PFAS Stormwater Management and Groundwater Protection: A Case Study and Implications for Secondary Sources of PFAS to Air

RAMBØLL Bright ideas. Sustainable change.

Authors

Scott Shock, PE; Jaana Pietari, PhD, MBA, PE; Russell Parkman, PE; Robin Snyder, BS, MLS

Background

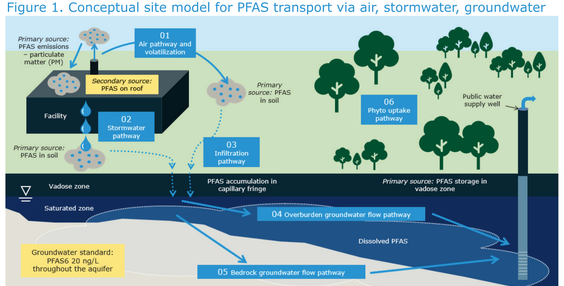
Per and polyfluoroalkyl substances (PFAS) have been widely used in manufacturing and other industrial applications. Many of these industrial applications have the potential to serve as "secondary" sources of PFAS via airborne emissions and may lead to aerial deposition of PFAS, resulting in residual contamination on process equipment, buildings, pavement, and soils.

Transport of deposited PFAS via stormwater can be an important pathway for PFAS migration into the environment, including through runoff to surface water, and infiltration to groundwater. Where air emissions sources of PFAS are present, stormwater management and treatment to remove PFAS may be necessary to protect surface water and groundwater receptors such as surface water intakes or supply wells for drinking water. This poster presents a case study and its implications as to industry sectors and facility locations that may be of interest.

Case Study – Surface Coating Facility

- Fluoropolymer spray coating and oven curing operations led to airborne emissions of PFAS (Figure 1).
- PFAS compounds, particularly PFOA, were identified in a public water supply well near the facility.
- Characterization and source evaluation were implemented, including forensic analyses, to identify and confirm PFAS sources from the facility and elsewhere.
- Airborne emissions of PFAS had affected the facility roof and surroundings.
- Roof runoff was identified as a source of PFAS transport.
- The roof had scuppers that discharged to the ground surface, where PFAS-bearing stormwater had infiltrated into the subsurface, impacting groundwater.
- Groundwater concentrations were above the regulatory threshold for drinking water in many sampling locations.
- Transport and fate modeling was implemented using SESOIL, MODFLOW, and MT3D to determine concentration reduction needed in stormwater to meet groundwater criteria.

Figure 1. Conceptual site model for PFAS transport via air, stormwater, groundwater



- A stormwater capture and treatment system using Granular Activated Carbon (GAC) was designed and installed to meet the drinking water standard in groundwater.

This case study illustrates the importance of:

1. Identifying which secondary sources, including manufacturing facilities that use PFAS, are potentially important air emissions sources of PFAS.
2. Proactively evaluating and addressing air and stormwater transport pathways to control PFAS migration to drinking water supplies.

Evaluation of Secondary PFAS Sources in the United States

To evaluate potentially relevant secondary industrial sources of PFAS, we:

1. Conducted a literature review to identify a selected set of industries known or anticipated to have air emissions.*
2. Identified the most relevant corresponding North American Industry Classification System (NAICS) codes corresponding to these industries.
3. Mapped the locations of this list of NAICS codes that represents secondary manufacturing facilities with a potentially significant PFAS air emissions pathway.

Results and Discussion

Potential secondary sources of PFAS to air (i.e., excluding PFAS manufacturers as "primary" sources) that we identified include:*

- Metals and machining, including chrome plating, spray coatings, etc.
- Textiles and leather production
- Paper and cardboard production, especially with coatings
- Chemicals manufacturing, including paints and coatings, surfactants, etc.
- Plastics and rubber products manufacturing
- Electronics manufacturing, including semiconductors
- Waste combustors and incinerators
- Wastewater treatment plants

A list of NAICS codes that we identified as potential secondary sources of interest is shown in Table 2. This is not anticipated to be an exhaustive list of categories where PFAS air emissions may be of importance. However, it provides a starting place for further evaluation and proactive response by these types of facilities.

The locations of facilities with these NAICS codes (excluding wastewater treatment plants) are shown in Figure 2. Note that further investigation is needed into the NAICS coding of waste combustors/incinerators in Oregon. This illustrates the need for further evaluation of NAICS data for any specific project context.

*Selected References (contact authors for full list):

D'Ambro E, Murphy B. 2021. Modeling PFAS Air Emissions, Deposition, and Chemistry [Webinar]. U.S. Environmental Protection Agency, Office of Research and Development, Center for Environmental Measurement and Modeling. May 18. [accessed 2023 Sep 24]. https://www.epa.gov/air-research/modeling-pfas-air-emissions-deposition-and-chemistry.

Glüge J, Scheringer M, Cousins IT, DeWitt JC, Goldenman G, Herzke D, Lohmann R, Ng CA, Trier X, Wang Z. 2020. An overview of the uses of per- and polyfluoroalkyl substances (PFAS). Environ Sci Process Impacts. 22(12):2345–2373. doi:10.1039/D0EM00291G.

Hamid H, Li LY. 2016. Role of wastewater treatment plant (WWTP) in environmental cycling of poly- and perfluoroalkyl (PFAS) compounds. Ecocycles. 2(2):43–53. doi:10.19040/ecocycles.v2i2.62.

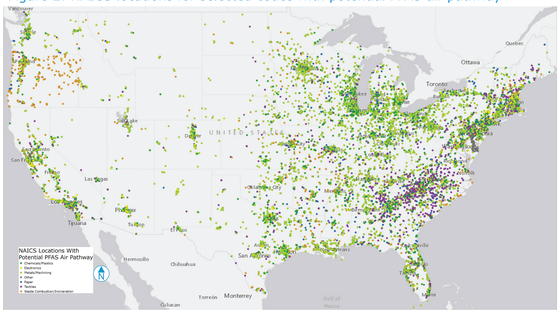
Longendyke GK, Katel S, Wang Y. 2022. PFAS fate and destruction mechanisms during thermal treatment: A comprehensive review. Environmental Science: Processes & Impacts. 24(2):196–208. doi:10.1039/D1EM00465D.

Wickersham LC, Mattila JM, Krug JD, Jackson SR, Wallace MAG, Shields EP, Halliday H, Li EY, Liberatore HK, Farrior S (Mac), et al. 2023. Characterization of PFAS air emissions from thermal application of fluoropolymer dispersions on fabrics. Journal of the Air & Waste Management Association. 73(7):533–552. doi:10.1080/10962247.2023.2192009.

Table 1: Selected NAICS codes with potential PFAS air pathway

2022 NAICS Structure	NAICS Code	NAICS Description
Water, Sewage & Other Systems	221320	Wastewater Treatment Plants
Textile Mills	313110	Fiber, yarn, and thread mills
	313210	Broadwoven fabric mills
	313220	Narrow fabric mills and Schiffli machine embroidery
	313230	Nonwoven fabric mills
	313310	Textile and Fabric Finishing Mills
	313320	Fabric coating mills
Textile Product Mills	314110	Carpet and rug mills
	314910	Textile bag and canvas mills
	314999	All Other Miscellaneous Textile Product Mills
Apparel Manufacturing	315280	Coats, waterproof (e.g. plastics, rubberized fabric, similar materials), rubberizing fabric and manufacturing coats
	315990	Bibs and aprons, waterproof (e.g. plastics, rubber, similar materials), rubberizing fabric and manufacturing bibs and aprons
Leather and Allied Product Manufacturing	316000	Leather and allied product manufacturing
	316110	Upholstery leather manufacturing
	316210	Footwear manufacturing; footwear leather or vinyl upper with rubber or plastic soles manufacturing
	316998	All other leather good and allied product manufacturing; Transmission belting, leather, manufacturing
Paper Manufacturing	322130	Paperboard mills; paperboard coating, laminating or treating in paperboard mills; leatherboard (i.e. paperboard based) made in paperboard mills
	322220	Coating purchased papers for packaging applications; leatherboard made from purchased paperboard; waxed paper
Chemical Manufacturing	325510	Paint and coating mfg; water repellant coatings for wood, concrete, and masonry mfg
	325611	Soap and other detergent manufacturing
	325612	Polish and other sanitation good mfg
	325613	Surface active agent manufacturing
Plastics and Rubber Products Manufacturing	326150	Cushions, carpet and rug, urethane and other foam plastics (except polystyrene) manufacturing
Fabricated Metal Product Manufacturing	332215	Nonstick metal cooking utensils
	332810	Coating, engraving, heat treating and allied activities
	332812	Hot dip galvanizing metals and metal products for the trade; coating of metal and metal products with plastics for the trade; powder coating metals and metal products for the trade
	332813	Electroplating, plating, polishing, anodizing, and coloring; chrome plating metals and metal products for the trade
	332999	All other miscellaneous fabricated metal product manufacturing
Machinery Manufacturing	333249	Surgical and medical instruments and apparatus
Computer and Electronic Product Manufacturing	334413	Semiconductor memory chips manufacturing
Miscellaneous Manufacturing	339112	Medical devices
Waste Management and Remediation Services	562213	Solid waste combustors and incinerators

Figure 2: NAICS locations for selected codes with potential PFAS air pathway



Conclusions

This case example illustrates the importance of:

1. Identifying which secondary sources, including manufacturing facilities that use PFAS, are potentially important air emissions sources of PFAS.
2. Proactively evaluating and addressing air and stormwater transport pathways to control PFAS migration to drinking water supplies.

An evaluation of the literature suggests that proactive evaluation and control of air and stormwater pathways may be particularly important for certain secondary PFAS sources that may have significant air emissions, such as metals and machining, textiles and leather production, paper and cardboard production, chemicals manufacturing, plastics and rubber manufacturing, electronics manufacturing, waste combustors and incinerators, and wastewater treatment.

Although this is not anticipated to be an exhaustive list of categories where PFAS air emissions may be of importance, it provides a starting place for further evaluation and proactive response by these types of facilities.

Contact

Scott Shock, PE
+1 206 336 1668
sshock@ramboll.com

Jaana Pietari, PhD, MBA, PE
+1 978 449 0358
jpietari@ramboll.com

Russell Parkman, PE
+1 978 449 0307
rparkman@ramboll.com

Robin Snyder, BS, MLS
+1 781 779 1628
rsnyder@ramboll.com