Risk Assessment Challenges Associated with Atmospheric Transport of PFAS

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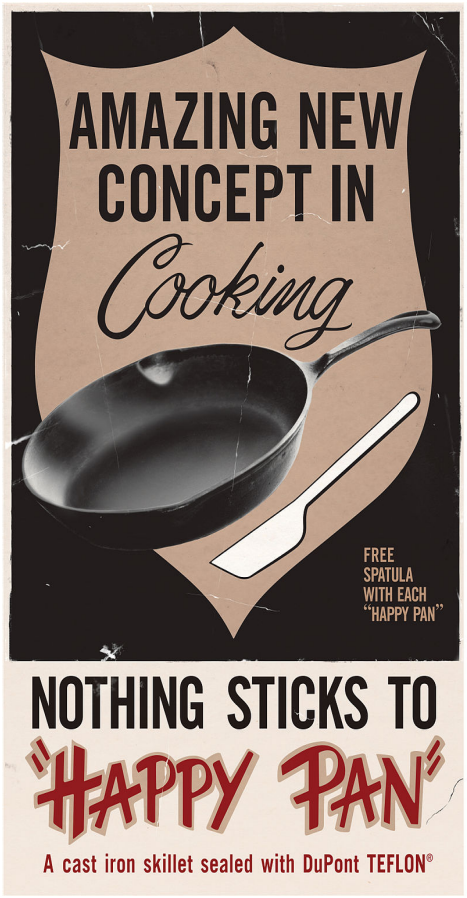
Presentation Overview

- PFAS Sources to the Atmosphere
- PFAS Atmospheric Transport
- Risk Assessment (RA) Basics
- Risk Communication 101
- Forensic Analysis of PFAS
  - Case Study
- RA Challenges Related to Atmospheric Transport of PFAS

Poly- & Per-fluoroalkyl Substances (PFAS)



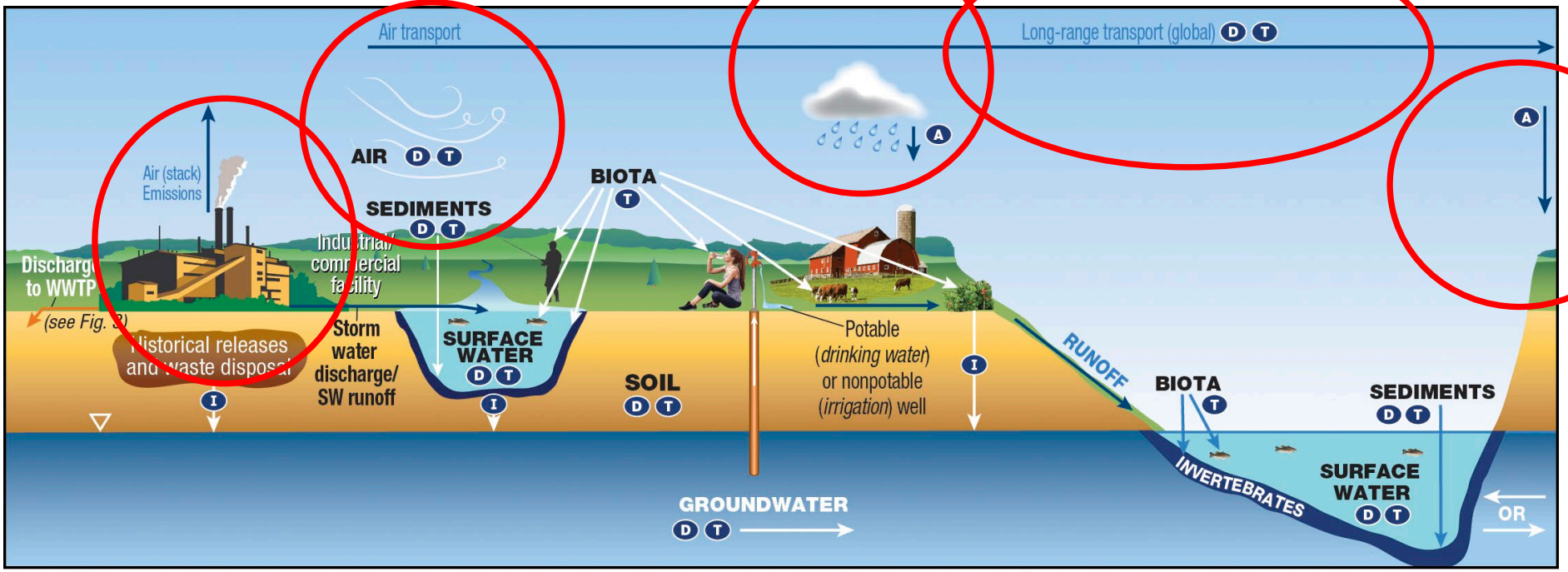
Generic family of consumer product chemicals that resist heat, grease, stains, and water

- **Per-fluoroalkyl substances**: **fully**-fluorinated alkyl tail
- **Poly-fluoroalkyl substances**: **non-fluorine atom** (usually hydrogen or oxygen) attached to at least one carbon atom
- **Poly-fluoroalkyl substance (precursors)** can be transformed into **per-**fluoroalkyl acids (PFAAs) via biotic (microbial breakdown) and abiotic (UV) processes

Atmospheric Transport of PFAS

Industrial Site

- Primary production plants & secondary manufacturing using PFAS
- Stack emission concerns



Source: March 2018 ITRC Factsheet: Environmental Fate & Transport for PFAS

Atmospheric Emissions

Particles

- Dominated by anionic PFAAs (*Ge et al. 2017; Dreyer et al. 2015; Ahrens et al. 2012*)
  - PFOA sorbs to smaller particles
  - PFOS sorbs to larger particles

Vapors

- Dominated by neutral FTOHs
- FTOH vapors are dominant PFAS present in air over urban areas, open oceans and remote areas (*Ahrens et al. 2012; Bossi et al. 2016; Lai et al. 2016; Wang et al. 2015; Dreyer et al. 2009*).

Atmospheric Transformation

- Neutral volatile PFAS precursors transform into PFCAs and PFSAs (PFOA, PFNA, and PFOS)
- Transformation occurs abiotically through indirect photolysis/oxidation by hydroxyl radicals (OH^-) (*Martin et al. 2006; Wallington et al. 2006; Ellis et al. 2003*).
- Transformation reaction rates can be slow (*Young and Maybury, 2010*).
- Slow reaction rates, combined with long atmospheric τ of precursors, allows for LRT of PFAS to extremely remote areas, including the Arctic and Antarctic (*Piekarz et al. 2007; Martin et al. 2006; Ellis et al, 2003*)

Atmospheric Deposition

- Wet and dry deposition remove PFAS from atmosphere
  - Particle-bound PFAS deposition through wet scavenging/deposition (precipitation) or dry deposition (settles to ground in dry weather) (*Slinn, 1984; Sehmel, 1984*).
  - Partitioning of PFAS vapors to water droplets, which fall as rain or snow (*Dreyer et al. 2010; Hurley et al. 2004*).
  - Deposition occurs over period of a few days (for particulates) to a few weeks (for vapors) (*Chen et al. 2016; Lin et al. 2014; Dreyer et al. 2010; Hurley et al. 2004*).

Atmospheric Deposition Factors

Source Factors

-Chemical properties

-Particle size

-Release characteristics

(smokestack height)

-Effluent rate/temperature

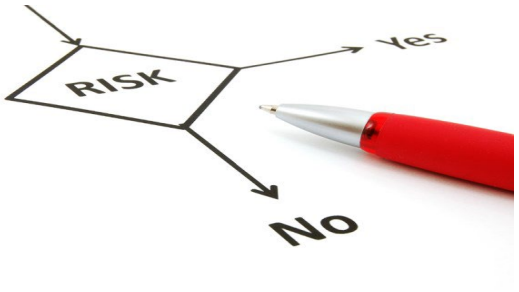
Regional Factors

-Local topography

-Weather patterns

(*upslope winds*)

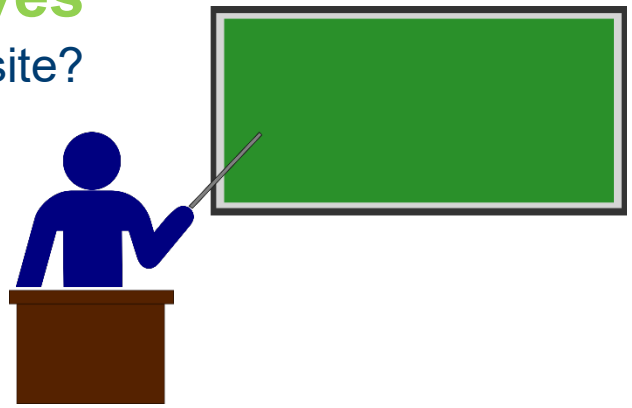
Risk Assessment (RA) Basics



- **Data Evaluation**
  - Identify PFAS Chemicals of Concern (COCs)
- **Exposure Assessment**
  - Identify exposure pathways in Conceptual Site Model (CSM)
  - Identify appropriate exposure assumptions for each receptor
  - Fate and transport analysis, including predictive modeling
- **Toxicity Assessment**
  - EPA's tiered approach for toxicity values
    - Tier 1 (IRIS), Tier 2 (PPTRVs),Tier 3 (Literature)
  - Toxicity value dependence on exposure period
    - Chronic, subchronic, acute
- **Risk Characterization**
  - Set cancer Target Risk Level (TRL), noncancer Hazard Index (HI)
  - Site background conditions, overlapping contamination
  - Consideration of uncertainties

Risk Communication 101

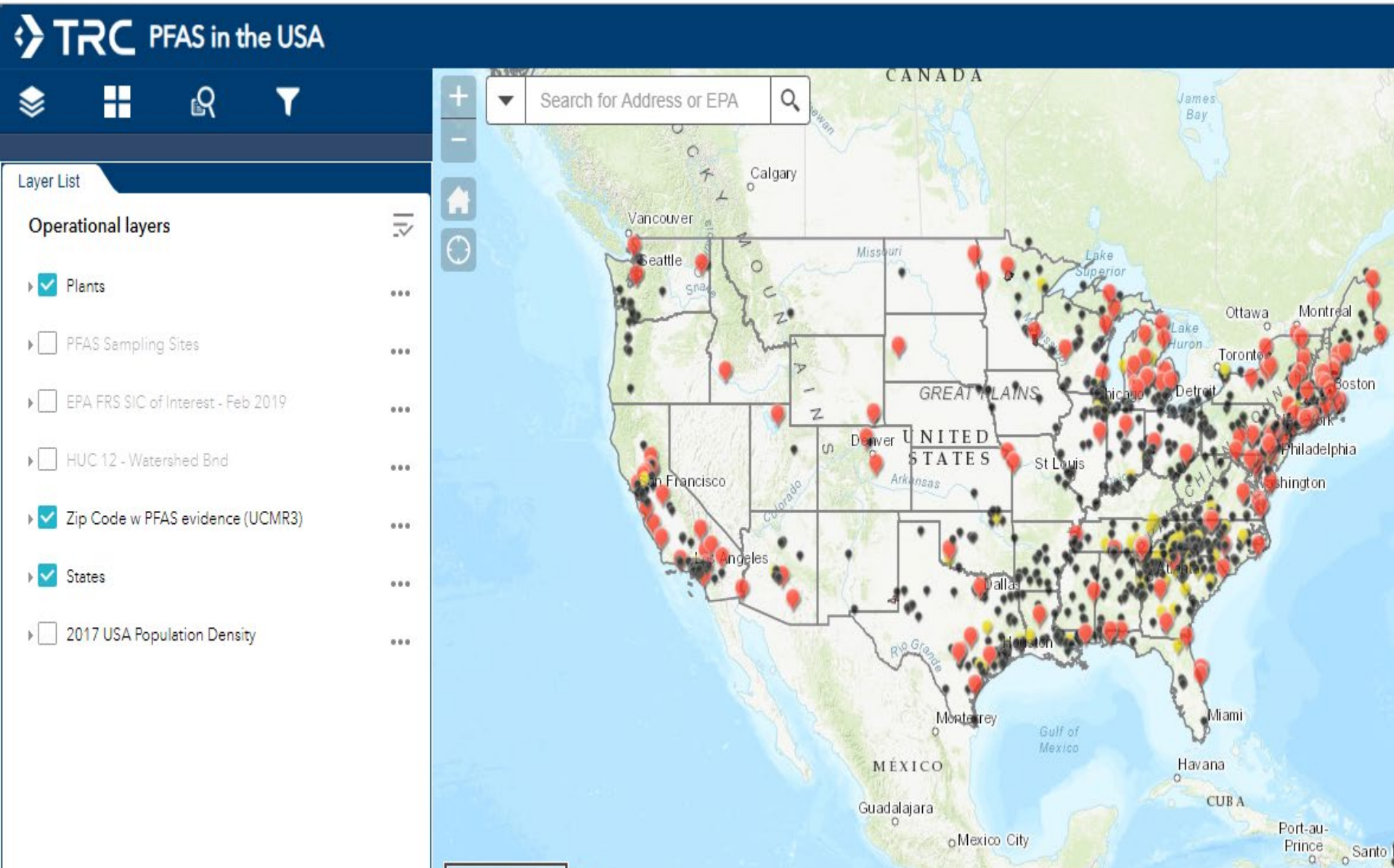
- **Identify Key Messages and Objectives**
  - Is the RA answering the right questions for your site?
- **Revisit CSM Often**
  - When new data collected or data gaps identified
  - Nature and extent



- **Use Storyteller Tools (Graphics, Maps)**
- **Build Relationships & Trust with All Stakeholders**
  - Frequent, in-person meetings

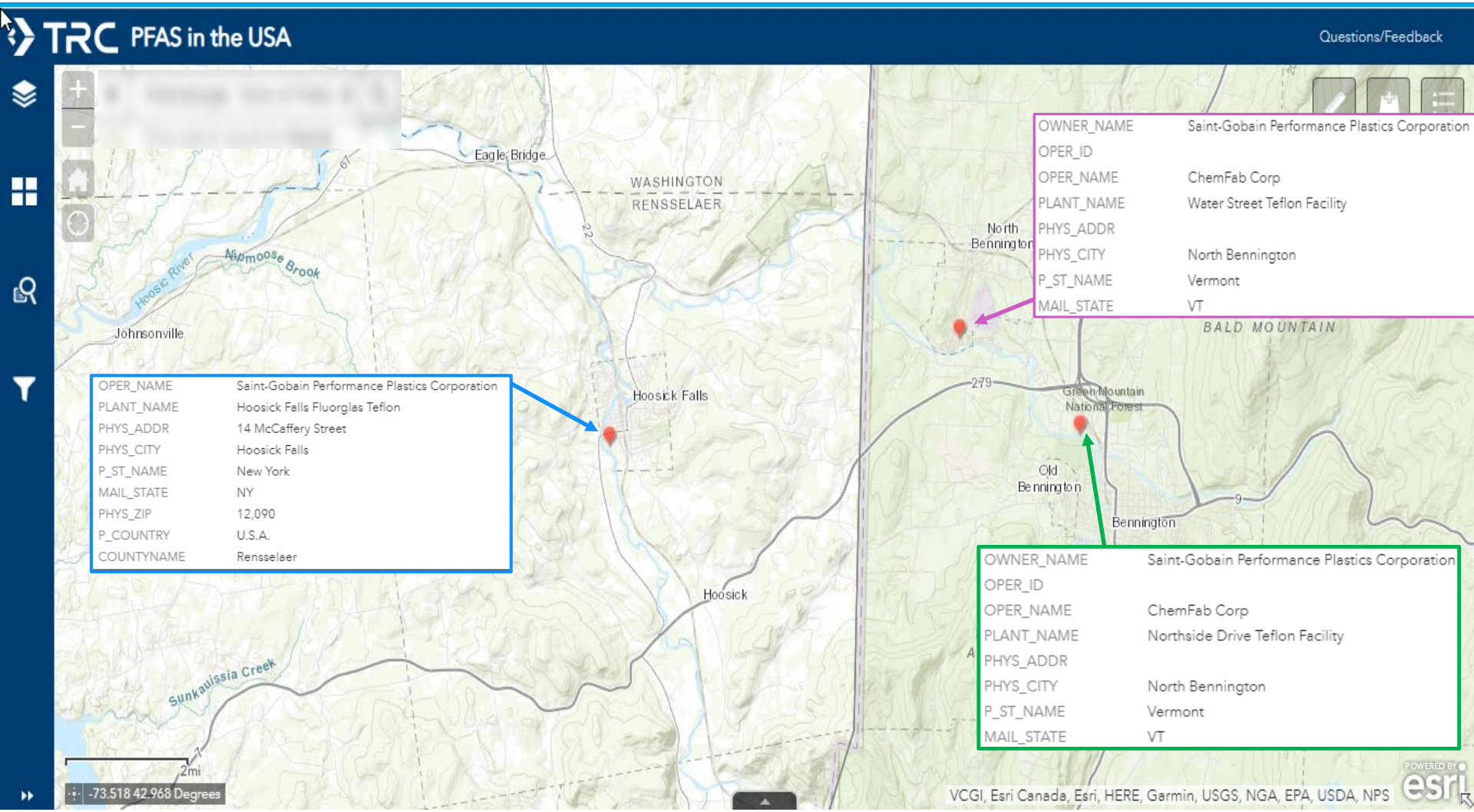
Forensic Analysis of PFAS

Evolving PFAS Databases/Mapping Tools

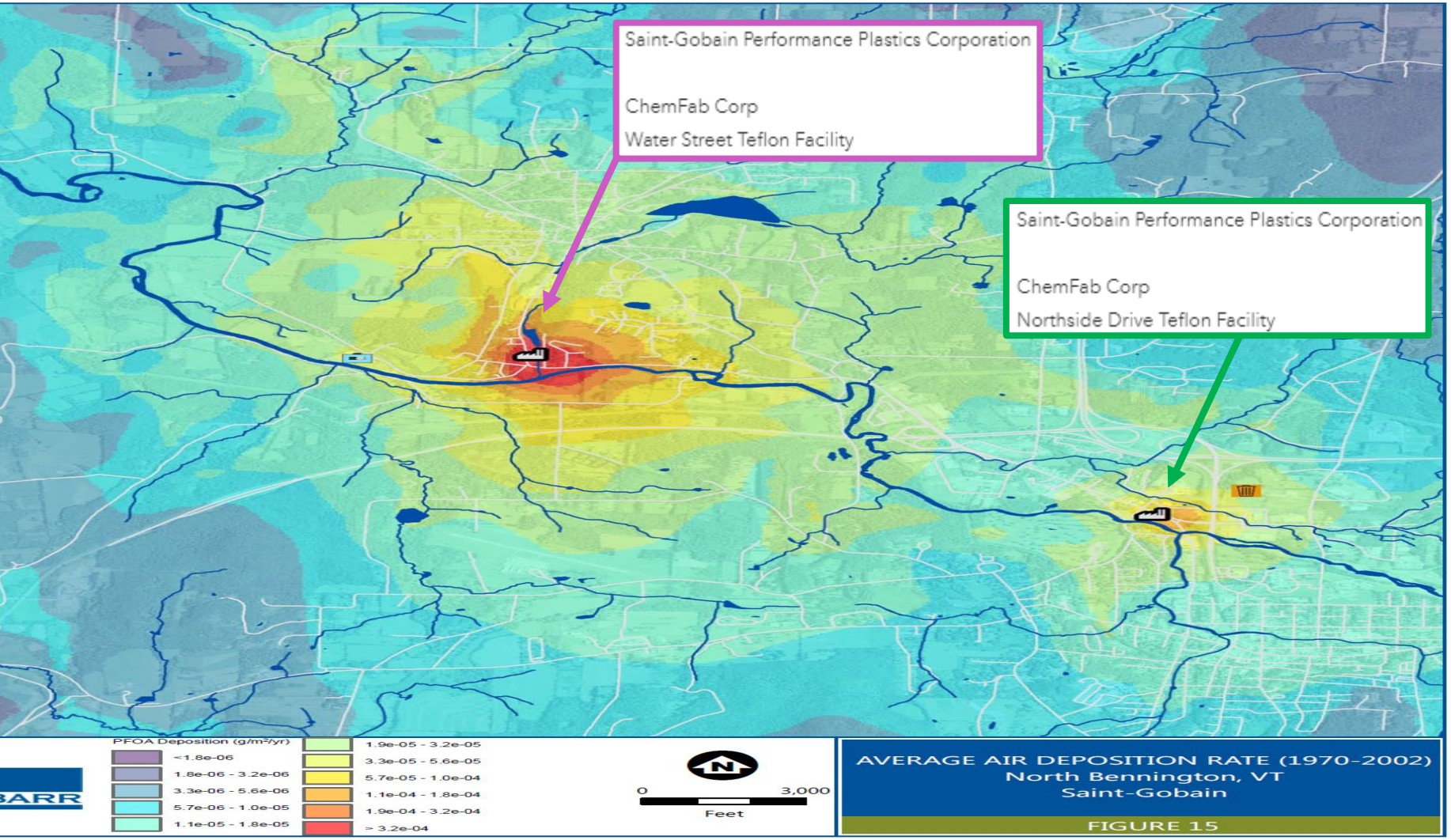


Atmospheric Transport Case Study

Hoosick Falls, NY & N Bennington, VT

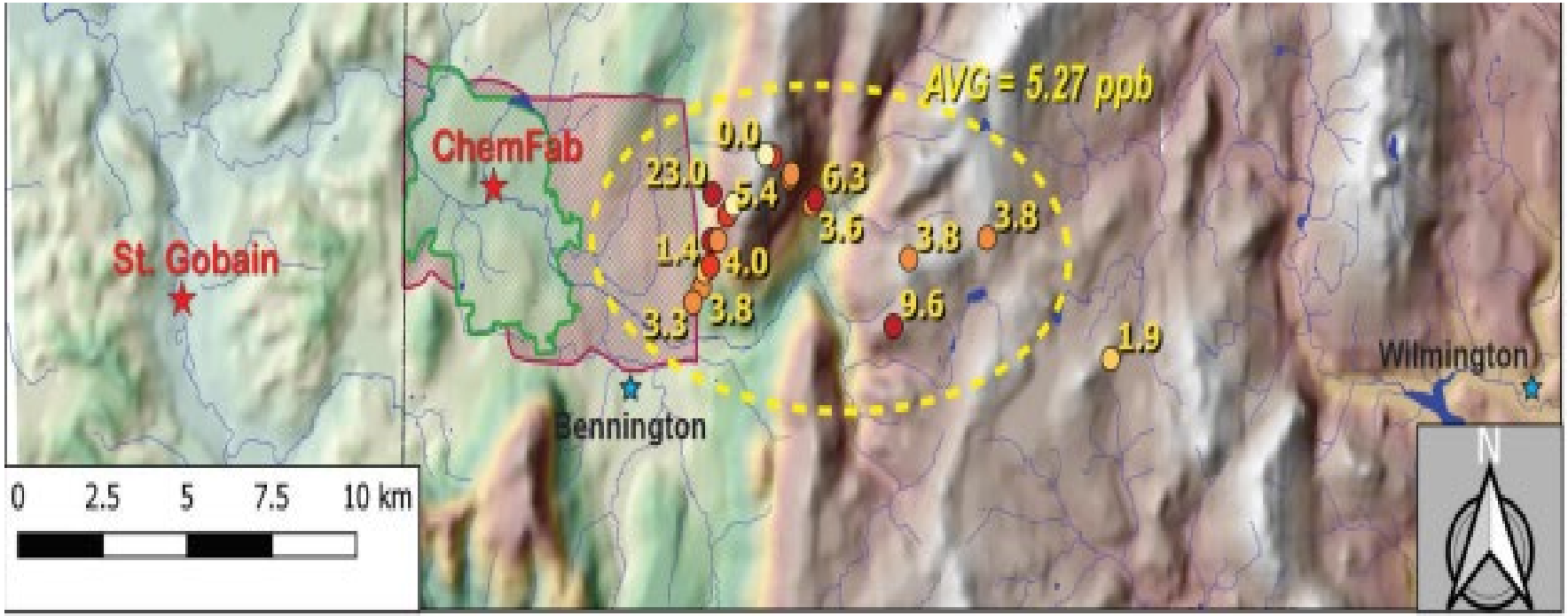


Atmospheric Transport Case Study
Large Deposition Area from Stack Emissions



Source: Draft Conceptual Modeling of PFOA Fate and Transport: North Bennington, VT Report (Barr, 2017)

Bennington College Study
Hoosick Falls, NY & N Bennington, VT



Average PFOA Concentration (dry weight) in top 14 inches of soil. All sampling sites are on land that has not been disturbed by human activity in the past 30 years. Trend shows higher PFOA concentration downwind (east) of manufacturers in Hoosick Falls, NY (St. Gobain) and North Bennington (ChemFab) that used PFOA as a process chemical. Produced by the Understanding PFOA project at Bennington College. Data as of July 24, 218; will be updated as data becomes available. Contact tschroeder@bennington.edu for more information.

RA Challenges Related to Atmospheric Transport of PFAS

- **Evolving or Lack of Regulatory Guidance**
  - Method for sampling & analysis of PFAS in air (stack) emissions on EPA's 2020 calendar
  - Lower EPA priority in modeling PFAS atmospheric fate & transport (EPA anticipates 2022 timeframe)
- **Stakeholder Concerns**
  - Risk management decisions based on site-specific conditions, not defaults
  - General distrust
  - Fear of underestimating risks

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