VERMONT
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

PFAS IN VERMONT
AQUEOUS FILM FORMING FOAM

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STATE OF VERMONT AGENCY OF NATURAL RESOURCES

DEPARTMENT OF ENVIRONMENTAL CONSERVATION

WASTE MANAGEMENT & PREVENTION DIVISION

SITES MANAGEMENT SECTION

PFAS IN VERMONT

Aqueous Film-Forming Foams

- **Vermont DEC PFAS Sampling Report**
- **Vermont's Current Regulatory Standard**
- **AFFF Background**
- **Airports & AFFF**
- **Case Study: Southern Vermont Regional Airport**
  - History
  - AFFF Use at the Airport
  - Water Supply Sampling Results
  - Site Investigation
- **AFFF Takeback Program**

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PFAS IN VERMONT

Discovery

- **February 2016:** the Vermont DEC discovers PFAS contamination in water supply wells in Bennington from a former Teflon coating plant

- Soonafter, the Vermont DEC learns that PFAS were used at a wire coating plant in Pownal, Vermont leading to another widespread water supply sampling effort

Source: Vermont DEC, July 2018, "*Perfluoroalkyl Substances (PFAS) Contamination Status Report*"

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PFAS IN VERMONT

Initial Response and Findings

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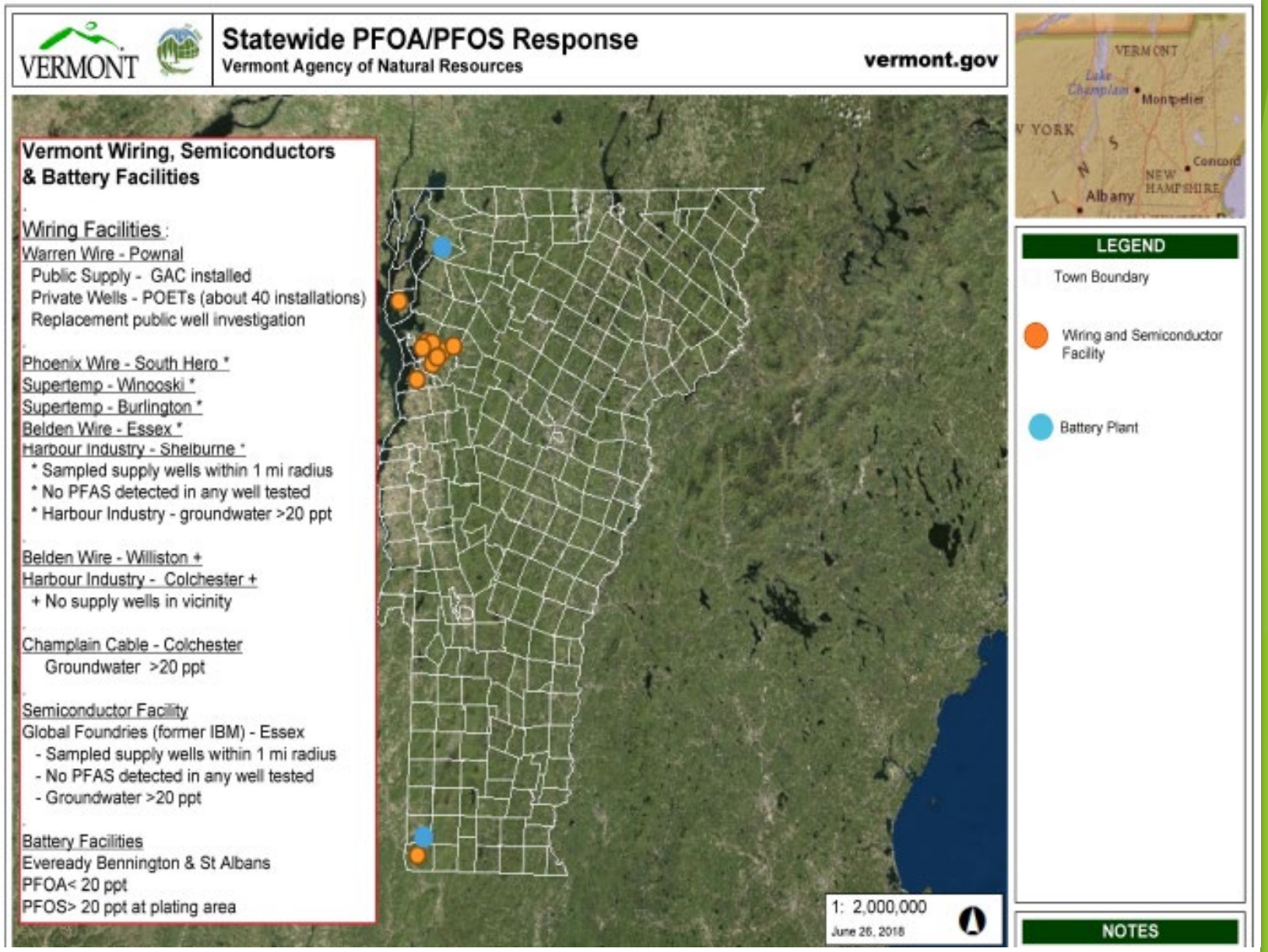

PFAS IN VERMONT

Initial Response and Findings

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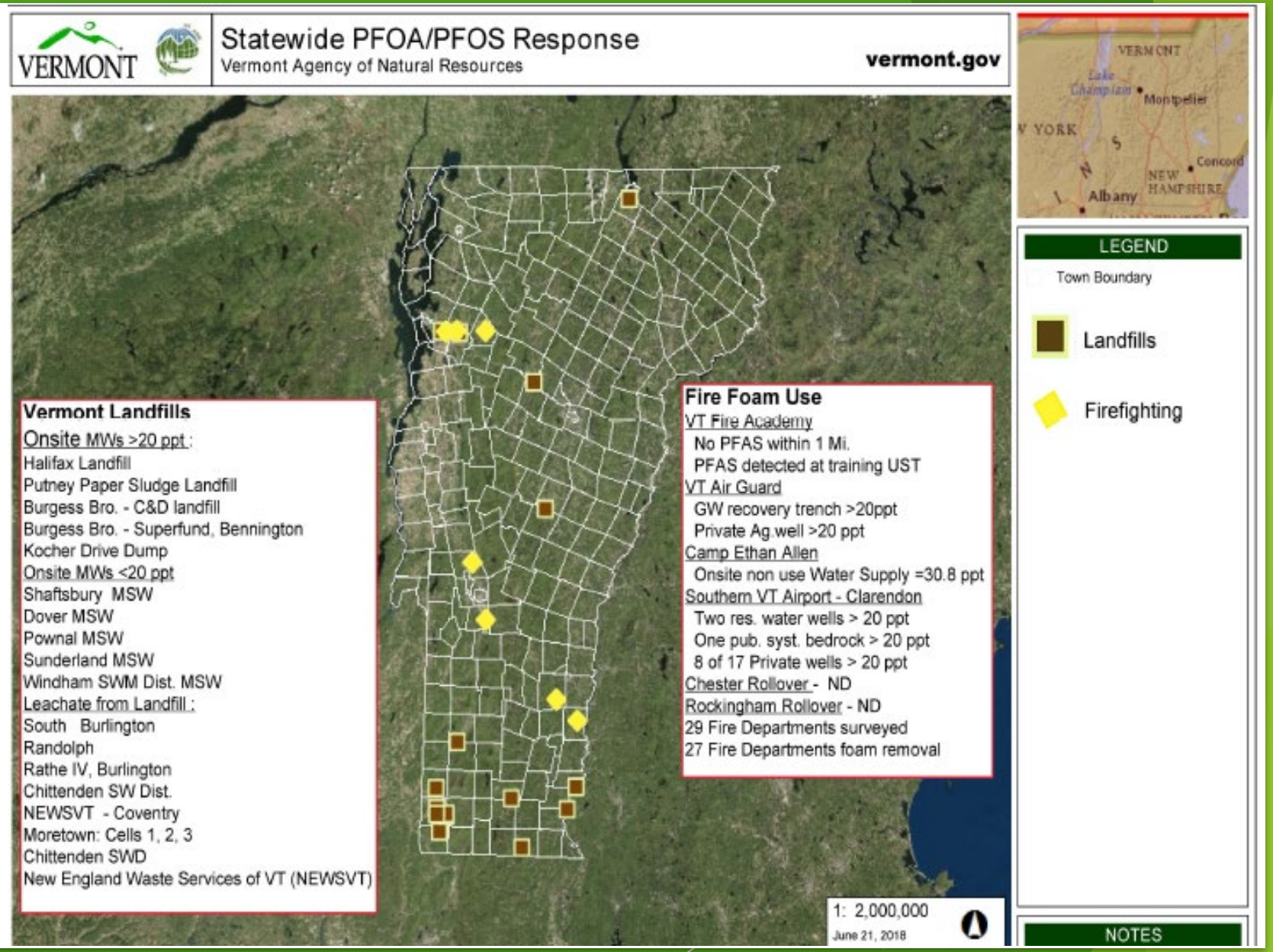
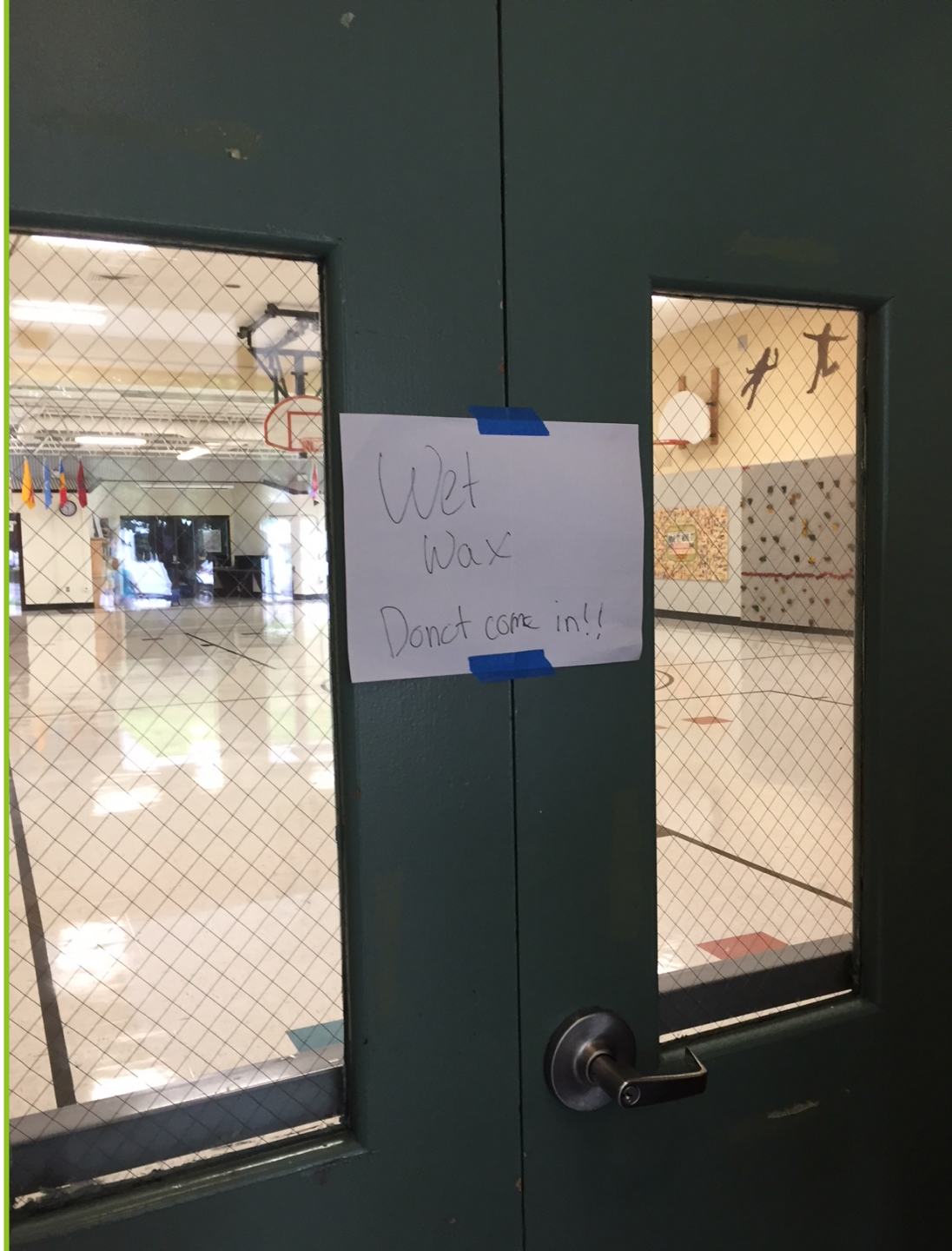


PFAS IN VERMONT - PRESENT

SCHOOLS

- PFAS is often found in floor cleaning products, stripping chemicals, waxes, and polish that may be used to maintain flooring at schools
- **Summer 2018:** Ten Schools with bedrock supply wells and onsite leaching fields were sampled for PFAS as part of a pilot program
- Two schools had PFAS > Drinking Water Health Advisory; GAC Treatment systems are currently being implemented
- Both schools are located in small Vermont towns with little to no industry



CURRENT REGULATORY STANDARD IN VERMONT FOR PFAS IN DRINKING WATER & GROUNDWATER

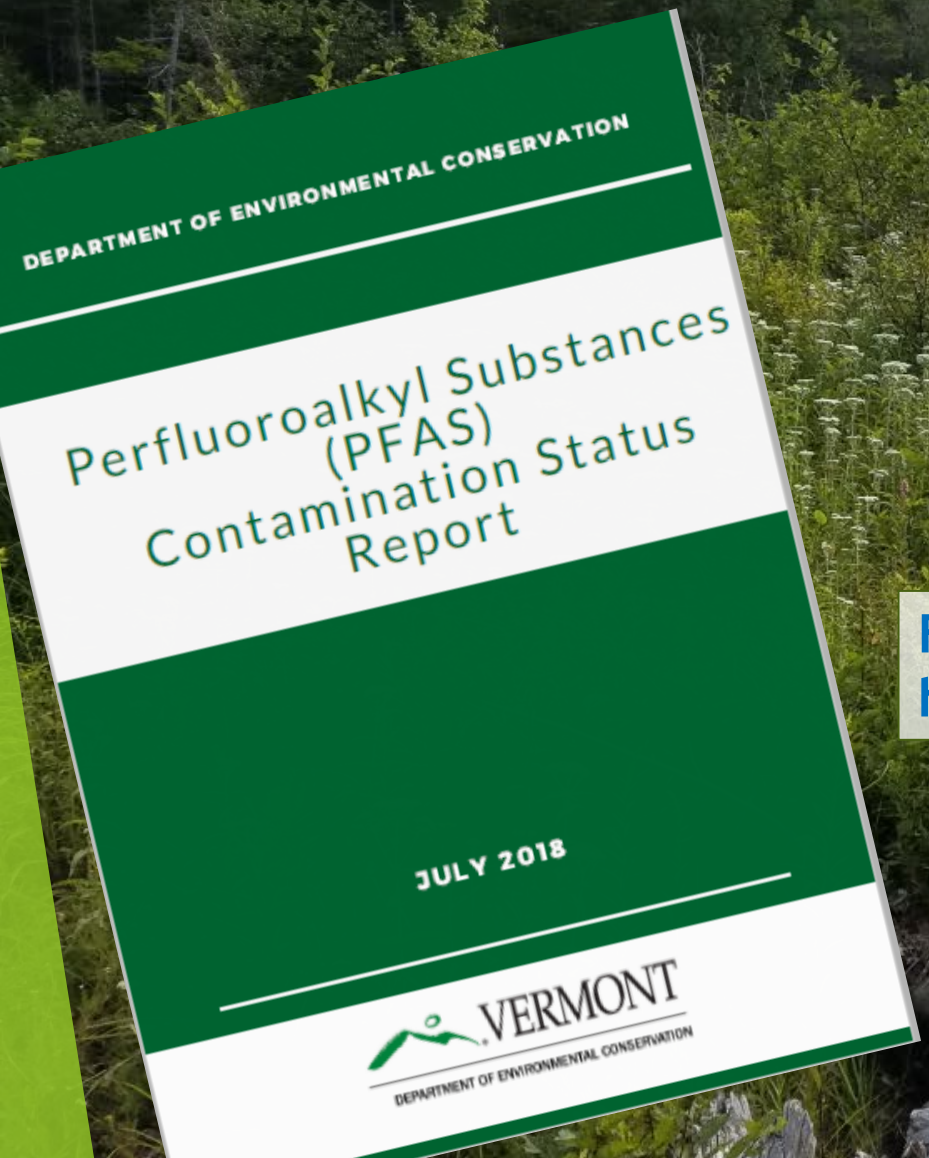
Compound	Health Advisory
Perfluorooctanoic acid (PFOA)	Combination of the five PFAS is 20 parts per trillion (ppt)
Perfluorooctane Sulfonic Acid (PFOS)	
Perfluorohexane Sulfonic Acid (PFHxS)	
Perfluoroheptanoic Acid (PFHpA)	
Perfluorononanoic Acid (PFNA)	Revised July 10, 2018

VERMONT DEPARTMENT OF HEALTH

Note: 1 nanogram per liter (ng/L) = 1 part per trillion (ppt)

VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION

PFAS IN VERMONT – Summary Report



FIND THE STATUS REPORT HERE:
https://dec.vermont.gov/content/pfas-sampling-report

AQUEOUS FILM-FORMING FOAMS

ITRC AFFF FACT SHEET – NOW LIVE!

Aqueous Film-Forming Foam (AFFF)

1 Introduction

1.1 What is AFFF?

Aqueous film-forming foam (AFFF) is highly effective foam intended for fighting high-hazard flammable liquid fires. AFFF products are typically formed by combining hydrocarbon foaming agents with fluorinated surfactants. When mixed with water, the resulting solution achieves the interfacial tension characteristics needed to produce an aqueous film that spreads across the surface of a hydrocarbon fuel to extinguish the flame and to form a vapor barrier between the fuel and atmospheric oxygen to prevent re-ignition. This film formation is the defining feature of AFFF.

There are two major classes of firefighting foams: Class A and Class B. Class A foams were developed in the 1980s for fighting wildfires. They are also used to fight structure fires. Class B foams are any firefighting

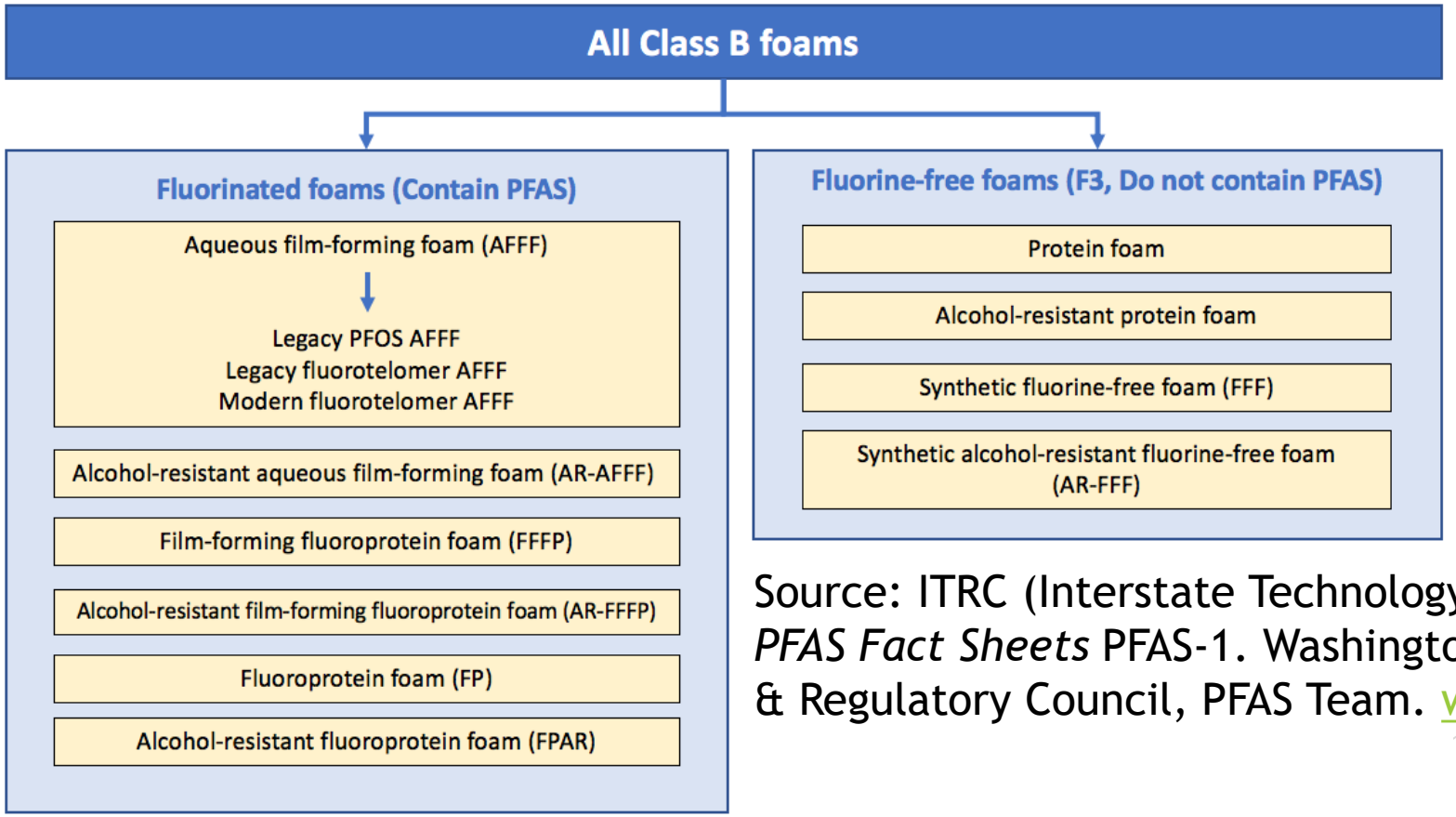
ITRC has developed a series of fact sheets that summarize the latest science and emerging technologies regarding Per- and Polyfluoroalkyl Substances (PFAS) (ITRC 2018). This fact sheet is targeted to local, state, and federal regulators and tribes in environmental, health, and safety roles as well as AFFF users at municipalities, airports, and industrial facilities.

The purpose of this fact sheet is to outline how to properly identify, handle, store, capture, collect, manage, and dispose of AFFF.

https://pfas-1.itrcweb.org/wp-content/uploads/2018/10/pfas_fact_sheet_afff__10_3_18.pdf

AQUEOUS FILM FORMING FOAMS (AFFF)

- AFFF is a concentrate that is blended with water to create a foam that is intended for fighting high-hazard liquid fires
- Of most concern are PFAS-containing Class B AFFF



Source: ITRC (Interstate Technology & Regulatory Council). 2018. *PFAS Fact Sheets* PFAS-1. Washington, D.C.: Interstate Technology & Regulatory Council, PFAS Team. www.itrcweb.org.

WHERE CLASS B AFFF IS IN SERVICE/DISCHARGED:

- ✓ Chemical Plants
- ✓ Flammable liquid storage and processing facilities
- ✓ Larger Airports (aircraft rescue and firefighting, hangars)*
- ✓ State HAZMAT Team
- ✓ Military Facilities*
- ✓ Fire Training Facilities
- ✓ Local Fire Departments
- ✓ Merchant Operations (oil tankers, offshore platforms)

* Currently required to use AFFF that meets the requirements of the U.S. Department of Defense (DoD) Military Specification (MILSPEC) "Fire Extinguishing Agent, Aqueous Film-Forming Foam"

Source: ITRC (Interstate Technology & Regulatory Council). 2018. *PFAS Fact Sheets* PFAS-1. Washington, D.C.: Interstate Technology & Regulatory Council, PFAS Team. www.itrcweb.org.

INVESTIGATING AFFF USE IN VERMONT

- Search the Vermont Spill Program's spill reports for hazardous material fires, tanker fires, and other rollovers and crashes
- Identify military bases that have fire fighting capabilities
  - Vermont Air National Guard
  - Camp Ethan Allen Training Site
- Identify FAA **Part 139** Airports in the State
  - Burlington International Airport (BTV)
  - Rutland Southern Vermont Regional Airport (RUT)
- Identify fire training academies in the State
- Monitor incoming spill reports for accidents with fires that may have had AFFF releases as part of the emergency response

FAA PART 139
AIRPORT OPERATING CERTIFICATE

- Part 139 Airports have operating certificates from the FAA that require certain safety and service requirements, including:
  - Fueling Facilities
  - Certain Terminal Requirements
  - Night Operations
  - **Aircraft Rescue and Fire Fighting (ARFF)**

AIRCRAFT RESCUE & FIRE FIGHTING (ARFF) REQUIREMENTS AT FAA PART 139 AIRPORTS

- Must have onsite ARFF capabilities including a pumper truck
- The pumper truck must be full of Class B AFFF at all times
- Required to use AFFF that meets the DoD MILSPEC for Aqueous Film-Forming Foam
- Airport must keep enough AFFF onsite to fill the truck 3 times in the event of an emergency

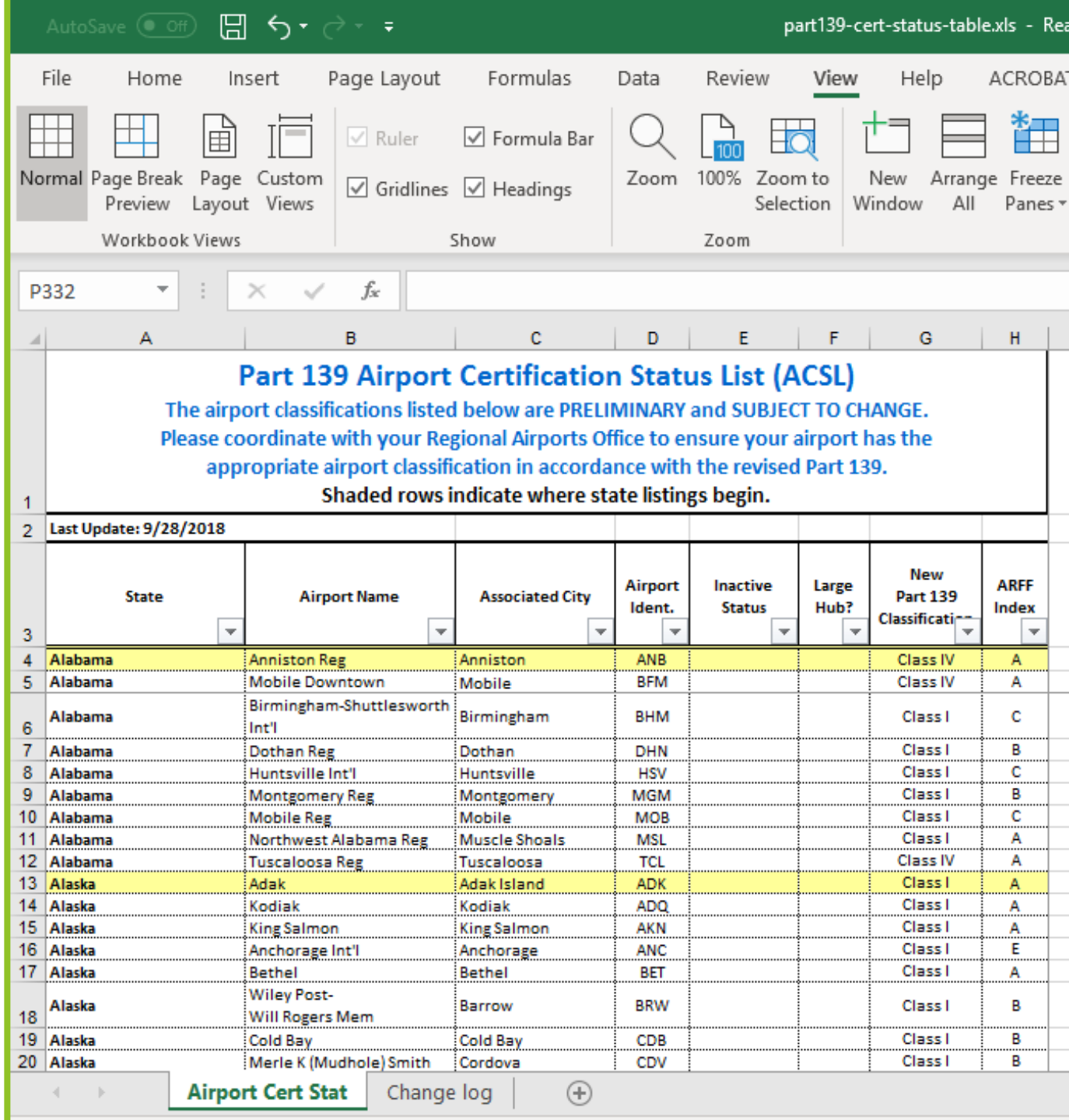
FAA-MANDATED AFFF AND EMERGENCY RESPONSE TESTING

- Each year, the FAA requires testing of the ARFF equipment, the AFFF, and the ARFF first responders
- **ARFF Equipment Testing:**
  - The pumper truck has its turrets and hand valves opened to ensure they effectively spray foam
- **AFFF Testing:**
  - The AFFF is tested to ensure it has the appropriate surface tension, expansion ratio, and other criteria
- **Emergency Response Testing:**
  - The ARFF first responders are tasked with responding to a mock emergency on the airfield. When they arrive on the scene, they are timed as to how long it takes for them to set up on a scene and run the pumps

FAA LISTING OF PART 139 AIRPORTS

https://www.faa.gov/airports/airport_safety/part139_cert/

Part 139 Airports by State	
RI	1
VT	2
NH	2
ME	4
CT	4
MA	9
NY	24



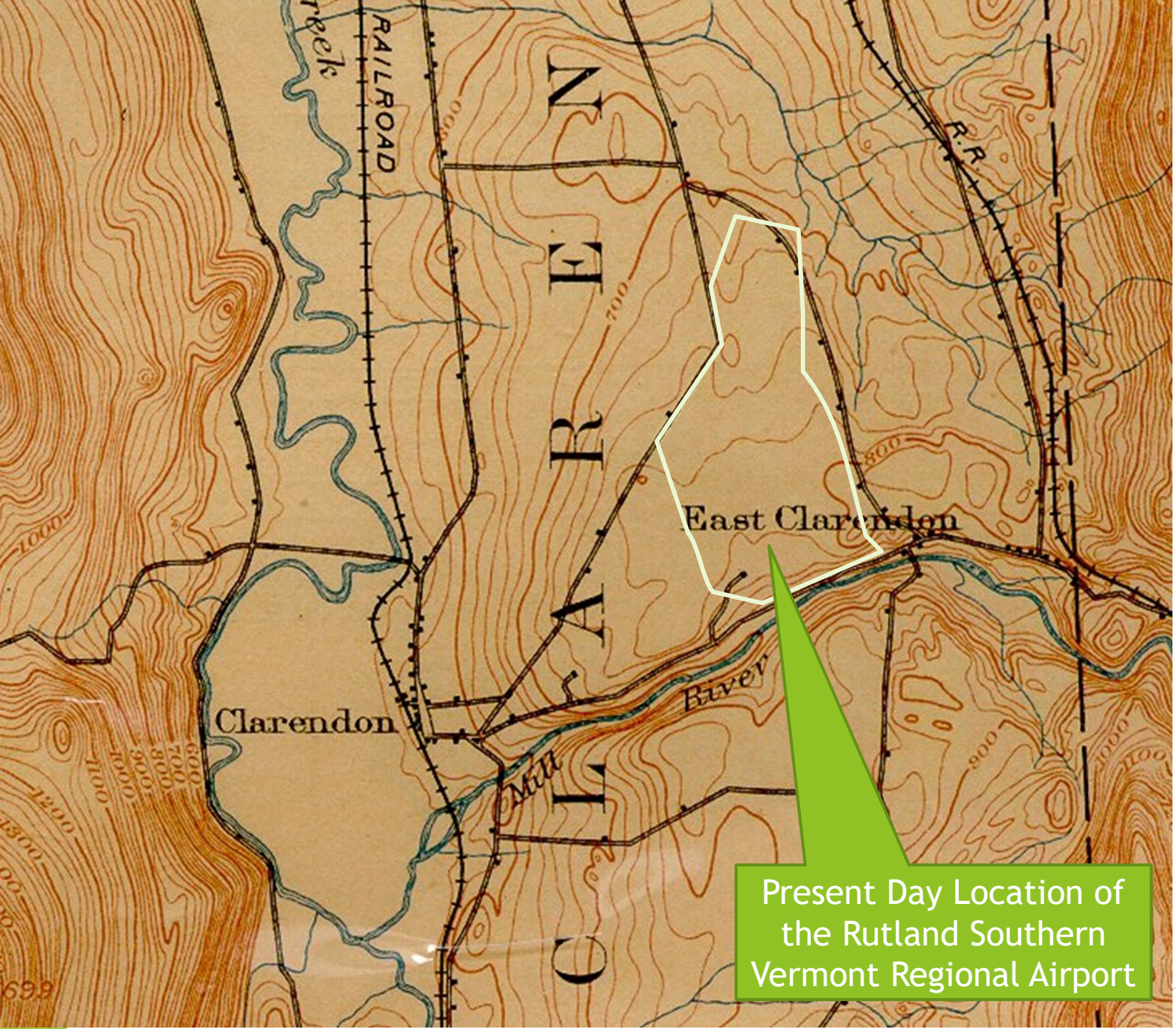
AREAS OF PFAS-CONTAMINATION CONCERN

- AFFF Storage Areas
- Areas on the airfield where AFFF was applied as part of an emergency response
- Firefighting training areas, burn pits, or other areas where AFFF may have been discharged as part of training
- Areas where AFFF was discharged as part of FAA testing
- Areas where AFFF was loaded or removed from ARFF vehicles during maintenance
- Historical disposal areas
- Airport stormwater system discharge points
- Pipeline terminals/bulk storage areas

Source: ACRP (Airport Cooperative Research Program). 2017. ACRP Research Report 173. Use and Potential Impacts of AFFF Containing Per- and Polyfluoroalkyl Substances (PFASs) at Airports. National Academy of Sciences. http://www.trb.org/ACRP/Blurbs/175866.aspx

CASE STUDY:
RUTLAND SOUTHERN VERMONT REGIONAL AIRPORT

Located in
Clarendon, VT



1893

Rutland, VT Quadrangle

USGS 15 Minute Series

AIRPORT CONSTRUCTION

Pictures are courtesy of the Historical Society of Clarendon Vermont

RUTLAND AIRPORT - 1946

WHEN DID THE AIRPORT START USING AFFF?

Before the August 6, 1986 Crash & Fire

- Learjet took off from the wrong runway (too short)
- Plane went thru fence at end of the runway and came to rest in a field on the other side of Route 7B Central
- The plane was carrying 1,000lbs of Aviation Gas
- **Fire broke out and was extinguished with AFFF**
- According to fire officials the plane was covered in AFFF throughout the salvage operation as well

LEARJET 55 LONGHORN

AUGUST 7, 1986
RUTLAND HERALD ARTICLE

The fuel tank in the right wing apparently burned, Lloyd said. Firefighters covered the plane with foam and water to prevent explosions and further fire from two remaining intact fuel tanks, he said. The plane was carrying about 1,000 pounds of aviation fuel, he said.

Foam covers all that remained of the Lear 55 jet that went off the runway at Rutland State Airport Wednesday. The plane came to rest in a field off old Route 7 and then burst into flames.

(Photos by Stephen Baumann)

Rutland area firemen spray foam on a Lear 55 jet that burned at Rutland State Airport Wednesday after it went off the end of the wrong runway. The passengers in the jet, which is owned by Federal Paperboard, were able to escape the plane before it was engulfed in flames.

1986 Spill Report

CASE # 133-86

Department of Water Resources and
Environmental Engineering

Incident Report

Date: 8-8-86 Time: 3:00PM

Location: Town/City: North Clarendon
Road, Street, Highway: RUTLAND AIRPORT
Address/Mile Marker:

Person Making Report
Name/Organization: Jim Blakesley A.O.T.
Telephone #: 828-2828 ~~WORK~~ HOME 483-6215
828 3601
Address:

Nature of Incident LEAR JET CRASH.
Exact Location: Rutland Airport
Time of Incident:
Type of Material: Jet Fuel
Quantity of Material: UNK.
Responsible Parties
owner/operator:
shipper/consignee:
carrier/facility:
Other Information: Plane Crashed on Wed Aug 6, 1986

Case Assigned To: Bill Bong -

Actions Taken: referred to Leon L. for visit by P. Cunning to Assess SITUATION Re: Clean-up

JUNE 2002: TWO PLANE CRASHES IN ONE MONTH!

Plane crash in Clarendon

Photo by Albert J. Marro

Clarendon firefighters spray foam on the wings of an airplane that went off the runway while landing Saturday at Rutland State Airport in North Clarendon. The plane went down an embankment and flipped onto its roof. The pilot, a Charlotte woman, said gusting winds caused her trouble as she was landing. She was shaken up, but not injured. *Story, Page D1.*

Crash: Plane destroyed

Continued from Page B1

The $65,000 plane was destroyed in the crash and leaked "considerable fuel," police said. Clarendon and Wallingford firefighters sprayed foam to minimize the chance of the fuel igniting.

On June 1, a Charlotte woman's plane went off the runway and down an embankment while landing at the airport. It flipped onto its roof. The woman, who was shaken up but not hurt, told authorities that high winds were a factor in that accident.

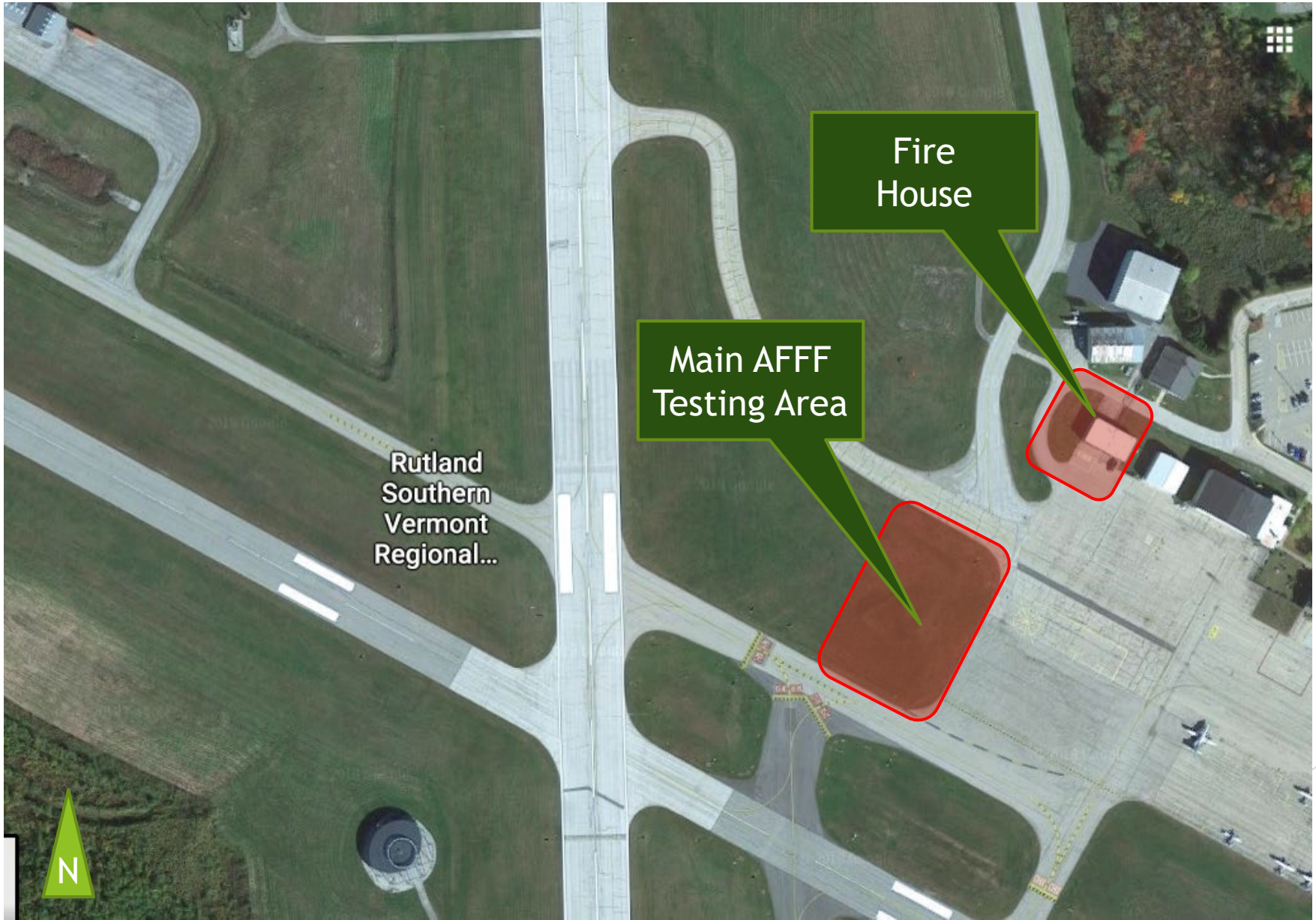
- Both of these crashes did not have fires as a result of the crash
- AFFF was applied as a precaution
- NTSB Crash Reports can aid in research of plane crashes and are available online
- Exact locations of these crashes to needs be determined

Articles from the Rutland Herald

IN AUGUST 2018, NO AFFF WAS USED IN THE RESPONSE TO THIS PLANE CRASH

JOHN H. BOYLAN STATE AIRPORT
ISLAND POND, VERMONT

AIRPORT AFFF OPERATIONS



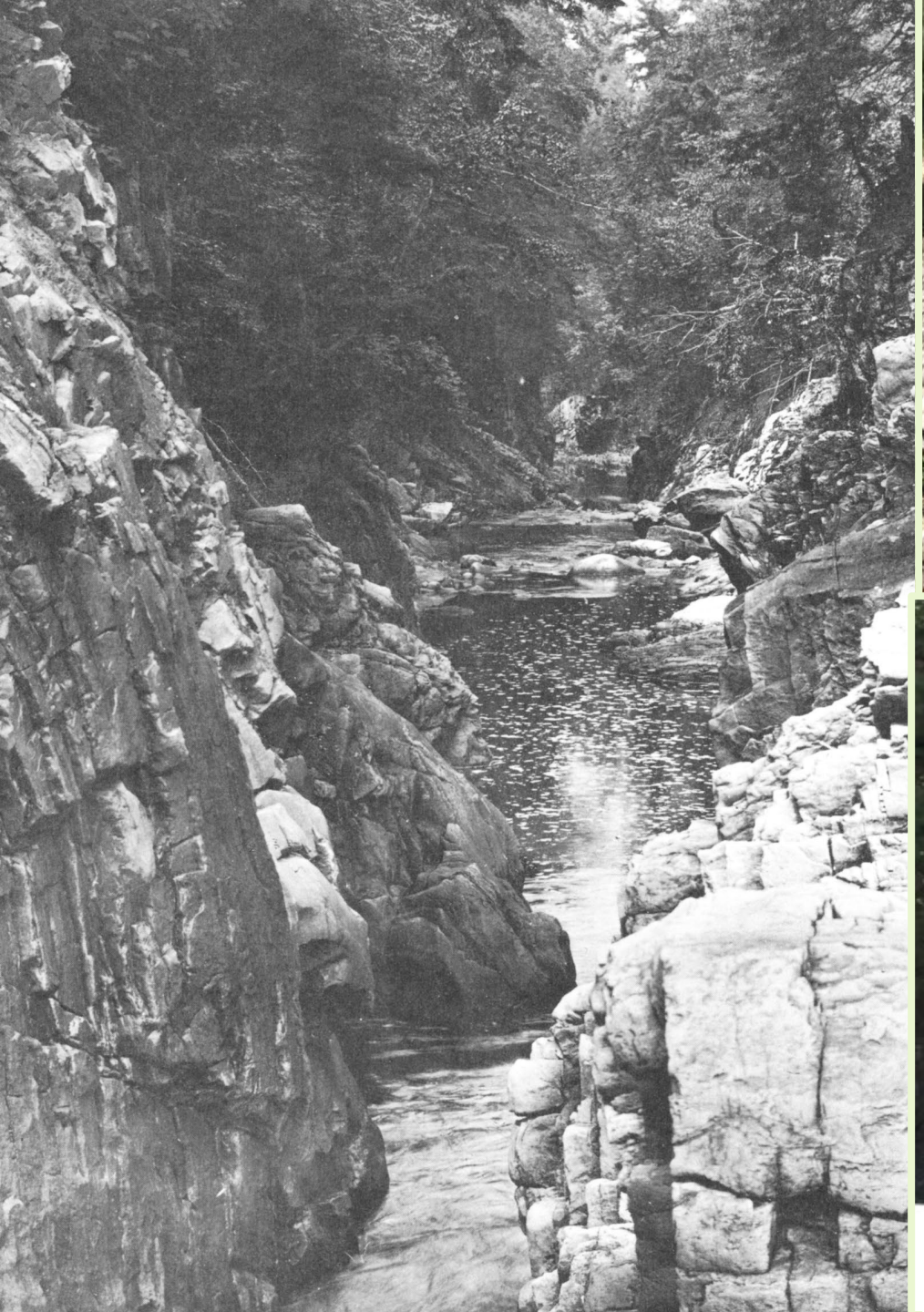
GEOLOGY

- Bedrock – Two Types:

Clarendon Springs Formation (Upper Cambrian)—Steel-gray-weathering, light-gray, massive calcitic dolostone grading upward into darker, more fissile calcitic dolostone containing white quartz knots near top; unit locally brecciated. Locally contains light-bluish-gray to whitish-gray calcite marble (Cspl) within dolostone and beneath the calcitic marbles of the overlying Shelburne Marble

Winooski Dolostone (Middle Cambrian)—Well-bedded dolostone weathering beige, cream, and buff, with green, red, or gray phyllite, siliceous partings, and thin beds of blue-quartz-pebble conglomerate and quartzite

- Surficial Geology:
  - Recessional moraine deposits on most of the site
  - Kame moraine deposits with sand deposits and ice contact outwash gravel in the eastern part of the site

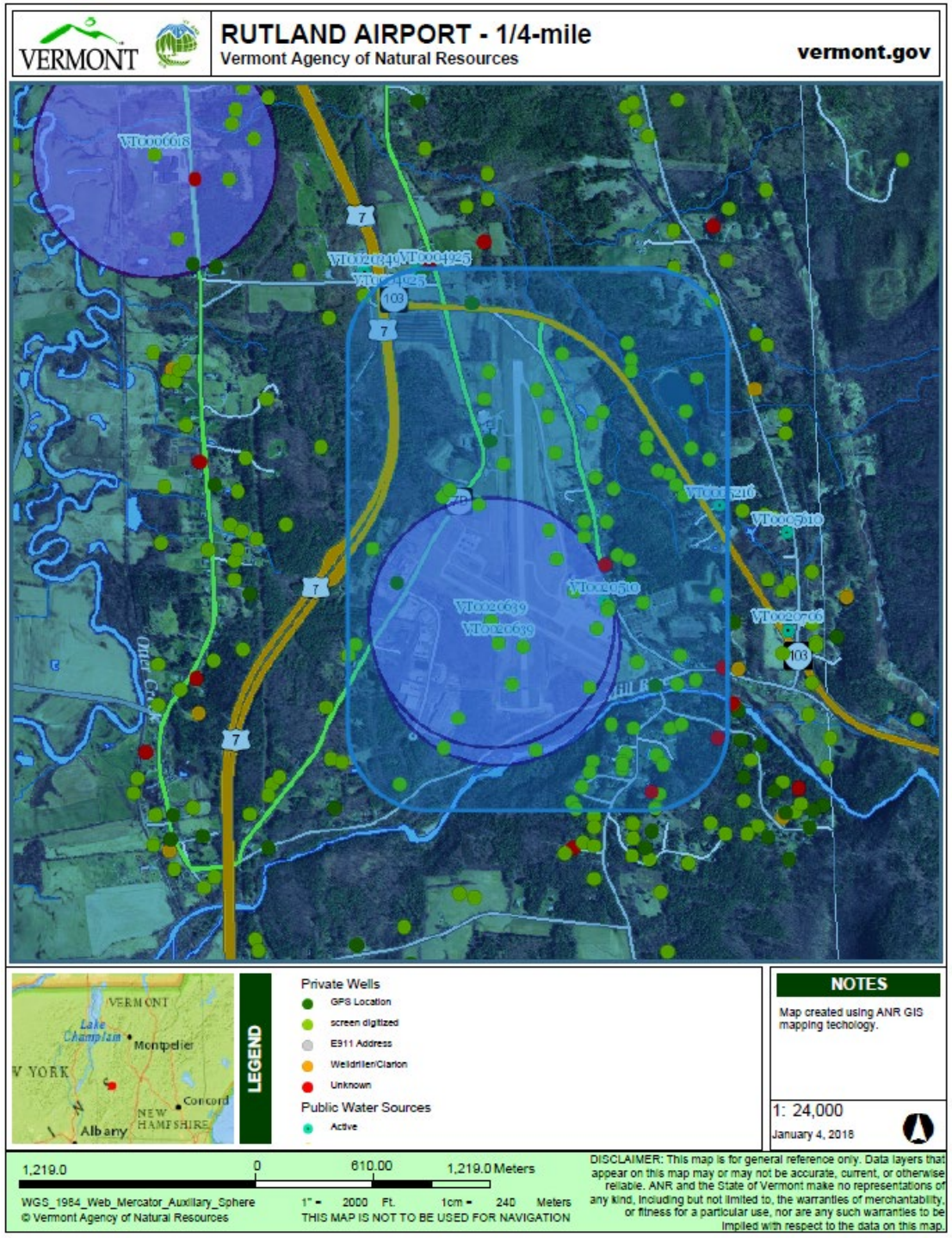


DRINKING WATER WELLS NEAR THE AIRPORT

- Within 1/4-mile of airport:
  - **83+ Private Wells**
  - 5 Public Wells (3 at airport)
  - 2 Source Protection Areas*

    *both located on airport property

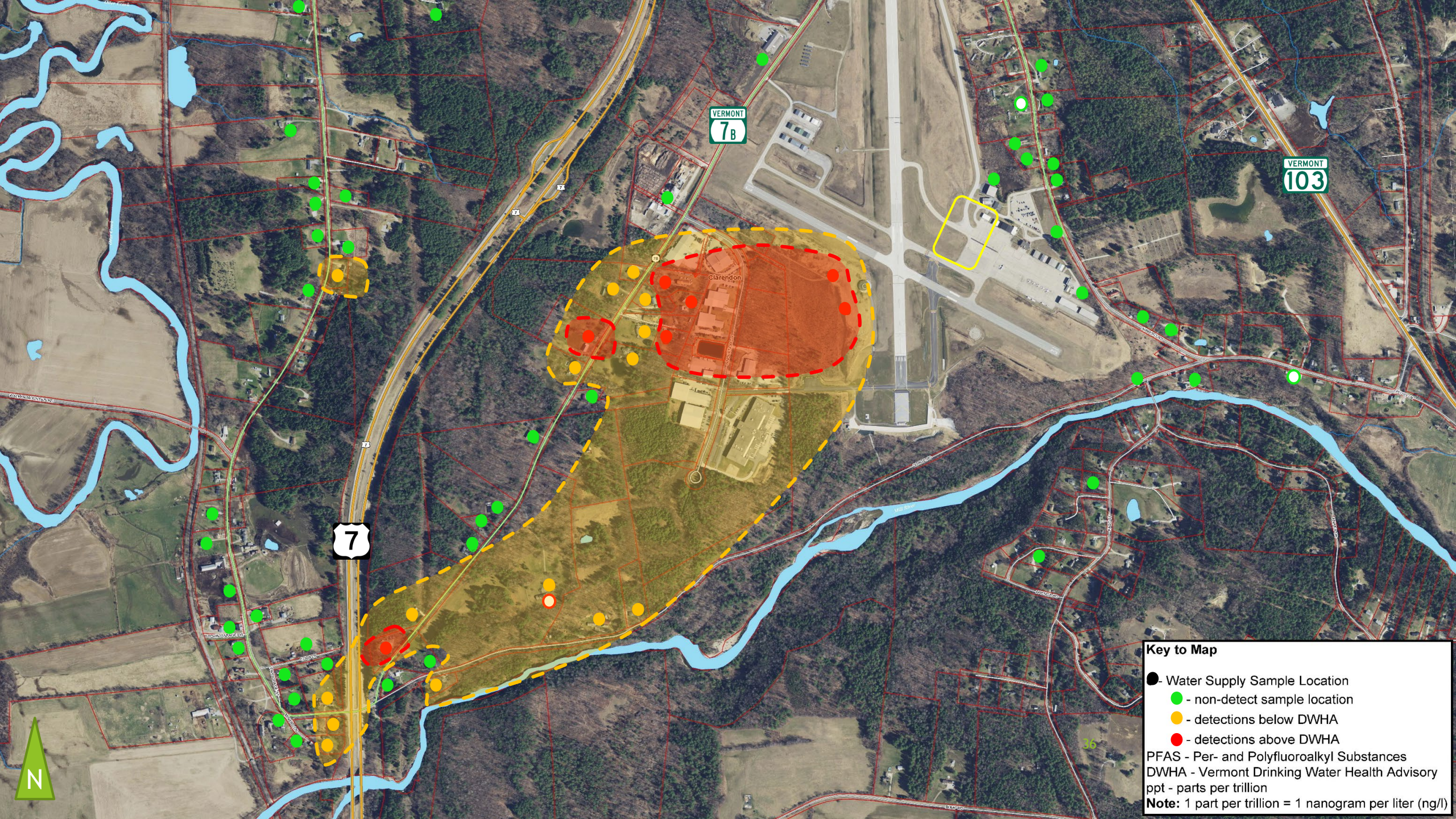
- Within 1-mile of airport:
  - **253+ Private Wells**
  - 9 Public Wells
  - 3 Source Protection Areas

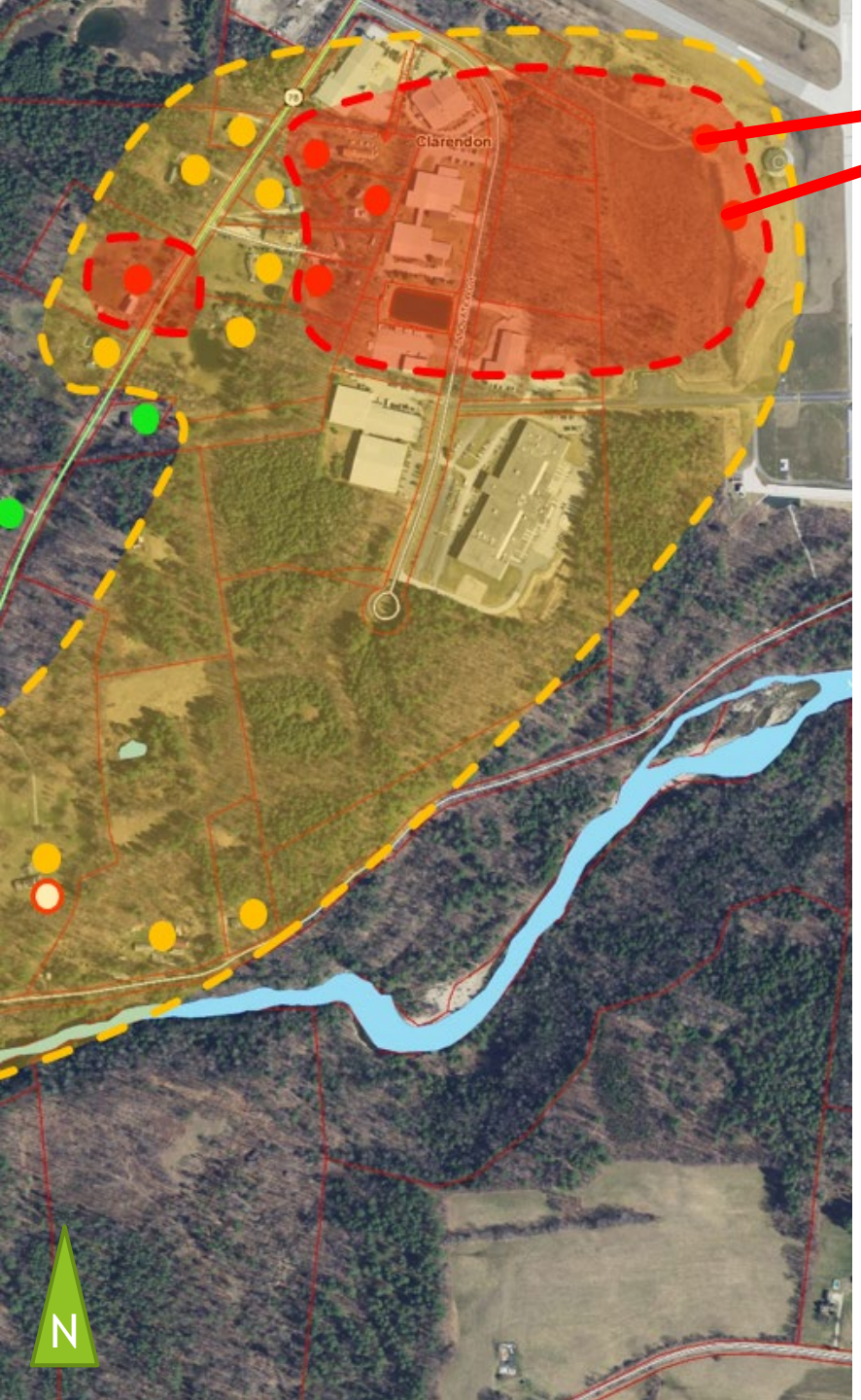


AFFF Test Area is located within the **Source Protection Areas** for the Business Park Wells

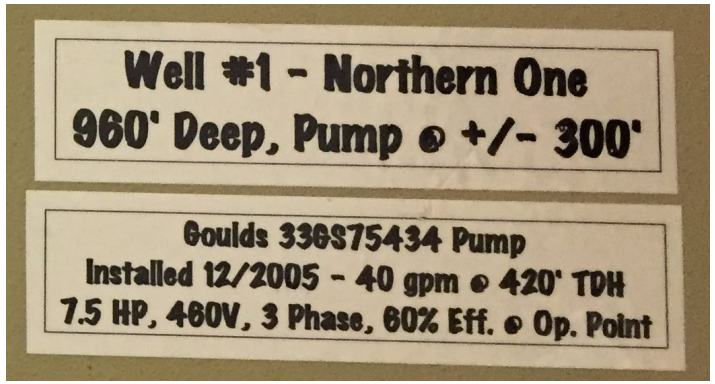
WATER SUPPLY TESTING SUMMARY

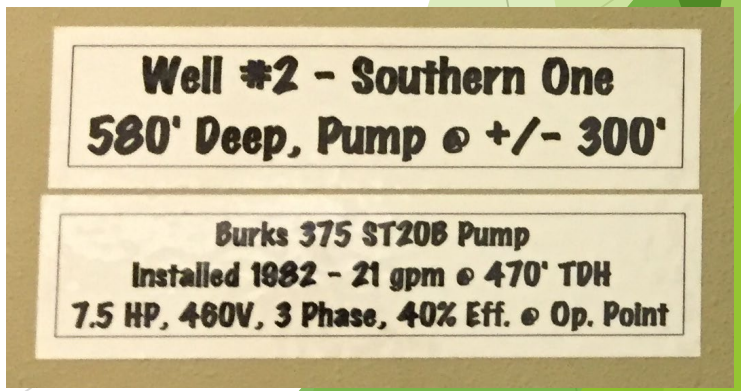
- 75 Bedrock supply wells sampled to date
- PFAS detections in 24 wells
- 4 Springs sampled to date; 2 with PFAS > VGES
- Treatment systems required on 8 bedrock supply wells
  - 5 Residential Point of Entry Treatment (POET) Systems
  - 1 Agricultural POET
  - Airport Business Park Water Treatment System (2 wells)
- Furthest wells with detections are 1-½ miles southwest of the Airport


VERMONT
7B
VERMONT
103
7
Clarendon
N
Key to Map
- Water Supply Sample Location
- non-detect sample location
- detections below DWHA
- detections above DWHA
PFAS - Per- and Polyfluoroalkyl Substances
DWHA - Vermont Drinking Water Health Advisory
ppt - parts per trillion
Note: 1 part per trillion = 1 nanogram per liter (ng/l)



Business Park Water System Wells Influent – August 2018	Concentration
Perfluorobutanoic Acid (PFBA)	31 ng/L
Perfluorooctanoic Acid (PFOA)	21 ng/L
Perfluoropentanoic Acid (PFPeA)	160 ng/L
Perfluorohexane Sulfonic Acid (PFHxS)	6.4 ng/L
Perfluorohexanoic Acid (PFHxA)	100 ng/L
Perfluorooctane Sulfonic Acid (PFOS)	7.1 ng/L
Perfluorononanoic Acid (PFNA)	2.6 ng/L
Perfluoroheptanoic Acid (PFHpA)	40 ng/L
1H,1H,2H,2H-Perfluorooctane Sulfonic Acid (6:2)	300 ng/L
TOTAL PFAS INCLUDED IN DWHA	**77.1 ng/L**





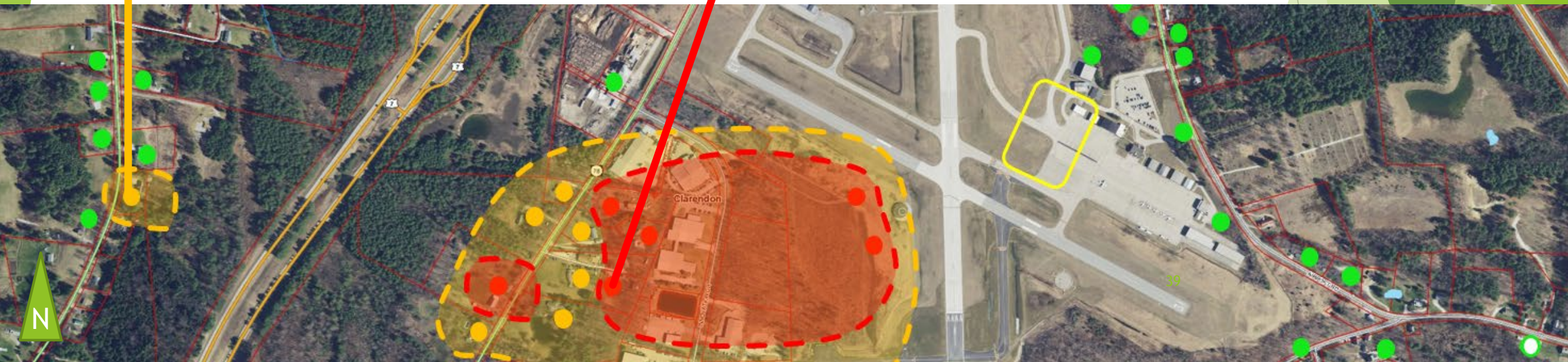
AIRPORT BUSINESS PARK TREATMENT SYSTEM

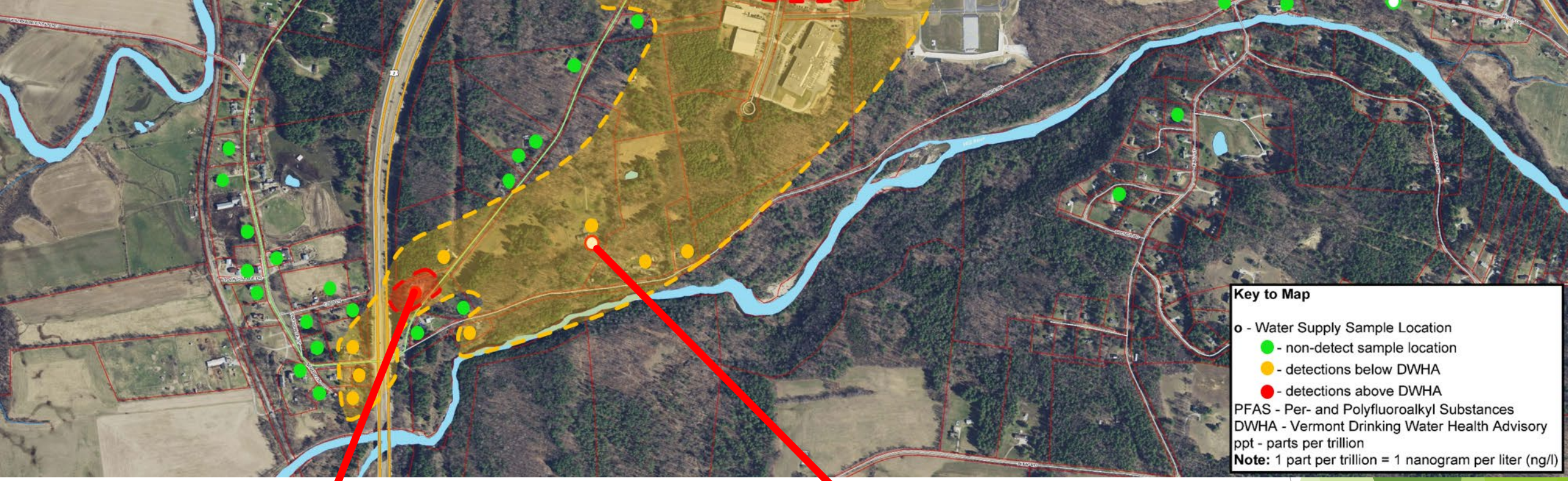
- PFAS Contamination Discovered in March 2018
- Bottled water and water totes provided to businesses and industries in the park
- Engineered treatment system constructed
  - Average Daily Demand = approx. 3,000 gal/day
  - Granulated Activated Carbon-based system
  - 4-48"x72" vessels that contain 54ft^3 of GAC
  - Empty Bed Contact Time = 12 minutes
- 'Do Not Drink' Order lifted on Sept. 1, 2018

SELECT RESIDENTIAL SUPPLY WELL RESULTS

Bedrock Supply Well	Concentration
Perfluorobutanoic Acid (PFBA)	3.2 ng/L

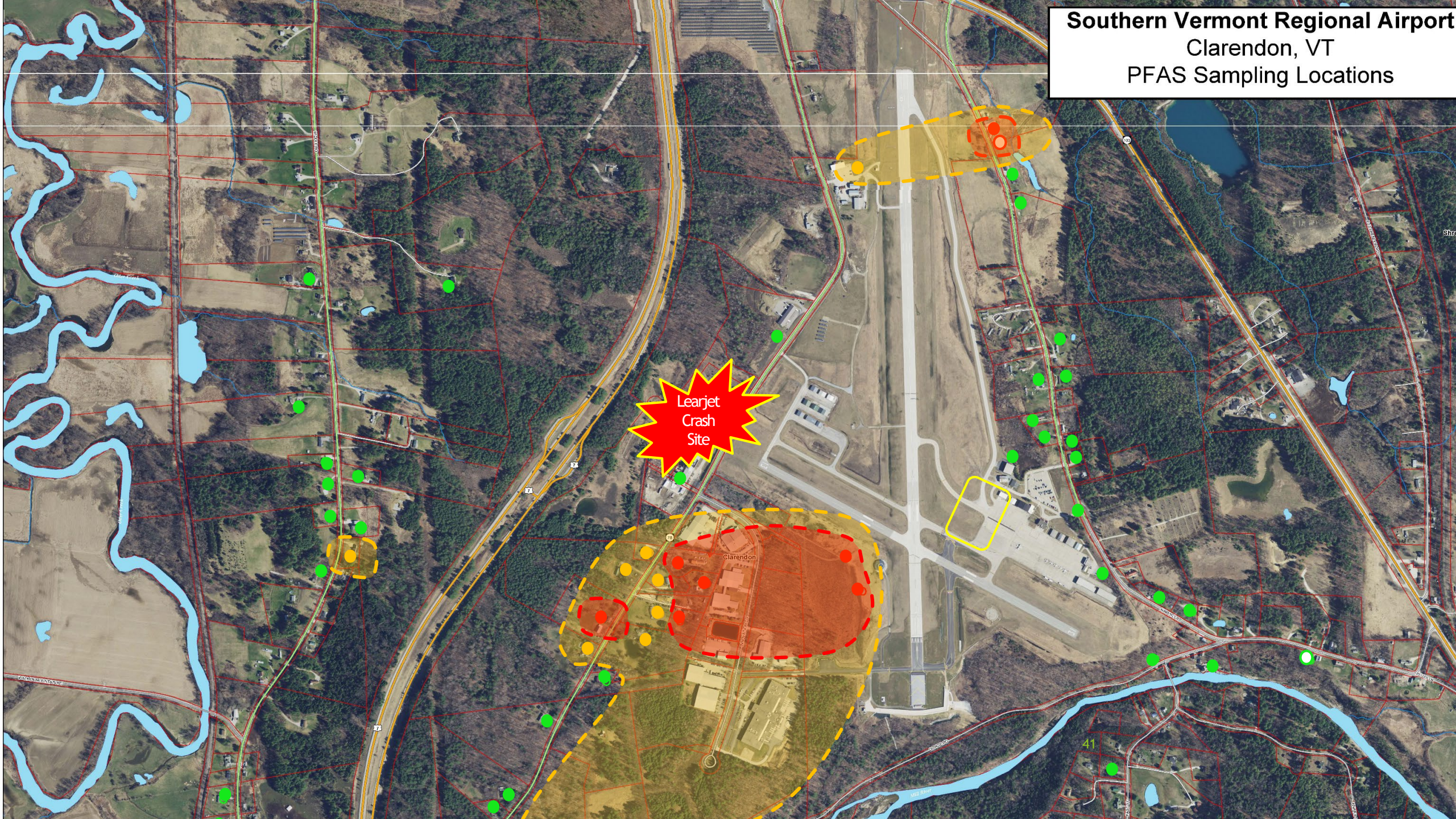
Bedrock Supply Well - 165ft Deep	Concentration
Perfluorobutanoic Acid (PFBA)	22 ng/L
Perfluorooctanoic Acid (PFOA)	16 ng/L
Perfluoropentanoic Acid (PFPeA)	79 ng/L
Perfluorohexane Sulfonic Acid (PFHxS)	3.6 ng/L
Perfluorohexanoic Acid (PFHxA)	45 ng/L
Perfluorooctane Sulfonic Acid (PFOS)	7.1 ng/L
Perfluorononanoic Acid (PFNA)	4.5 ng/L
Perfluoroheptanoic Acid (PFHpA)	28 ng/L
TOTAL PFAS INCLUDED IN DWHA	**59.2 ng/L**

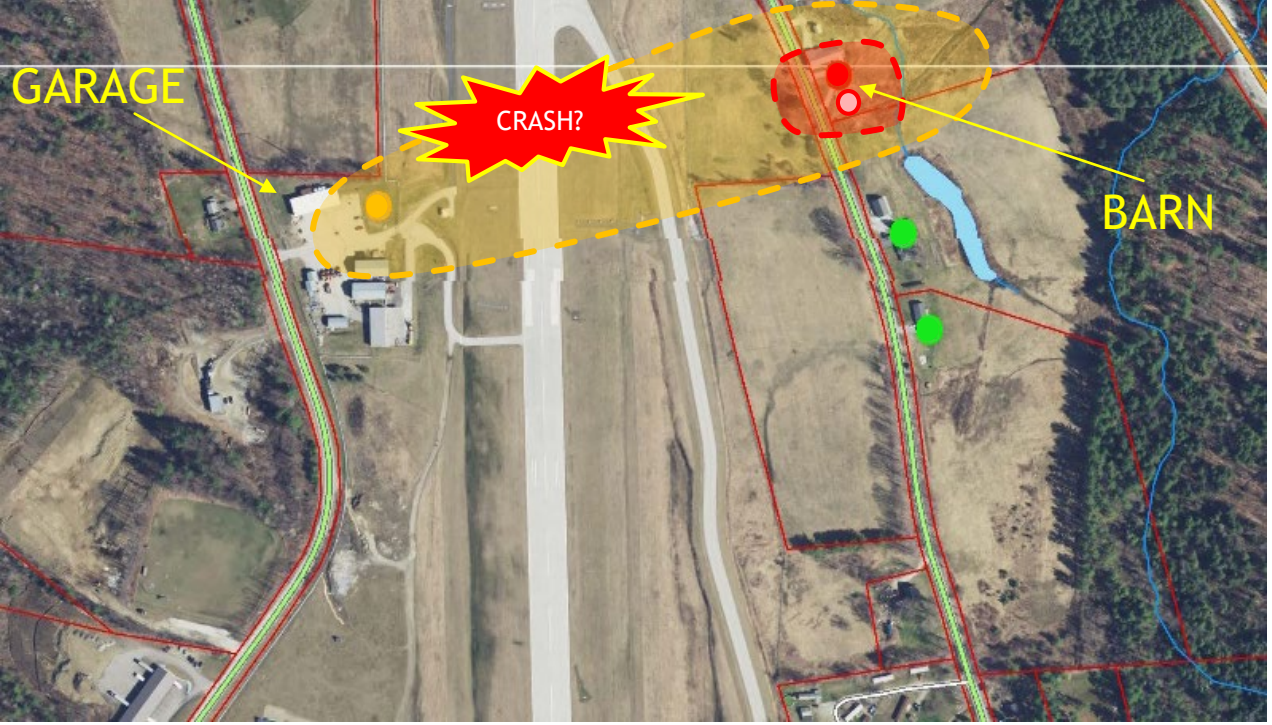




Bedrock Supply Well - Depth Unknown	Concentration
Perfluoroheptanoic Acid (PFHpA)	2.4 ng/L
Perfluorooctanoic Acid (PFOA)	6.3 ng/L
Perfluoropentanoic Acid (PFPeA)	4.4 ng/L
Perfluorohexane Sulfonic Acid (PFHxS)	2.4 ng/L
Perfluorohexanoic Acid (PFHxA)	3.7 ng/L
Perfluorooctane Sulfonic Acid (PFOS)	12 ng/L
TOTAL PFAS INCLUDED IN DWHA	**24.4 ng/L**

Spring	Concentration
Perfluoroheptanoic Acid (PFHpA)	19 ng/L
Perfluorooctanoic Acid (PFOA)	3.8 ng/L
Perfluorohexane Sulfonic Acid (PFHxS)	4.5 ng/L
Perfluorohexanoic Acid (PFHxA)	61 ng/L
Perfluorooctane Sulfonic Acid (PFOS)	2.5 ng/L
TOTAL PFAS INCLUDED IN DWHA	**29.8 ng/L**


Southern Vermont Regional Airport
Clarendon, VT
PFAS Sampling Locations
Learjet
Crash
Site
Clarendon

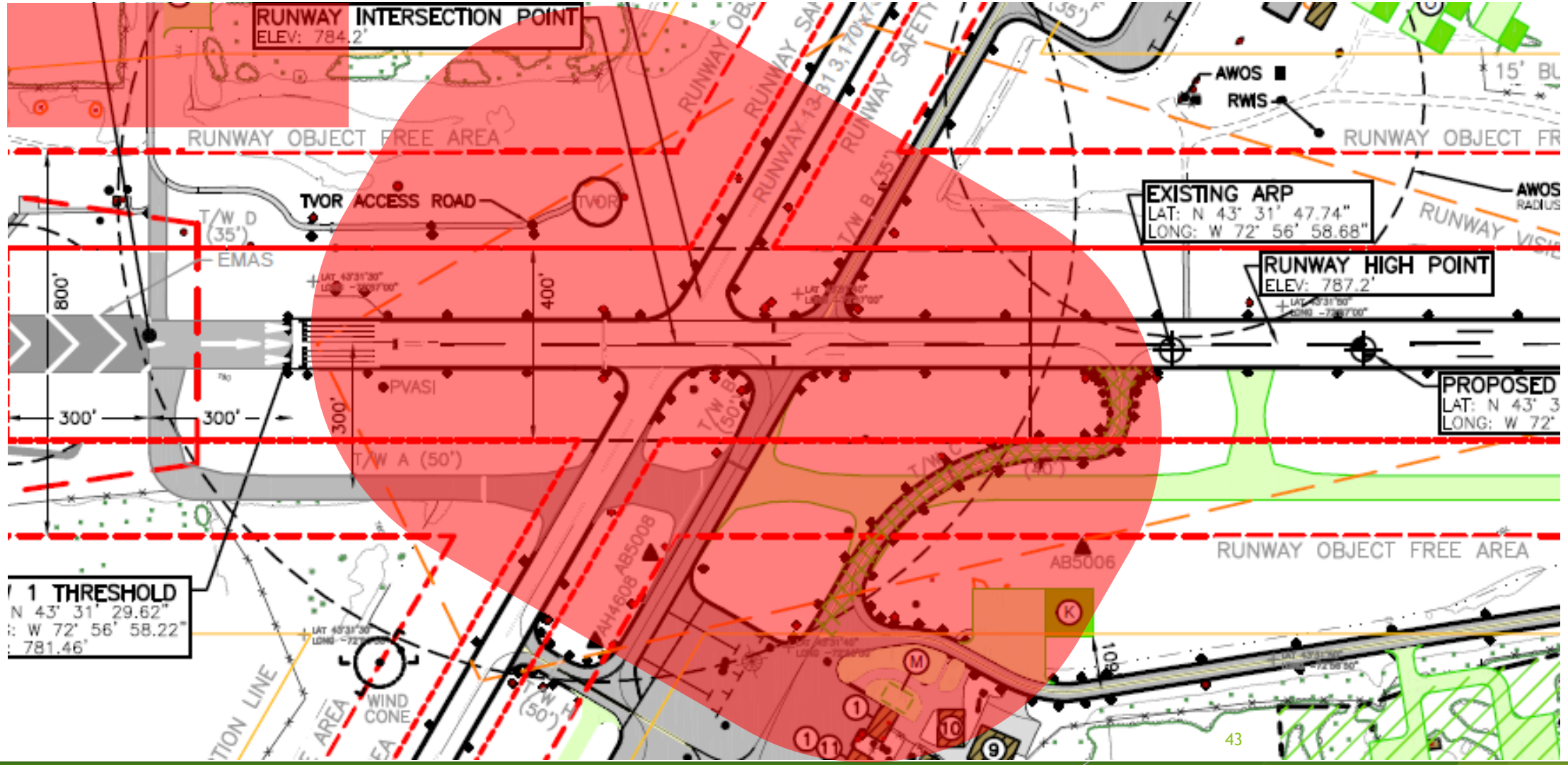


Garage Bedrock Supply Well (445ft)	Concentration
Perfluorobutanoic Acid (PFBA)	6.0 ng/L
Perfluorooctanoic Acid (PFOA)	3.0 ng/L
Perfluoropentanoic Acid (PFPeA)	2.1 ng/L
Perfluorohexane Sulfonic Acid (PFHxS)	4.3 ng/L
Perfluorohexanoic Acid (PFHxA)	1.9 ng/L
Perfluorooctane Sulfonic Acid (PFOS)	2.0 ng/L
TOTAL PFAS INCLUDED IN DWHA	**9.3 ng/L**

Spring at Barn	Concentration
Perfluoroheptanoic Acid (PFHpA)	120 ng/L
Perfluorooctanoic Acid (PFOA)	70 ng/L
Perfluorohexane Sulfonic Acid (PFHxS)	3.8 ng/L
Perfluorohexanoic Acid (PFHxA)	140 ng/L
Perfluorononanoic Acid (PFNA)	8.6 ng/L
Perfluorobutane Sulfonic Acid (PFBS)	1.7 ng/L
TOTAL PFAS INCLUDED IN DWHA	**202.4 ng/L**

Barn Bedrock Supply Well	Concentration
Perfluoroheptanoic Acid (PFHpA)	30 ng/L
Perfluorooctanoic Acid (PFOA)	13 ng/L
Perfluorohexane Sulfonic Acid (PFHxS)	3.8 ng/L
Perfluorohexanoic Acid (PFHxA)	38 ng/L
TOTAL PFAS INCLUDED IN DWHA	**46.8 ng/L**

SITE INVESTIGATION CHALLENGES



SITE INVESTIGATION CHALLENGES

SITE INVESTIGATION CHALLENGES

ARFF BUILDING MONITORING WELL

Analyte	Concentration
Perfluorobutanoic acid (PFBA)	740 ng/L
Perfluorobutane sulfonic acid (PFBS)	9.9 ng/L
Perfluoropentanoic acid (PFPeA)	2,900 ng/L
Perfluoropentane sulfonic acid (PFPeS)	*Not Analyzed*
Perfluorohexanoic acid (PFHxA)	1,700 ng/L
Perfluorohexane sulfonic acid (PFHxS)	460 ng/L
Perfluoroheptanoic acid (PFHpA)	1,100 ng/L
Perfluoroheptane sulfonic acid (PFHpS)	69 ng/L
Perfluorooctanoic acid (PFOA)	340 ng/L
Perfluorooctane sulfonic acid (PFOS)	760 ng/L
Perfluorononanoic acid (PFNA)	6.1 ng/L
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	1,200 ng/L
TOTAL PFAS INCLUDED IN THE VGES	**2,666.1 ng/L**

WHAT ELSE IS VERMONT DOING TO ADDRESS AFFF?

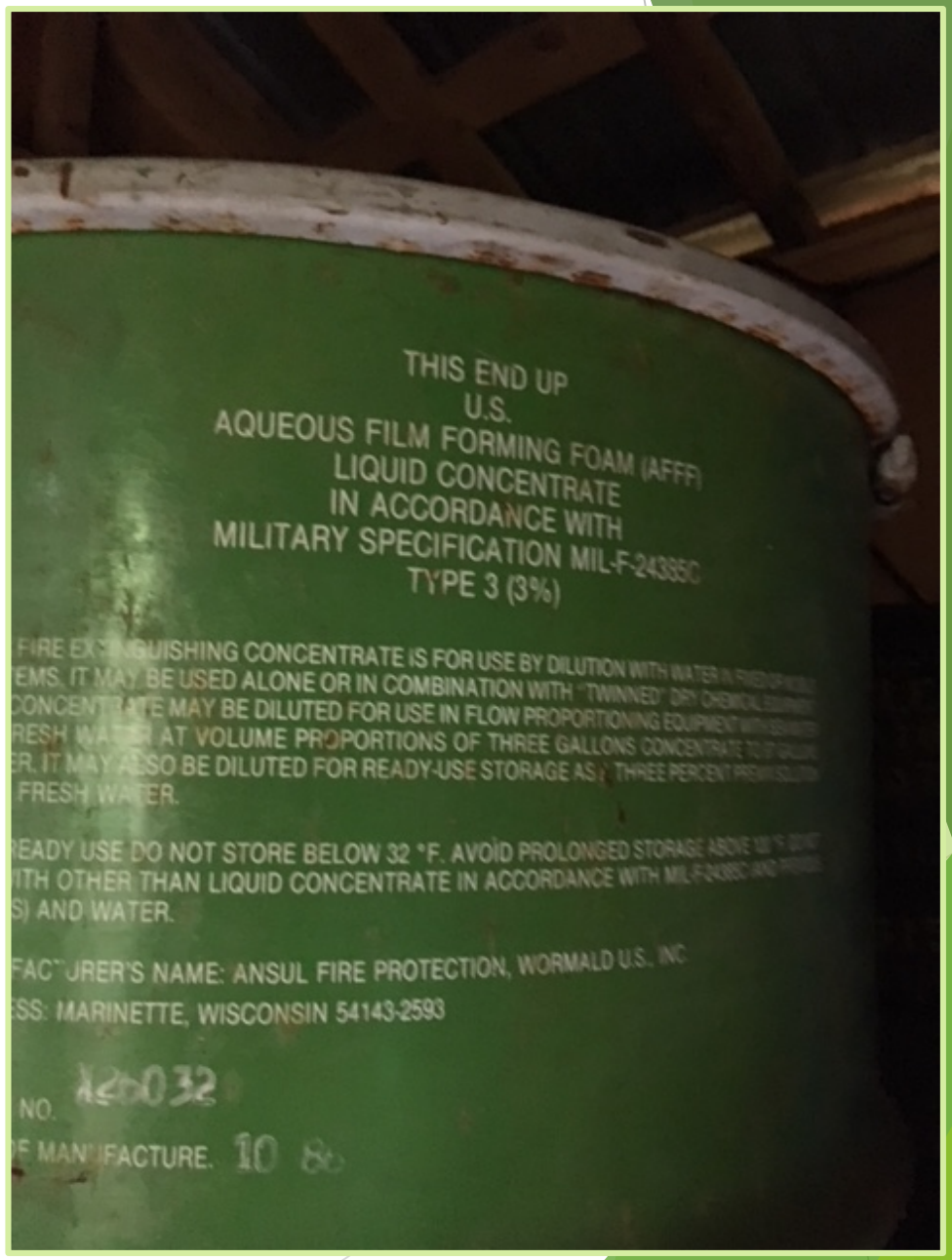
STATEWIDE AFFF TAKEBACK PROGRAM

- Survey sent to all local, municipal, and city fire chiefs in the State
- Results indicated that fire departments across the State were storing anywhere from 5 to 250+ gallons of AFFF concentrate
- Many departments had AFFF concentrate that was greater than 15 years old (legacy AFFF)
- More than 90% of the fire departments that responded that they had AFFF in stock expressed interest in having PFAS-containing AFFF removed from their site

PFOS-based
'Legacy AFFF'

STATEWIDE AFFF TAKEBACK PROGRAM

- Fire department's had a 4 week window to contact the Vermont DEC regarding their stock of legacy (pre-2003) AFFF concentrate
- State's contractor to pickup AFFF at the fire department if they had more than 25-gallons of AFFF concentrate
- Fire Department's with 25-gallons of less of AFFF could drop them off at their local Solid Waste District
- Initial estimates indicate **2,250-gallons** of unused, legacy AFFF concentrate will be disposed of in the program



AFFF FINAL DESTINATION = INCINERATOR

The selected facility can incinerate waste at temperatures ranging from 1,800ºF to 2,200ºF

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DEPARTMENT OF ENVIRONMENTAL CONSERVATION

WASTE MANAGEMENT & PREVENTION DIVISION

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VERMONT

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Photo courtesy of the Vermont Department of Fish & Wildlife