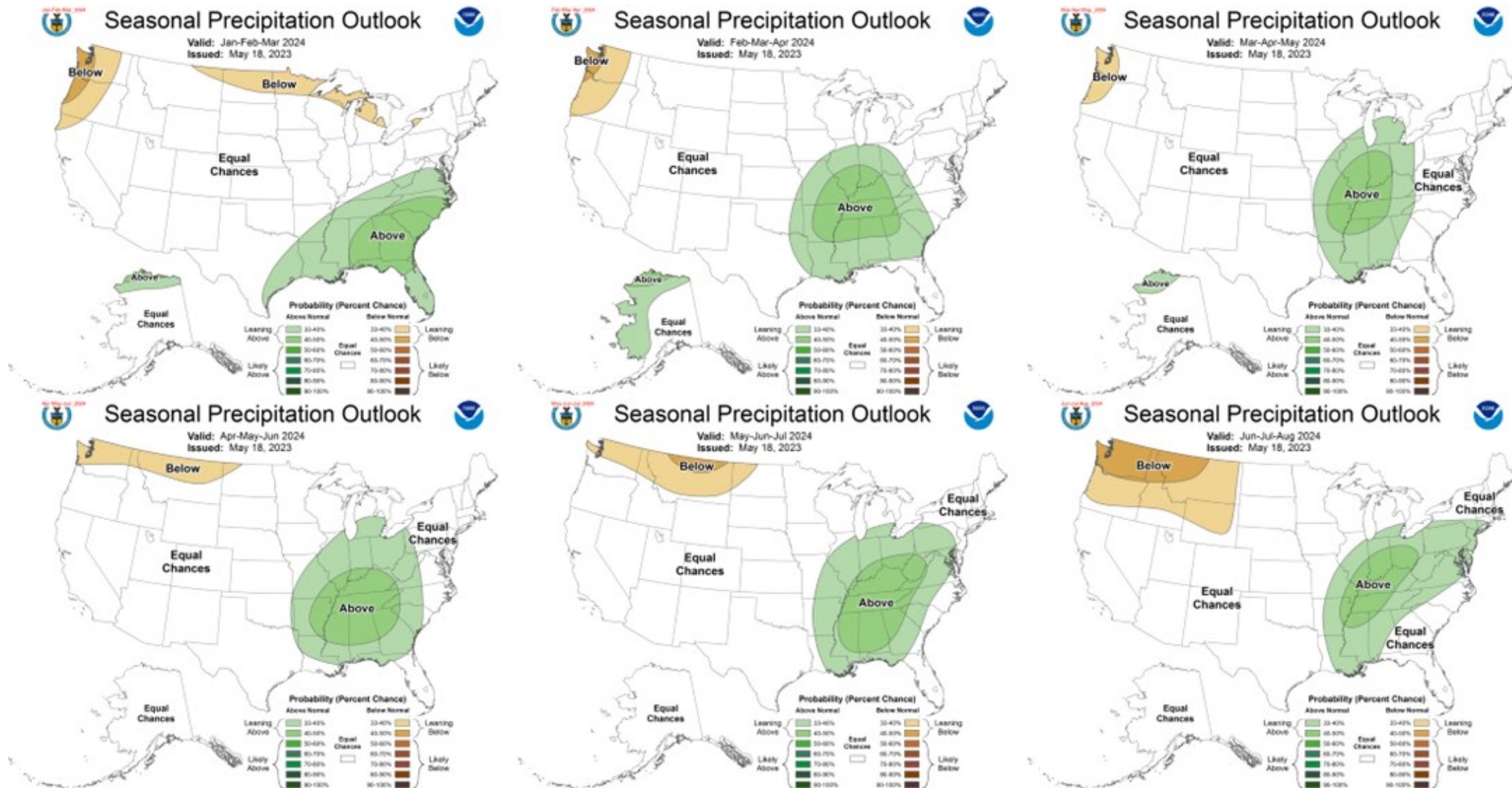
Valid for June 2023
Released May 31, 2023



Precipitation Forecast May 2023 – December 2023



Precipitation Forecast November 2023 – June 2024



Challenges

Contaminants

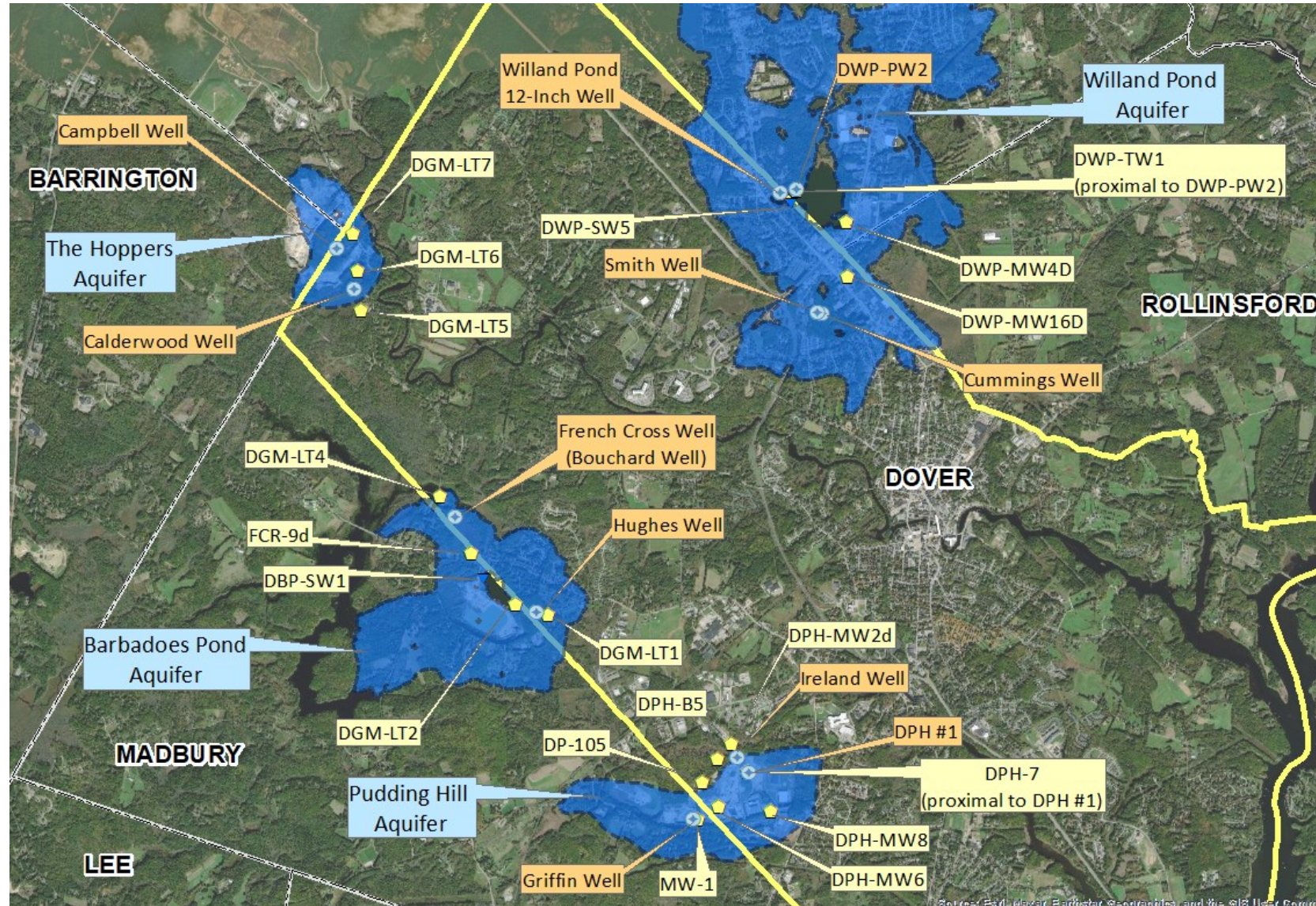


Indicator Water Quality Monitoring Locations

10 Production Wells

14 Groundwater Monitoring Wells

5 Surface Water Locations



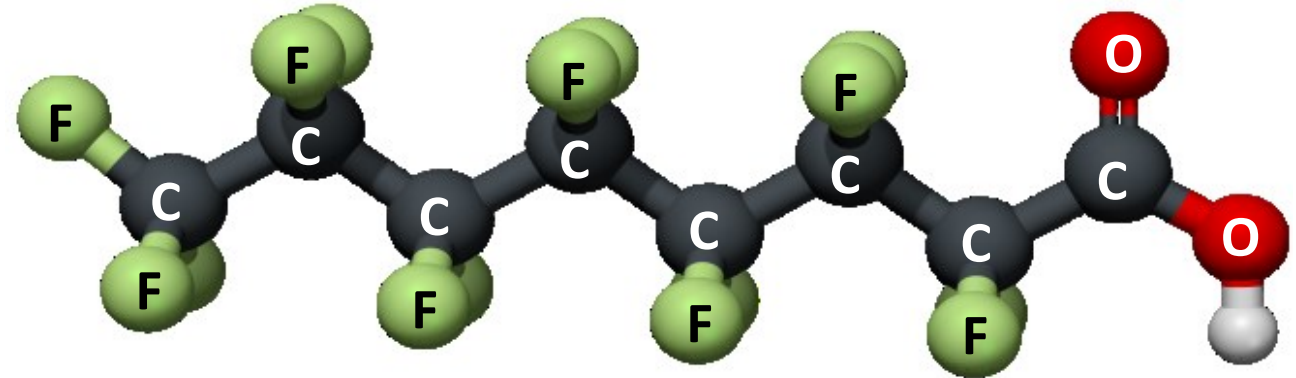
Emerging Contaminants – PFAS

(Per- and Polyfluoroalkyl Substances)

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

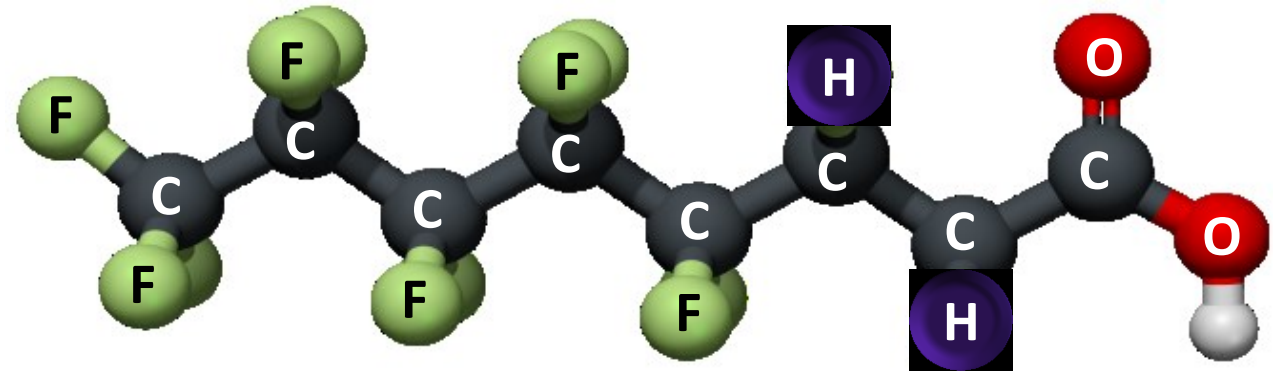


Perfluorinated = Completely Fluorinated



Perfluorooctanoic Acid (PFOA)

Polyfluorinated = Incompletely Fluorinated



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

Persistent: C-F bonds extremely stable in the environment

Bioaccumulative & Toxic

Emerging contaminant of concern (**goalposts moving**)

Regulations and environmental concentrations at parts per trillion

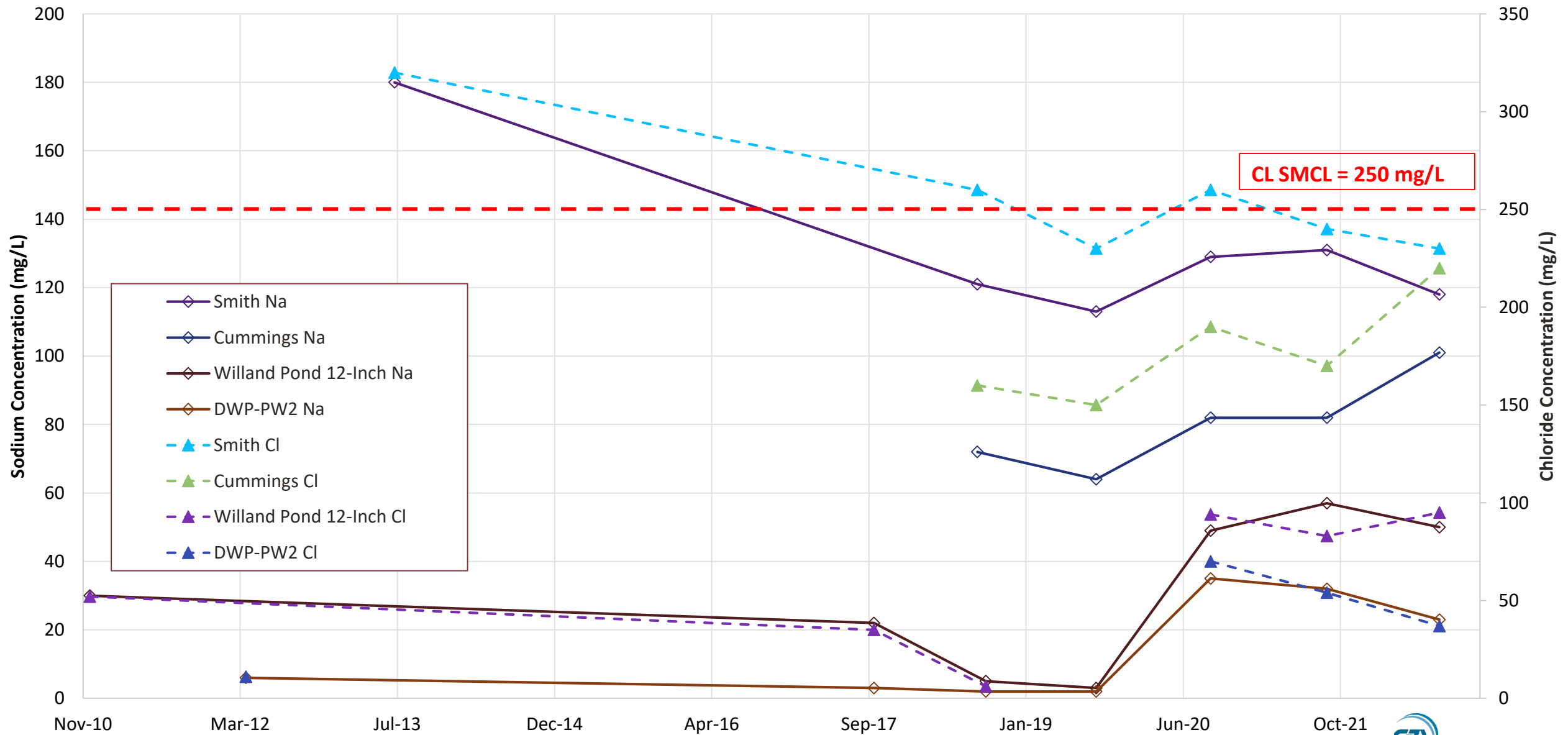
NH AGQS/MCLs established for four PFAS (11 to 18 parts per trillion – nanograms per liter)

EPA recently proposed MCLs of 4 ng/L for certain PFAS

Monitoring for PFAS is ongoing in Dover

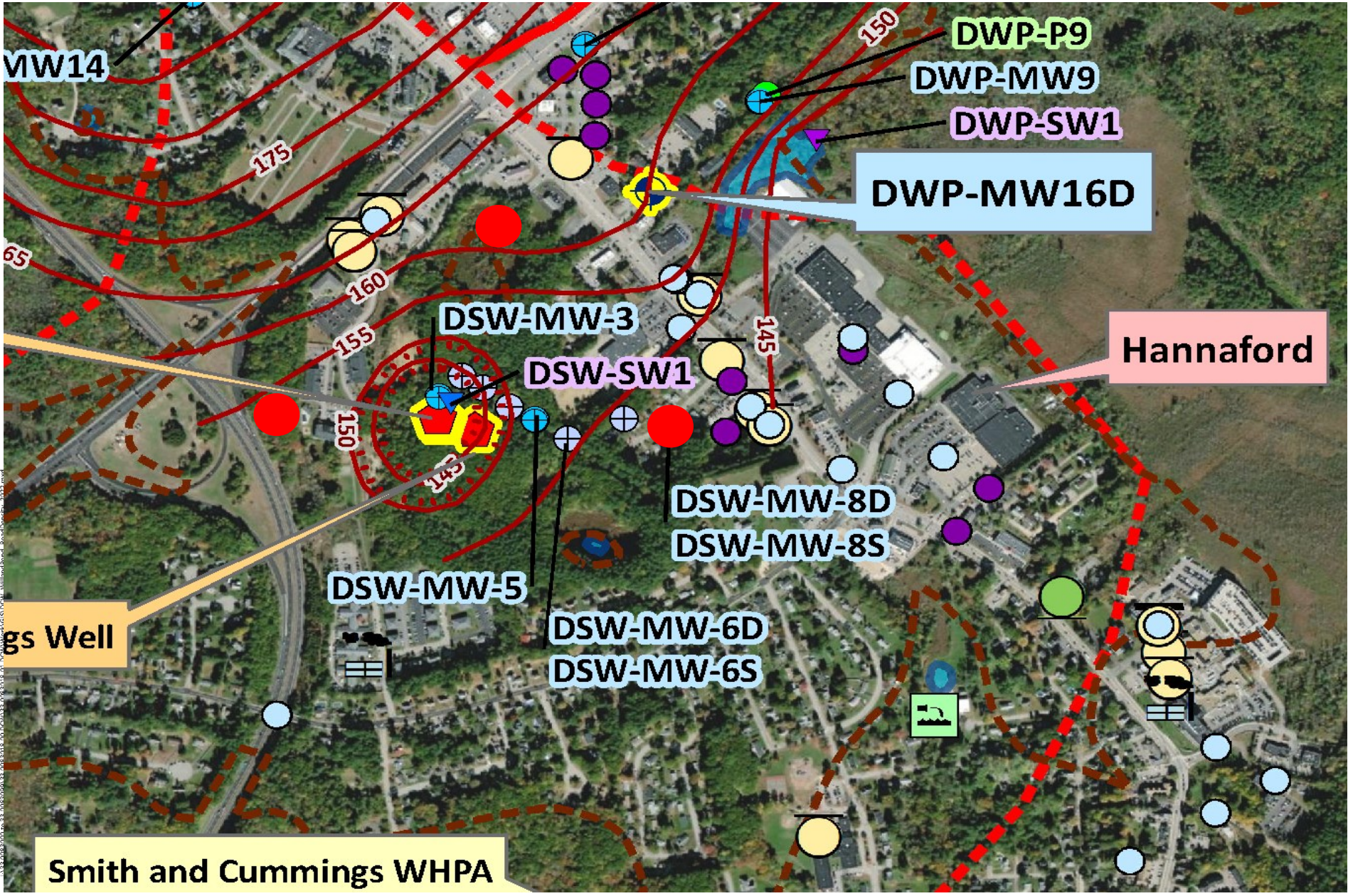
PFAS detected in the Pudding Hill Aquifer

Willand Pond Aquifer Na and Cl



Proposed Chloride Sonde Locations

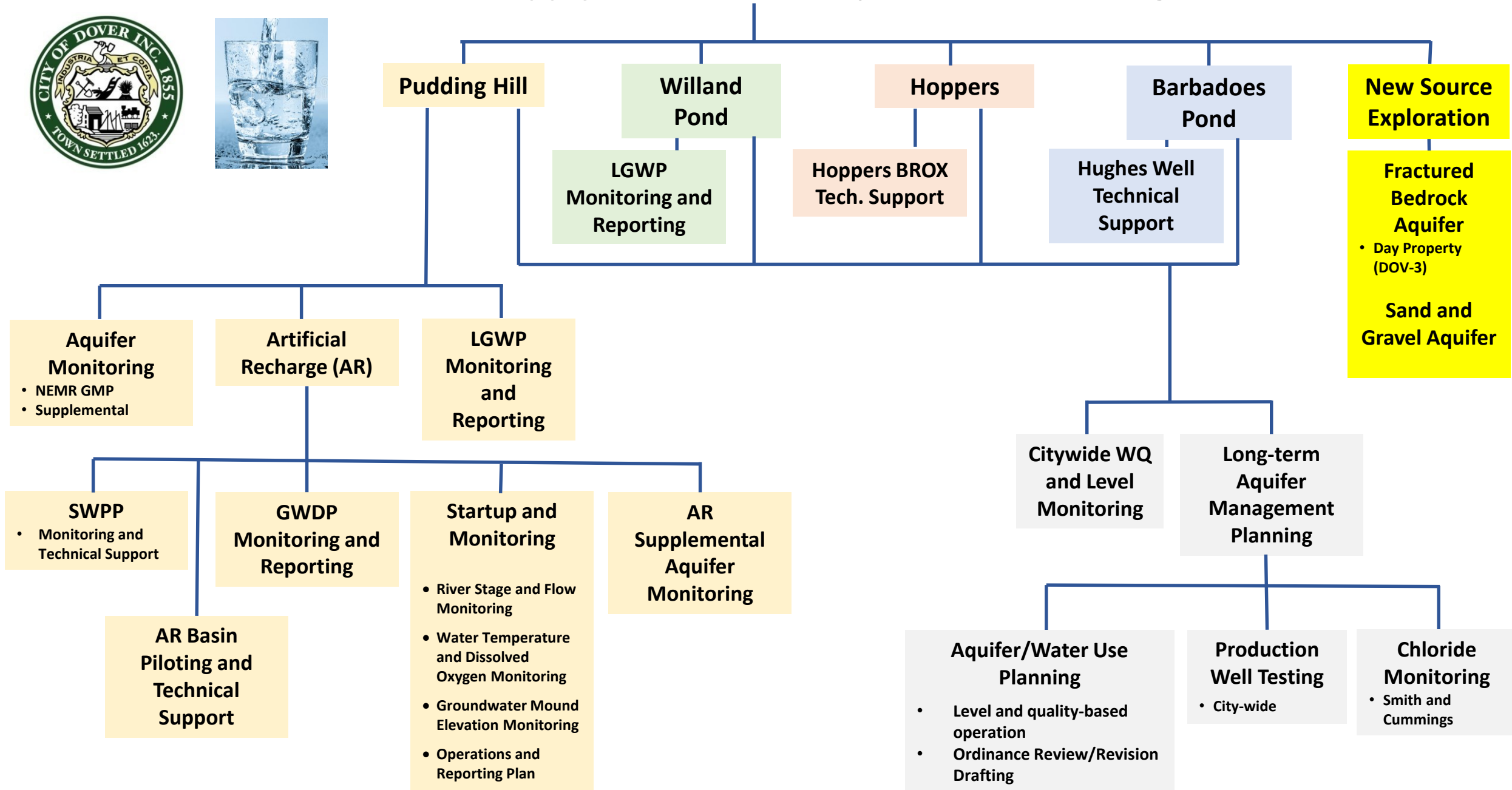
Deploy three sondes

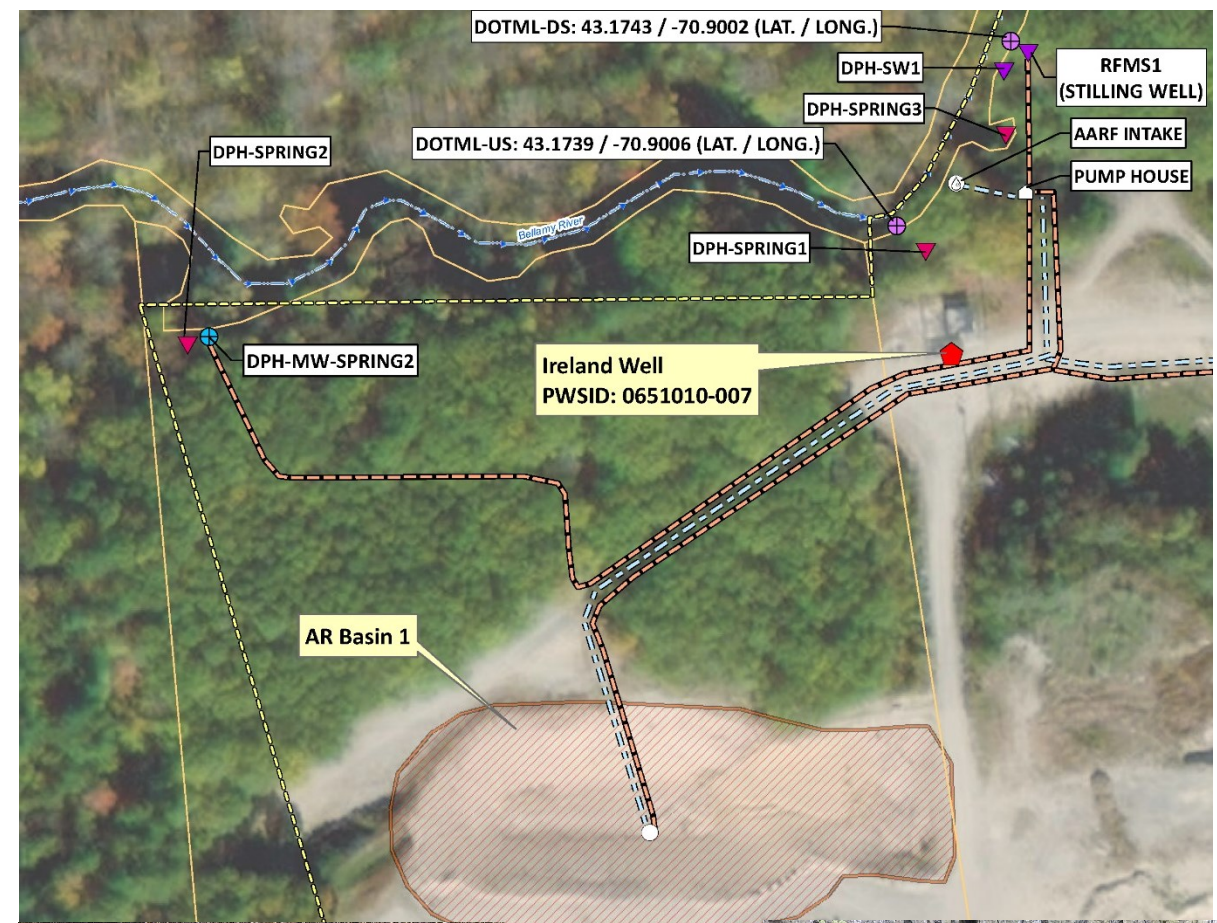
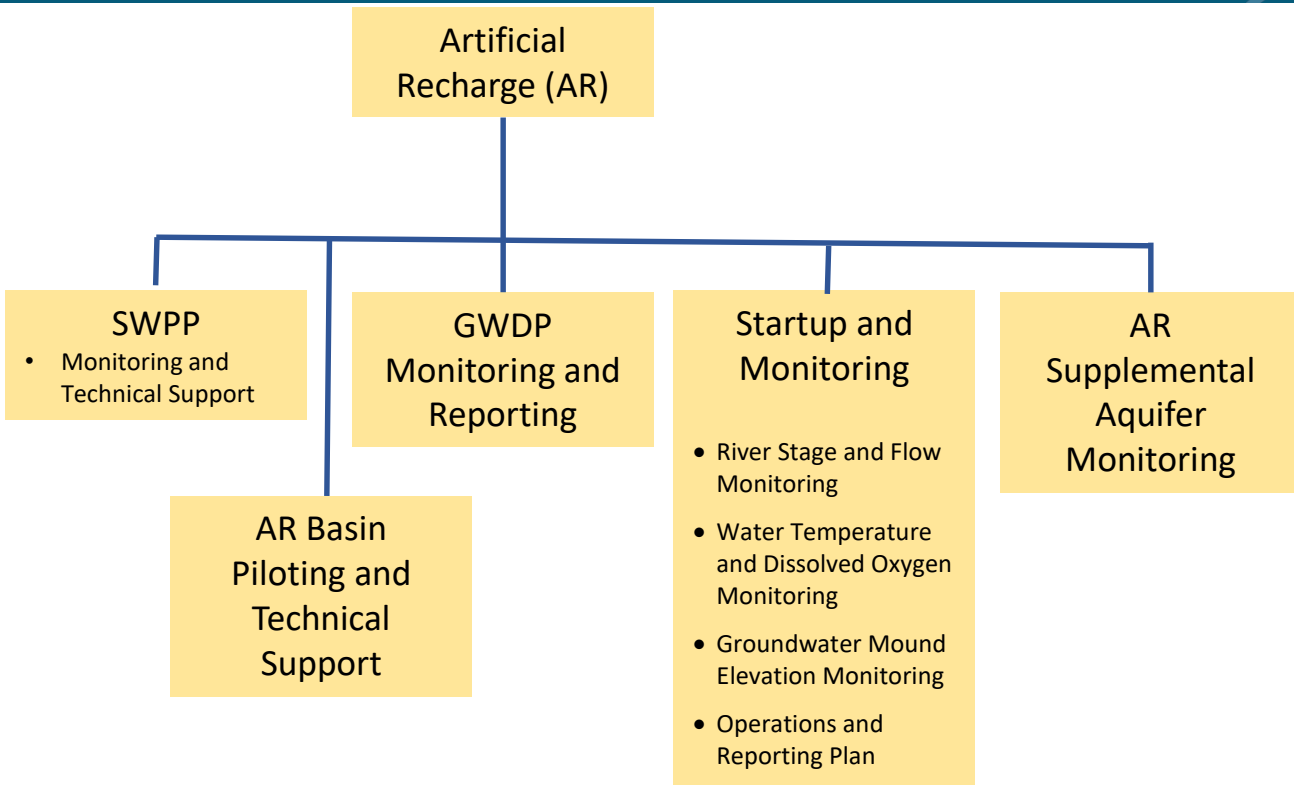


Water Resource Project Overviews



Dover Water Supply – EGGI/GZA Project Relational Diagram





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

John Storer, P.E. Director of Community Services
288 Central Avenue
Dover, New Hampshire 03820

WATER QUALITY CERTIFICATION
In fulfillment of
Section 401 of the United States Clean Water Act (33 U.S.C. 1341)
And NH RSA 485-A:12, III
WQC # 2019-404P-001

Activity Name	Bellamy River Artificial Recharge Facility
Activity Location	Pudding Hill Road Dover, New Hampshire
Affected Surface waters	Bellamy River (NHRRV600030903-08) Unnamed Wetlands
Owner/Applicant	City of Dover
Applicable Federal and State permit(s):	- U.S. Army Corps of Engineers General 404 Permit for NH - New Hampshire Department of Environmental Services (NHDES) Wetlands Permit - NHDES Shoreland Impact Permit - NHDES Groundwater Discharge Permit - NHDES Large Groundwater Withdrawal Permit - EPA NPDES Construction General Permit
Date of Approval (subject to Conditions below)	June 19, 2020

A. INTRODUCTION

The City of Dover (Applicant) is proposing to construct an artificial recharge (AR) facility located in the Pudding Hill Aquifer along the Bellamy River in Dover, New Hampshire. The AR facility will withdraw water from the Bellamy River and discharge it to two infiltration basins (AR basins). Groundwater recharge is needed to increase the sustainable yield of two of the City's water supply production wells (Inland and DP #3) and to help manage groundwater quality within the Pudding Hill Aquifer. A more complete description of the Activity is provided in Finding 0 of this Certification.

This 401 Water Quality Certification (WQC or Certification) documents laws, regulations, determinations and conditions related to the Activity for the attainment and maintenance of New Hampshire (NH) surface water quality standards, including the provisions of NH RSA 485-A:1 and NH Code of Administrative Rules Env-Reg 1100, for the support of designated uses identified in the standards.

B. 401 CERTIFICATION APPROVAL

Based on the facts, findings and conditions noted below, the New Hampshire Department of Environmental Services (NHDES or DES) has determined that there is a reasonable assurance that construction and operation of the Activity

The State of New Hampshire
Department of Environmental Services
Robert R. Scott – Commissioner

January 10, 2020
WILLIAM BOULANGER
DOVER PUBLIC WORKS DEPT.
271 MAIST ROAD
DOVER, NH 03820

GROUNDWATER DISCHARGE PERMIT

SUBJECT: DOVER – City of Dover, Department of Public Works, 271 Maist Road, Pudding Hill Aquifer Recharge Facility
Site# 198401044 / Project# 39074 / Activity# 276013

Dear Mr. Boulanger,

Please find enclosed the Groundwater Discharge Permit Number GWP-108401044-D-001 approved by the Water Division of the NH Department of Environmental Services (NHDES) for the discharge of surface water into the ground via rapid infiltration basins for aquifer recharge, in Dover, NH.

This permit is issued for five (5) years. All water discharged shall be managed as outlined in the application. This permit also requires all groundwater and surface water sampling results be submitted electronically to the NHDES' Environmental Monitoring Database (EMD).

Should you have any questions, please contact me at the Water Division at (603) 271-2858 or by e-mail at mitchell.focker@des.nh.gov or Stephen Roy or (603) 271-3918 stephen.roy@des.nh.gov.

Sincerely,

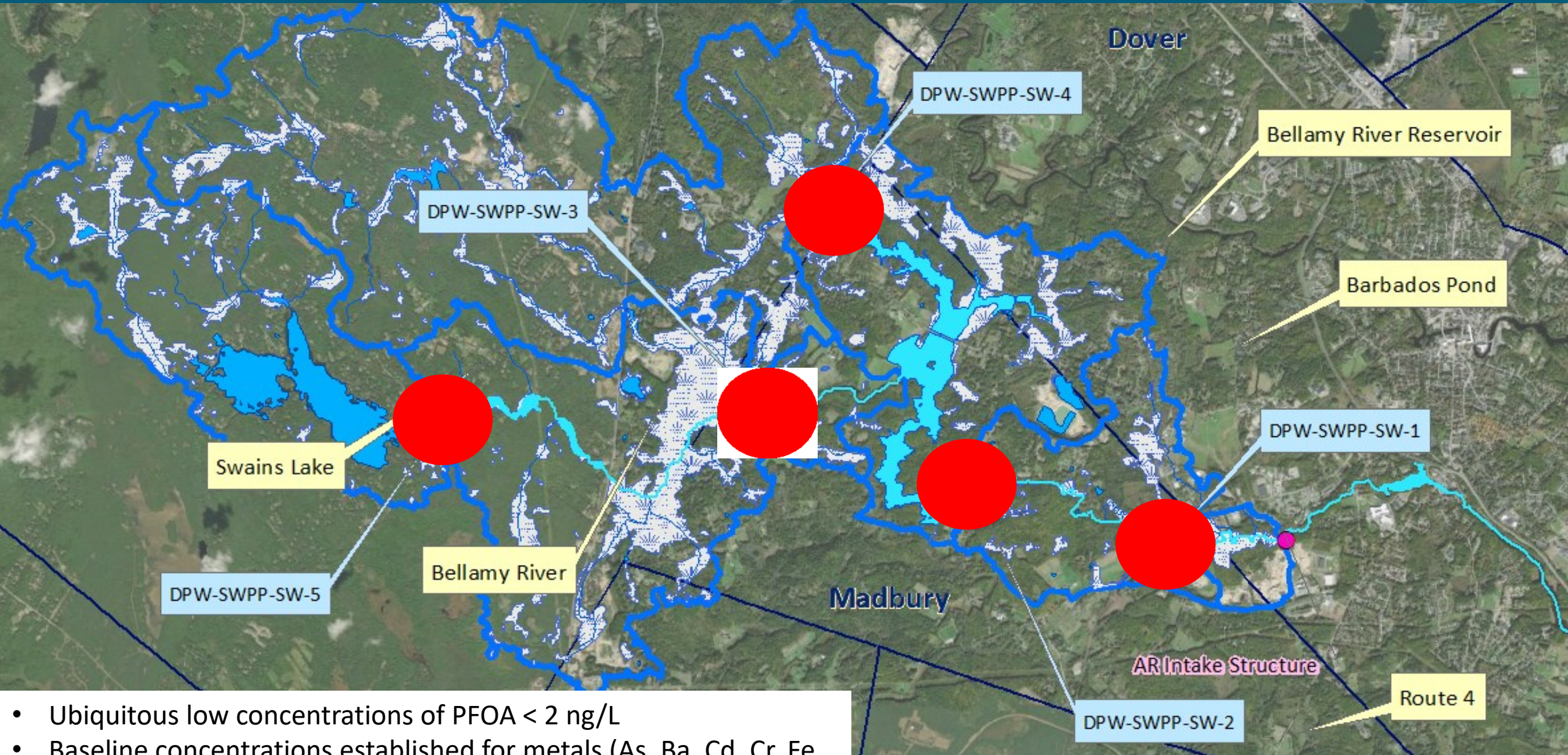


Mitchell Focker, P.E.
Drinking Water & Groundwater Bureau

cc: >> The Kingdom/Construction/Engineering/Projects/2019/01/10/Footer/198401044-D-001.gsp ASAPP.doc
e-copy: Stephen Roy, Brandon Karim, Andrew Noll, WD-CWGR
Ted Gies, Gregg Corrigan, WQD, Waterford
Paul Rydz, WWD, 1/10/20
Dean Paschke, John Storer, City of Dover
Jin Weck, James Emery, Emery and Garrett Groundwater / GZA

P.O. Box 95, 29 Hassen Drive, Concord, New Hampshire 03302-0095
Telephone: (603) 271-3139 • Fax: (603) 271-3171 • TDD Access: Relay NH 1-800-735-2964
100% Web Site: www.des.nh.gov

SWPP Surface Water Quality Monitoring



- 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

Challenges

Land Use



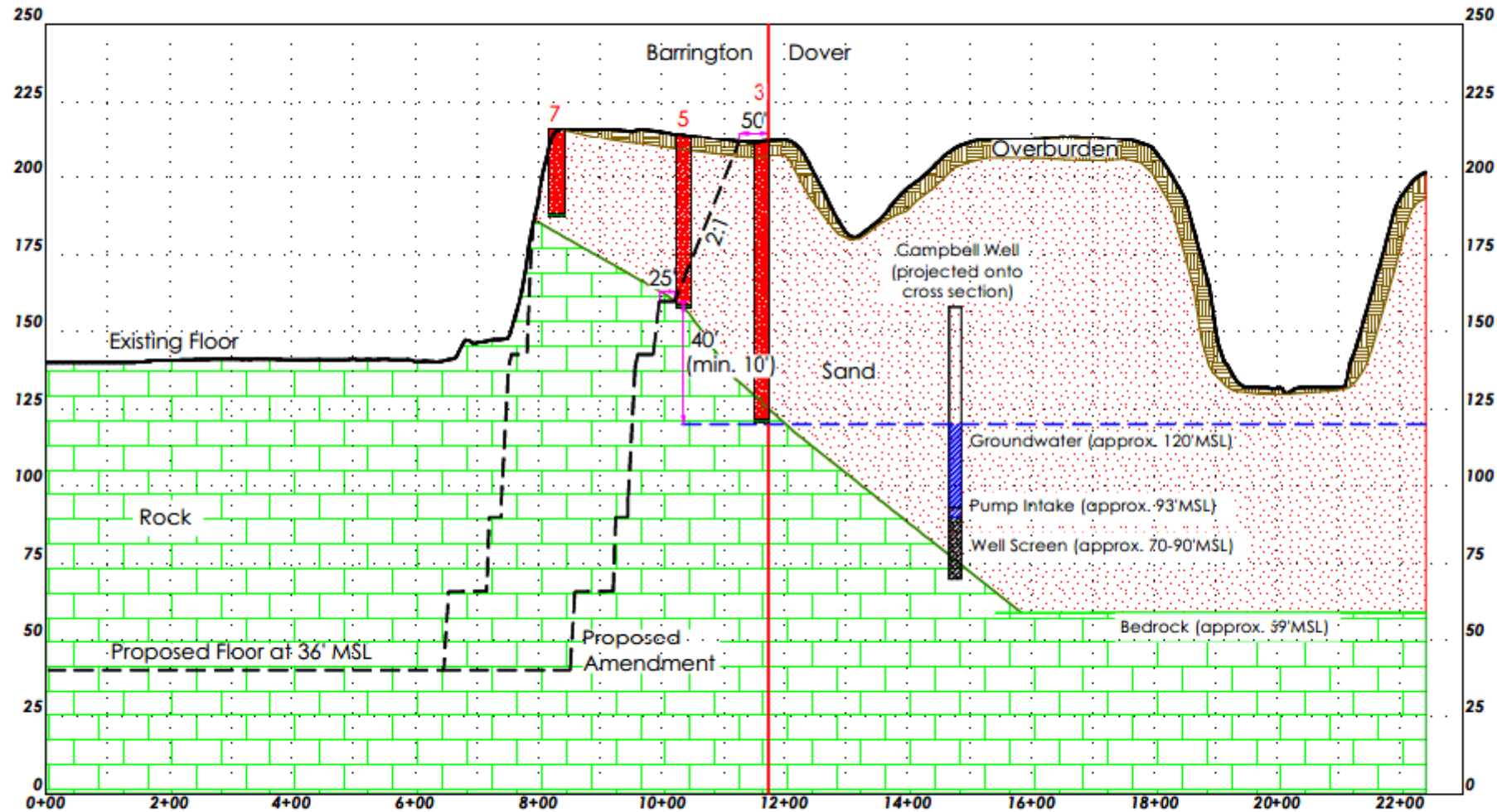
Hoppers Aquifer Brox Pit



Brox Pit

GEOLOGIC CROSS SECTION

VERT. SCALE 5X



A

GEOLOGIC LEGEND:



Overburden



Sand



Concord Granite

A

New Source Exploration

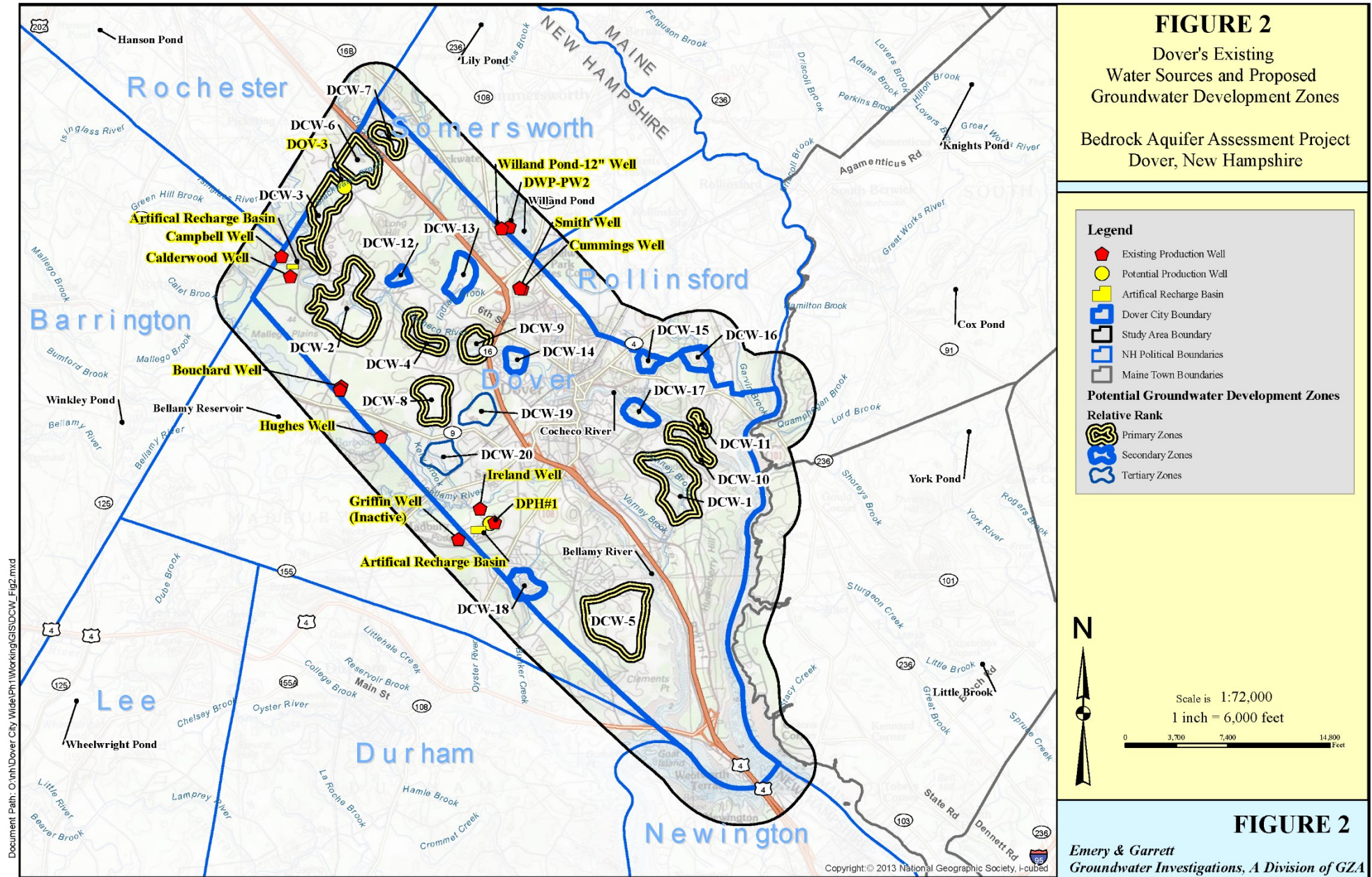


New Source Exploration

Potential Hughes
Well Replacement

Revaluation and
Update of potential
groundwater
resources based on
2018 EGGI study

Evaluation of the Day
Property/Vicinity



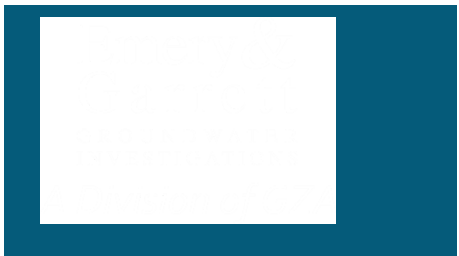
New Source Exploration – Sand and Gravel

Exploration for potential sand and gravel Aquifer resources in the vicinity of the Pudding Hill Aquifer





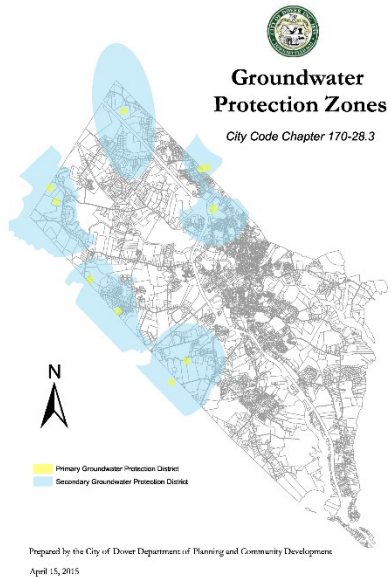
Next Steps/Action Items



- Pudding Hill Treatment and AR
- Completion and implementation of Aquifer Management Plan
- Operations Review
- UCMR5
- New Source Exploration

Aquifer Management Plan Key Elements

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



> 3 feet above trigger

< 3 feet above trigger
but still above trigger

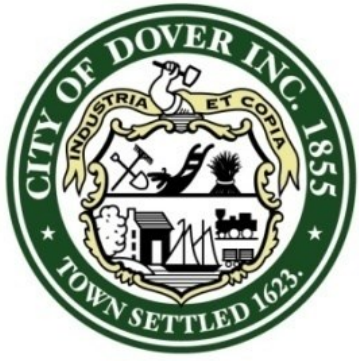
at or below trigger

Pumping is ok

Consider using
other WPs

Stop

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



Discussion



Bull Pen