THE CLASS OF 1964 POLICY RESEARCH SHOP

CHEMICALS OF CONCERN: ASSESSING THE EFFECTS OF VERMONT S. 25 ON HEALTH, ENVIRONMENT, AND ECONOMY

PRESENTED TO THE VERMONT HOUSE COMMITTEE ON HUMAN SERVICES

Representative Theresa Wood, Chair

This report was written by undergraduate students at Dartmouth College under the direction of professors in the Nelson A. Rockefeller Center. Policy Research Shop (PRS) students produce non-partisan policy analyses and present their findings in a non-advocacy manner. The PRS is fully endowed by the Dartmouth Class of 1964 through a class gift given to the Center in celebration of its 50th Anniversary. This endowment ensures that the Policy Research Shop will continue to produce high-quality, non-partisan policy research for policymakers in New Hampshire and Vermont. The PRS was previously funded by major grants from the U.S. Department of Education, Fund for the Improvement of Post-Secondary Education (FIPSE) and from the Ford Foundation and by initial seed grants from the Surdna Foundation, the Lintilhac Foundation, and the Ford Motor Company Fund. Since its inception in 2005, PRS students have invested more than 70,000 hours to produce more than 200 policy briefs for policymakers in New Hampshire and Vermont.

PRS POLICY BRIEF 2324-03
March 21, 2024

PREPARED BY:
Elizabeth Chun
Aidan Ferrin
Nico Ludkowski

NELSON A. ROCKEFELLER CENTER FOR PUBLIC POLICY AND THE SOCIAL SCIENCES
Contact:
Nelson A. Rockefeller Center, 6082 Rockefeller Hall, Dartmouth College, Hanover, NH 03755
http://rockefeller.dartmouth.edu/shop/ • Email: kristin.e.smith@dartmouth.edu

TABLE OF CONTENTS

EXECUTIVE SUMMARY

In recent years, there has been a growing awareness of the environmental and health concerns posed by Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) and various other chemical families commonly found in consumer products. Vermont State S. 25 seeks to address these concerns; if passed, it would prohibit the manufacturing, sales, and distribution of cosmetic, menstrual, textile, and athletic turf products that include 14 chemical groups known to have adverse effects. In anticipation of the Vermont State House's upcoming vote, we assessed how S. 25 would affect Vermont's environmental health, human health, and economic landscapes, and how the new regulations would disproportionately affect communities of color and vulnerable populations. To answer these questions, we utilized four methodologies: (1) an analysis of existing research on the impact of the chemicals of concern on environmental health, human health, and businesses; (2) case studies of states and regions that have previously passed comparable bills to Vermont S. 25; (3) case studies of extant alternatives to chemical of concern products; and (4) interviews with experts on the chemicals of concern. Ultimately, we synthesized the results into this comprehensive report for the Vermont House of Representatives.

1 INTRODUCTION

There is a growing body of research exposing the harmful health and environmental effects of PFAS and other chemical families, as well as pointing to their widespread presence in drinking water, consumer products, and other sources.[1] Additionally, manufacturers and corporations have faced increased scrutiny in recent years due to burgeoning recognition that these entities often create conditions conducive to harm to both the environment and public health. Chemicals of concern like PFAS are often incredibly widespread and bioaccumulative, building up in both environments and organisms and increasing the likelihood of human exposure. In living tissue, many of these chemicals foster cancers, disrupt endocrine signaling pathways, decrease vaccine response, and affect the development of fetuses and children.

In response to this, there have been recent efforts on both the federal and state levels to trace and regulate these chemicals. Vermont State S. 25, "An Act Relating to Regulating Cosmetic and Menstrual Products Containing Certain Chemicals and Chemical Classes and Textiles and Athletic Turf Fields Containing Perfluoroalkyl and Polyfluoroalkyl Substances," is one of these. S. 25 pinpoints 14 chemical groups—hereafter referred to as "chemicals of concern"—and asserts that, if any amount and any combination of these chemicals of concern is found in a cosmetic or menstrual product for non-necessary reasons, the producer may not manufacture that product, sell, offer for sale, distribute for sale, nor distribute it for use.[2] Additionally, S. 25 extends the aforementioned regulatory frameworks to ski wax, textile, and athletic turf products that contain PFAS.[3] The 14 chemical families of concern are listed in the box below.

S. 25 unanimously passed the Vermont State Senate in April 2023 and now awaits House action. Its passage would likely create complex trade-offs through its varied effects on the environment, public health, and impacted businesses and industries. This report assesses and weighs these potential impacts to provide the Vermont House of Representatives with a comprehensive understanding of the potential costs and benefits tied to S. 25.

14 CHEMICAL FAMILIES OF CONCERN:

1. Ortho-phthalates
2. Isobutylparaben
3. Perfluoroalkyl and polyfluoroalkyl substances (PFAS)
4. Lead and lead compounds
5. Formaldehyde and formaldehyde-releasing agents
6. Asbestos
7. Methylene glycol
8. Aluminum salts
9. Mercury and mercury compounds
10. Triclosan
11. 1,4-dioxane
12. m-Phenylenediamine and its salts
13. Isopropylparaben
14. o-Phenylenediamine and its salts

2 PROBLEM STATEMENT

If passed, Vermont State S. 25 would play a significant part in the effort to curb environmental and public health harms from the chemicals of concern in Vermont. However, regulating harmful chemicals comes at a cost. Namely, these chemicals are integral to many consumer-packaged products, and their restriction could create challenges for affected businesses, industries, and consumers alike. This report seeks to understand these complex trade-offs as they would emerge from the passage of S. 25.

3 METHODOLOGY

Four primary methodological steps were employed to carry out this analysis, with the overall goal of gaining a thorough understanding of the impacts of S. 25 on the health of the environment, human health, and businesses.

3.1 EXISTING LITERATURE ANALYSIS

First, a comprehensive review of existing literature was conducted in an effort to understand the impact of PFAS and other chemicals of concern on three specific disciplines: environmental health, human health, and businesses and industries. Section 6 elaborates on the impacts of the chemicals of concern on the environment. Section 7 elaborates on the impacts of the chemicals of concern on human health, with a specific subsection dedicated to that of marginalized groups. Section 8 elaborates on the significant role of the chemicals of concern in businesses and certain industries. Understanding these manifold contributions—both positive and negative—of the chemicals of concern allows us to set a foundation for comprehensively understanding the potential effects of the bill at hand.

3.2 CASE STUDIES: ANALYSIS OF EXISTING BILLS IN OTHER JURISDICTIONS

Other bills, many similar to Vermont's S. 25, target chemicals of concern in multiple manners, ranging from state-wide bans upon certain concentrations in all products or even all non-necessary uses of PFAS, to bills banning the sale of products with chemicals of concern. Due to the specific and multifaceted nature of S. 25, there are no known bills or laws that target identical subject products and chemicals, so several bills both from the United States and the European Union were located to use as an aggregate comparison for its provisions. These will be used in concert to approximate the tenets of S. 25 and investigate the extent to which there is precedent for this measure. All of the consequent bills will be discussed in further detail later in the brief.

3.2.1 Maine and Rhode Island

Two states have introduced bills prohibiting the sale of all products with non-avoidable uses of PFAS by 2030 and 2032 respectively: Maine's H.P. 1113 and H.P. 138 (which have both become laws), and Rhode Island's House Bill 5673 (which is still in committee).[3] Maine is of special relevance because its geographic location, demographics, and median and per capita household incomes are similar to those of Vermont, making the state a notable proxy for Vermont's bill and context.

3.2.2 New York and Washington State

The second set of bills studied will be New York's A6969 Bill (Safe Personal Care and Cosmetics Act), which is still in committee, and Washington State's House Bill 1047 (Toxic-Free Cosmetic Act). Both focus on the non-PFAS chemicals of concern in cosmetics that Vermont's S. 25 also encompasses.[4] Washington's bill passed on May 15, 2023, and the manufacture and sale ban on cosmetic products with eight harmful chemicals will take effect on January 1, 2025.

3.2.3 The European Union

On February 7, 2023, the European Chemical Agency (ECHA) proposed restrictions on approximately 10,000 individual PFAS chemicals. This move aligns with the EU's sustainability agenda outlined in the October 2020 chemicals strategy, emphasizing the transition to safer and sustainable chemicals. However, the plan's implementation faces challenges, and despite the EU's initial commitment, the absence of the strategy in the 2024 work program suggests potential abandonment, possibly due to the complexity of regulating numerous PFAS compounds and the practical challenges of banning them from essential products.[5]

3.3 CASE STUDIES: PFAS ALTERNATIVES IN INDUSTRY

Manufacturers have developed several alternatives to products containing chemicals of concern with the intent of being more conscious of the environment and human health in the wake of recent findings from the scientific community. Therefore, a comprehensive examination of these alternatives across various industries, including ski wax, textiles, cosmetics, and artificial turfs was conducted to examine their viability, both from an economic and quality standpoint. This aims to elucidate the feasibility and implications of transitioning towards chemical-of-concern-free alternatives in response to S. 25.

3.4 EXPERT INTERVIEWS

Expert interviews were conducted using a semi-structured format, allowing for an in-depth exploration of key topics related to the impacts of chemicals of concern, alternatives, and potential business responses to regulatory policies. Interview questions were designed to elicit expert opinions, insights, and recommendations pertaining to the adoption of safer alternatives free of the chemicals of concern listed in S. 25 and the implications of the proposed Vermont bill.

3.4.1 Celia Chen, PhD

Dr. Celia Chen, a renowned expert in environmental science and policy at Dartmouth College, provided insights into the ecological impacts of PFAS contamination and the feasibility of transitioning to PFAS-free alternatives. Her expertise informed the assessment of the environmental implications associated with PFAS usage and the potential benefits of regulatory interventions.

3.4.2 Megan Romano, PhD

Dr. Megan Romano is an epidemiologist at the Geisel School of Medicine. She studies how exposure to environmental endocrine disrupting chemicals (EDCs)—including PFAS, ortho-phthalates, and parabens—during pregnancy and gestation creates complications, as well as how it affects individuals later in life. Her expertise was invaluable to the understanding of the human health impacts of chemicals of concern both in regard to the human lifespan, as well as the specific fears of communities exposed to these chemicals.

3.4.3 Chelsea Murtha

Chelsea Murtha is the senior director of sustainability at the American Apparel & Footwear Association (AAFA), a conglomerate that represents over 1,000 brands ranging from Calvin Klein to the American Textile Company. She offered invaluable perspectives regarding industry advocacy and regulatory compliance related to alternatives for chemicals of concern, informing our analysis of business dynamics, stakeholder concerns, and the potential impacts of legislation on both product quality and consumers.

4 BACKGROUND

4.1 FEDERAL POLICY LANDSCAPE

In April 2021, the Environmental Protection Agency (EPA) established the EPA Council on PFAS in order to develop a strategy to protect public health and the environment from the impacts of PFAS.[6] Additionally, in October 2021, the EPA announced the "PFAS Strategic Roadmap," which charts the

EPA's specific plans to regulate PFAS through 2024. In the Roadmap, the EPA highlights three key goals:

1. **Research:** Invest in research, development, and innovation to increase understanding of PFAS exposures and toxicities, human health and ecological effects, and interventions that incorporate the best available science.
2. **Restrict:** Pursue a comprehensive approach to proactively prevent PFAS from entering air, land, and water at levels that can adversely impact human health and the environment.
3. **Remediate:** Broaden and accelerate the cleanup of PFAS contamination to protect human health and ecological systems.

Given that PFAS remains widely used in numerous industries, the EPA seeks to follow the Roadmap to enact regulations focused not only on mediating the downstream effects of PFAS pollution but also on looking upstream to prevent further PFAS from newly entering the environment. The Roadmap states the EPA's intention to "impose appropriate limitations on the introduction of new, unsafe PFAS into commerce and … use all available regulatory and permitting authorities to limit emissions and discharges from industrial facilities."[7]

Under the Biden-Harris administration, the EPA has actively begun taking steps toward these goals. In January 2022, the EPA submitted an initial plan to the White House Office of Management and Budget (OMB) to designate two PFAS, Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonic Acid (PFOS), as hazardous substances under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).[8] In October 2023, the EPA released a final rule that will improve PFAS reporting to the Toxic Release Inventory by eliminating an exemption that allows facilities to avoid reporting PFAS levels when they use those chemicals in small concentrations.[9] Furthermore, in March 2023, the EPA announced its proposal of a National Primary Drinking Water Regulation (NPDWR) under the Safe Drinking Water Act to establish health-protective nationwide levels for six PFAS known to occur in drinking water.[10]

These EPA actions are necessary steps toward the safe national management of PFAS, but they are still limited in scope: they do not regulate harmful chemicals beyond PFAS, and they do not regulate PFAS levels in industrial production and consumer products. Thus, these gaps leave room for states to create their own regulations.

4.2 VERMONT POLICY LANDSCAPE

On the state level, Vermont previously enacted Bill S. 20 (referred to in this report as "Law S.20" for clarity) in May 2021 to restrict PFAS, bisphenols, and ortho-phthalates in certain Class B firefighting foams, personal protective equipment (PPE), food packaging products, rugs, carpets, aftermarket water- and stain-fighting products, ski wax, and substances deemed harmful to children.[11] After being introduced to the Vermont State Senate on January 13th, 2021, Law S. 20 followed a fairly typical process of amendments before being unanimously passed to the House on March 19th.[12] The 145 members of the Vermont State House also passed the bill unanimously in early May, and it was signed into law by Governor Scott on May 19th, 2021.[13] As of January 1st, 2024, all components of Law S. 20 have come into effect, but there has not been sufficient time to analyze outcomes of the bill as of the current date.

S. 25 builds upon Law S. 20, expanding chemical regulations into new product categories. Specifically, S. 25 is designed to target those products that come into direct contact with the bodies of consumers, while Law S. 20 targets safety and packaging equipment as well as textiles that do not directly contact bodies.[14] S. 25 unanimously passed the Senate in April 2023 and now awaits House action.

4.3 CHEMICALS OF CONCERN IN S. 25

S. 25 identifies 14 chemical families of concern as subjects for regulation. In aggregate, these comprise nearly 20,000 individual chemical compounds. PFAS, which constitutes one of the chemical families of concern, alone includes more than 15,000 individual chemical compounds.[15] Additionally, the chemical families of concern can be characterized as those that build up in the body or environment over time and cause chronic harm—i.e., "forever chemicals"—versus those that cause harm more acutely. Of the 14 chemical families of concern included in S. 25, only PFAS are considered forever chemicals. Given this property and the unique pervasiveness of PFAS,[16] we will address PFAS separately from the 13 other chemical families of concern throughout this report.

4.3.1 PFAS: Physical Properties

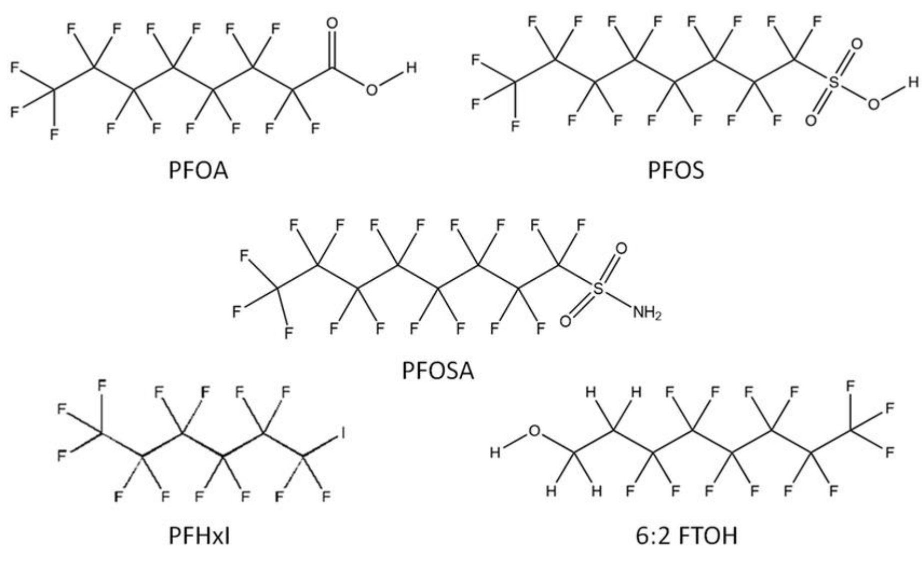

Figure 4.3.1. Structures of Five PFAS Showing C-F Chain and Alkyl Groups[17]

Per- and polyfluoroalkyl substances (PFAS) are a class of manmade chemicals that are named so due to their structure: a carbon-fluorine chain in the form of an alkyl group, a polyatomic ion consisting of carbon and hydrogen in specific ratios. The carbon-fluorine bond is the strongest in all of organic chemistry, as well as the fourth strongest between any two single atoms, and therefore PFAS are incredibly resilient to degradation.[18] All PFAS are non-polar—that is they have no biased distribution of electric charge—and therefore are water-soluble, which allows them to interact uniquely with both organisms and the environment.[19]

PFAS can be characterized as short-chain and long-chain groups based on the number of constituent carbon atoms, with the latter having six or more.[20] This chain length contributes to the physical properties of different PFAS; those with shorter chains typically take liquid forms at room temperature, whereas longer-chain PFAS are typically crystalline and powdery in the same conditions.[21]

4.3.2 Non-PFAS Chemicals of Concern: Physical Properties

S. 25 pinpoints 13 chemical families of concern beyond PFAS. These include elemental compounds like lead, mercury, and aluminum salts, as well as more complex structures such as isopropylparaben and ortho-phthalates. Specifically, the 13 chemical families of concern are listed in the table below.

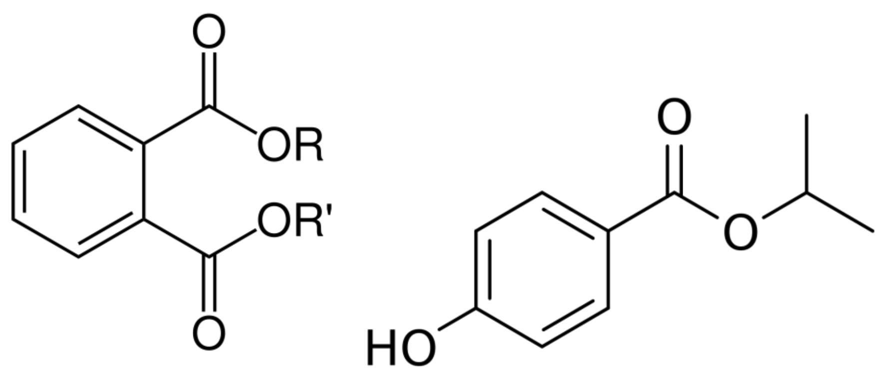

Figure 4.3.2. Base Structure of an Ortho-phthalate (left) and Full Structure of Isopropylparaben (right)

TABLE 4.3.2

Descriptions of 13 non-PFAS chemical families of concern addressed in Vermont S. 25

	NAME	DESCRIPTION
1	Ortho-phthalates	Organic compounds with a phthalate structure, consisting of a benzene ring and two ester functional groups, found most commonly in vinyl products
2	Formaldehyde and formaldehyde-releasing agents	Formaldehyde is a simple organic compound with the structure HCHO while formaldehyde-releasing agents are compounds that release formaldehyde over time.

		They are found occasionally in building materials, lacquers, and glues, as well as tissue preservatives
3	Methylene glycol	A chemical compound with two hydroxyl (OH) groups attached to a methylene (CH_2) unit, found commonly in hair-smoothing products
4	Mercury and mercury compounds	Mercury is a metallic element, while mercury compounds are chemical compounds that include mercury atoms bonded to other elements. It is no longer commonly used but can be encountered via contaminated organisms, typically fish
5	1,4-dioxane	A heterocyclic organic compound with a five-membered ring containing two oxygen atoms, found most often in detergents and shampoos
6	Isopropylparaben	A paraben with an ester structure where an isopropyl group is attached to a para-hydroxybenzoic acid moiety, found most commonly in bath and body care products
7	Isobutylparaben	A paraben with an ester structure where an isobutyl group is attached to a para-hydroxybenzoic acid moiety, commonly found in bath and body care products
8	Lead and lead compounds	Lead is a heavy-metal element, and lead compounds consist of lead atoms bonded to other elements. It is no longer commonly found but has historically been used in the creation of paints, ceramics, cosmetics, and leaded gasoline
9	Asbestos	A group of naturally occurring minerals with a fibrous structure, including chrysotile, amosite, and crocidolite. It is no longer used but can be found in older paint, insulation, and floor tiles
10	Aluminum salts	Compounds containing aluminum ions bonded to various anions, found commonly in talc, clay, perlite, and products that contain these substances
11	Triclosan	An organic compound with a phenolic structure, found commonly in antibacterial soaps and hand sanitizers
12	m-Phenylenediamine and its salts	Aromatic compounds with amino groups (NH_2)

		attached to a phenylene ring, existing in the meta (m-) position, depending on the relative positioning of the amino groups. It can be found in textiles, leathers, and hair dyes
13	o-Phenylenediamine and its salts	Aromatic compounds with amino groups (NH_2) attached to a phenylene ring, existing in the ortho (o-) position, depending on the relative positioning of the amino groups. It can be found in dyes, pigments, and fungicidal products

PFAS and other chemicals of concern have manifold impacts on the environment, human health, and certain industries. Section 5 begins by investigating bills similar to Vermont S. 25 that have been raised in Maine, Rhode Island, New York, Washington State, and the European Union; these bills provide a context in which to understand S. 25. The subsequent sections delve into S. 25 and its effects. Section 6 centers on the environment, exploring the negative environmental impacts caused by the chemicals of concern (Section 6.1) and the effectiveness of S. 25 in addressing these concerns. Section 7 centers on human health, exploring the negative human health impacts caused by the chemicals of concern (Section 7.1) and the effectiveness of S. 25 in addressing these concerns. Section 8 centers on the market, exploring the role that the chemicals of concern play for businesses and industries (Section 8.1) and the impact of S. 25 on these businesses and industries and their consumers (Section 8.2). Finally, Section 9 discusses the need to protect communities of color and marginalized populations from bearing disproportionate burdens due to the bill.

5 INVESTIGATION OF SIMILAR BILLS

Across multiple other states and nations, several bills have recently been proposed or adopted that possess similar characteristics to S. 25. The following section will analyze and discuss selected bills from four states and the European Union.

Importantly, there are a few limitations to these case analyses. First, no single bill regulates the same chemicals or products identically to S. 25; however, each of these selected bills contains elements that make them valuable comparisons to S. 25. Second, among the bills that have passed, very few have currently gone into effect; furthermore, those that have taken effect have not been in effect for a long enough duration to allow for published research on their effects. It is consequently not yet possible to effectively discern the impacts of such legislation.

Thus, we analyze these similar bills not to understand their effects, but to understand the circumstances in which they were passed, the specific provisions that they include (which may provide insight into the provisions of S. 25), and any challenges that arose during their development and passage. Additionally, the section demonstrates that other states and even nations are similarly concerned about these chemicals and products and that regulatory steps are already being taken in regions beyond Vermont.

5.1 MAINE

Maine's H.P. 1113, "An Act to Stop Perfluoroalkyl and Polyfluoroalkyl Substances Pollution," is of particular importance when considering S. 25, as Maine and Vermont share many geographic, demographic, and economic similarities, leading to parallels between the potential impacts from similar policies.[22]

H.P. 1113 was passed in April 2021 and later amended in June 2023 with H.P. 138 "An Act to Support Manufacturers Whose Products Contain Perfluoroalkyl and Polyfluoroalkyl Substance."[23,24] The latter granted manufacturers of products with intentionally added PFAS until January 1, 2025, to submit a notification to the State describing the product using an estimate of the number of units sold in the state and nationally, as well as the amount of contained PFAS (or organic fluorine) and its purpose.[25] Manufacturers (barring some exceptions) who fail to do this will be banned from selling or distributing products with intentionally added PFAS.[26] The combined bills also ban the sale of all products with intentionally added PFAS by January 1, 2030, save for situations in which the use of PFAS has been determined unavoidable, or the product containing PFAS has been previously used and is resold.[27] Additionally, H.P. 1113 states that the government will implement a "PFAS source reduction program" to reduce PFAS discharges into the environment, encourage safer alternatives to PFAS, educate the public and corporations, and provide grants to publicly owned treatment works to develop and expand pretreatment processes.[28]

5.2 RHODE ISLAND

Rhode Island is another small-population New England state with a bill—H.B. 5673, "Comprehensive PFAS Ban Act of 2023"—that proposes a complete ban of all uses of PFAS (except if considered unavoidable), in this case by December 31st, 2032; it is currently being held for further study. The ban does not apply to the sale or resale of used products but does ban the sale of any product containing intentionally added PFAS after January 1, 2025.[30] On this date, the manufacturing and sale of outdoor apparel for severe wet conditions containing PFAS is also banned unless there is a label stating that the specific product in question is "made with PFAS chemicals," ultimately to phase out these products with intentionally added PFAS by January 1, 2028.[31] This bill would impact a broader scope of products than VT S. 25 since it is a ban on all PFAS-containing products.

Rhode Island's bill contains a measure similar to Maine's, requiring manufacturers of any products with intentionally added PFAS sold in RI to register by Jan 1 2026 such products on a publicly available database with the amount and type of PFAS compounds, their intended purposes, the amount of products imported and sold in RI during the previous calendar year, and the manufacturer's contact information. A common theme among these bills is increasing the amount of information available to the public about PFAS-containing products. RI's bill also does not contain a "sell-through" provision, which ensures a period of time for manufacturers with leftover stock of these banned products to sell them off before the ban on sale takes effect.[33]

5.3 NEW YORK

New York's State Assembly bill A6969 is a bill currently under discussion in the Committee on Environmental Conservation. The "Safe Personal Care and Cosmetics Act" proposes a ban on personal care and cosmetics products that contain any of a list of restricted substances as a functional ingredient, and also bans products that contain these substances as nonfunctional byproducts or contaminants as a result of manufacturing at a level above the "practical quantification limit"[33] The practical quantification limit is defined as the lowest possible amount of the restricted substance that can be reasonably achieved given the limits of precision and accuracy in "routine laboratory operating conditions."[34] Manufacturers have a two-year period to phase out these products, as the ban will go into effect two years after the bill does.[35] The bill aims to bring New York's cosmetics regulations closer in line with those of the European Union which prohibits substances categorized as "carcinogenic," "mutagenic," or "toxic" from being in cosmetics.[36] The list of restricted substances is very similar to the chemicals of concern enumerated in S. 25, such as PFAS, orthophthalates, formaldehyde and formaldehyde releasers, parabens, lead and lead compounds, triclosan, and asbestos.[37] Therefore, this bill is a solid proxy for the cosmetics provision of S. 25.

5.4 WASHINGTON STATE

Washington House Bill 1047, "Concerning the use of toxic chemicals in cosmetic products" passed on May 15, 2023, and took effect on July 23. While it is too soon to see the general effects of the bill, we think it is still worthwhile to include it in this section. The law prohibits the manufacturing, distribution, or sale of cosmetic products containing intentionally added ortho-phthalates, PFAS, formaldehyde and formaldehyde-releasing chemicals, methylene glycol, mercury and mercury compounds, triclosan, m-phenylenediamine and its salts, and o-phenylenediamine and its salts.[38] This bill does contain a sell-through provision, which grants in-state retailers with these restricted products until January 1, 2026, to sell and exhaust their stock.[39]

Another provision of interest is the requirement that by June 1, 2024, the Departments of Ecology and Health must assess the hazards of other chemicals that serve the same or similar functions in cosmetics as the banned chemicals and make that information public.[40] Additionally, by May 2024 the Department of Ecology is required to implement an initiative to support small cosmetic manufacturing businesses to get environmental health certifications from the EPA or other organizations for their products, which are designed to identify products without the identified hazards. The initiative would provide technical support, resources for hazardous chemical assistance, and resources to reformulate products using safer alternative chemicals.[41] Similarly, another initiative will support independent cosmetologists and small businesses that provide cosmetology services to transition to using safer products. The support would provide resources to find safer alternatives and/or financial incentives to replace products containing toxic chemicals with safer alternatives.[42]

5.5 EUROPEAN UNION

The European Chemical Agency (ECHA) proposed a restriction for around 10,000 PFAS chemicals on February 7, 2023.[43] Additionally, in October 2020, the European Union (EU) created a chemicals strategy for sustainability, which discusses a need to transition to safer and more sustainable chemicals, but also notes that this transition has taken longer than expected and requires stronger policy and financial support.[44,45] The plan also has designs to ensure that "consumer products do not contain chemicals that cause cancers, gene mutations, affect the reproductive or the endocrine system, or are persistent and bioaccumulative" except if their uses are unavoidable (which is the case for some uses of PFAS).[46] However, it appears that the EU may have abandoned this plan since it is not mentioned in the European Commission's 2024 work program.[47] This could be due to the difficulty of carrying out the ban when so many products, especially those in green tech or medical fields, utilize these toxic chemicals and require them to function. The sheer number of PFAS compounds the restriction attempts to regulate increases the difficulty of implementation.

6 ENVIRONMENTAL HEALTH

6.1 IMPACT OF CHEMCIALS OF CONCERN ON ENVIRONMENTAL HEALTH

6.1.1 PFAS

PFAS are utilized by various businesses and industries. During production and use, PFAS migrate into the surrounding soil, water, and air. They also tend to accumulate in animals through the contamination of entire food chains.[48,49,50] As a result, PFAS have become ubiquitous in the natural environment, with relevant concentrations having been detected in the air, groundwater, freshwater, marine water, drinking water, and soil.[51] They have been found across continents and oceans, and even in remote parts of the globe where no direct sources are identified, including Himalayan mountaintops and the North and South Poles.[52] Ecosystems in regions including the U.S., China, Africa, and Europe are impacted by PFAS,[53,54,55,56,57] and the presence of PFAS has also been recorded in aquatic systems, flora, and fauna globally.[58]

Further contributing to PFAS' pervasiveness, their strong carbon-fluorine bond makes them incredibly degradation-resistant.[59] In addition, PFAS are extremely atmospherically transferable, causing them to move quickly through the environment before their contamination can be contained.[60] PFAS are also highly mobile in non-atmospheric conditions and easily permeate into the soil and groundwater once extant in a particular environment.[61]

Figure 6.1.1. illustrates the various pathways through which PFAS enter and travel through the environment to impact both aquatic and terrestrial ecosystems.

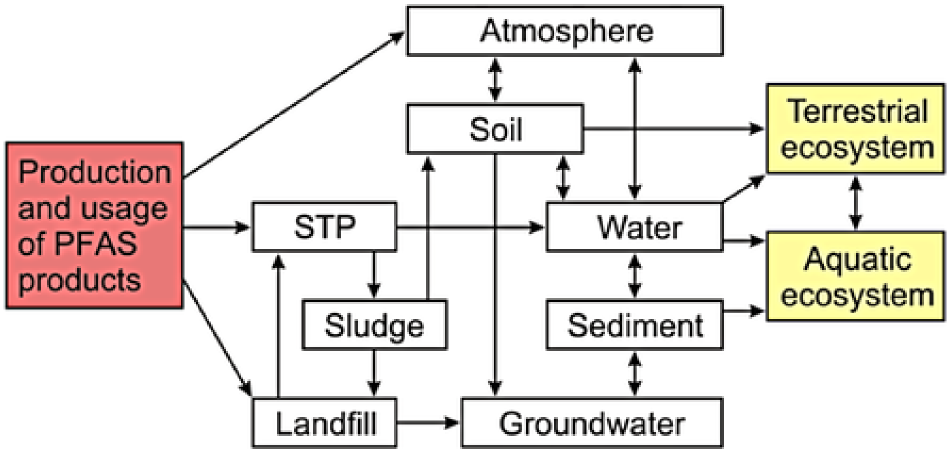

Figure 6.1.1. Pathways of PFAS in the Environment [62]

Research has demonstrated that the presence of PFAS has harmful effects in both aquatic and terrestrial ecosystems. To expand upon the former, there is significant concern about PFAS in aquatic ecosystems because water is one of the main pathways for human exposure (the health effects of PFAS on humans are further discussed in Section 5). For instance, the detection of PFAS compounds such as perfluoroalkane sulfonates (PFSAs) and perfluoroalkyl carboxylates (PFCAs) in water samples at various locations—including Europe,[63,64] China,[65,66] the U.S.,[67] Brazil,[68,69] France,[70] and Spain[71]—has raised health concerns. Other PFAS compounds, such as perfluorohexanoic acid (PFAxA),[72] perfluorooctanesulfonamide (PFOSA),[73] and perfluorinated phosphonic acids (PFPAs),[74] have also been commonly detected in water samples. Moreover, the occurrence of PFAS in water is particularly concerning because traditional sewage treatment plants (STPs) are currently unable to eliminate PFAS from water through common water treatment processes.[75] There are three treatment processes for PFAS labeled as effective by the EPA: granular activated carbon, ion exchange resins, and high-pressure membrane systems.[76] They are all expensive to implement.

In terrestrial ecosystems, one of the foremost concerns is PFAS release and carryover by plants as well as the possibility of PFAS permeating underneath soil layers and groundwater. There is evidence that PFAS can deteriorate soil quality by disturbing soil enzyme activity, altering microbial availability, and damaging enzyme cellular structures.[77,78,79] Although using reagents such as clay and Portland cement seem like promising techniques for soil remediation, they do not provide definite techniques for eliminating PFAS permanently.[80] Finally, PFAS uptake by plants poses the risk of PFAS traveling up the food chain to reach humans.[81]

6.1.2 Non-PFAS Chemicals of Concern

The chemicals of these 13 families of concern are used in countless industries for a diverse range of purposes. Some notable or common industries and processes include plastics manufacturing, general preservation procedures, and solvent stabilization.[82,83] While the diversity and number of these chemicals of concern ensure that there is no single manner in which the environment is affected by their presence, some key concerns will be elaborated upon below.

Mercury is considered a "global pollutant" due in large part to the ability of elemental mercury (as opposed to mercury compounds) to circulate in the atmosphere for periods as long as one year before deposition, traveling immense distances from where it was produced.[84] In all forms, mercury has large impacts on aquatic ecosystems specifically, as it can both bioaccumulate and bioconcentrate in organisms at all echelons of the food chain. Each permutation of mercury is toxic in unique manners, but in regards to the consumption of both inorganic and organic mercury compounds by animal species, damage to the kidneys, clotting factors, spinal cord, and brain are potential consequences.[85]

Triclosan is a broad-spectrum antimicrobial and preservative agent present throughout a range of soaps, cosmetic products, athletic gear, and food packaging. Up to 96 percent of the triclosan present in products is rinsed down drains and ends up in the local water column before eventually entering the soil; therefore the compound has been historically scrutinized for detrimental health impacts.[86] The compound is not acutely toxic to mammals, but has chronic effects of tumorigenesis, especially of the liver.[87] It is also incredibly bacteriotoxic to a diverse range of algae and photosynthetic eukaryotes crucial to the health of many aquatic ecosystems.[88] Triclosan also appears to contribute to the tendency of bacteria to develop multidrug resistance.[89]

6.2 EFFECTIVENESS OF S. 25 IN IMPROVING ENVIRONMENTAL HEALTH

PFAS and the other chemicals of concern enter the environment when they are used in manufacturing processes or when products containing them are circulated.[90] By banning the chemicals of concern in several popular consumer packaged goods (cosmetic, menstrual, ski wax, textile, and athletic turf products), S. 25 ensures that the production and circulation of these product types will no longer contribute to the proliferation of the chemicals of concern in the environment.

While this is one aspect to curb the number of detrimental products, it is important to recognize that S. 25 only addresses the *production* and *circulation* of these products. It does not address their *disposal*. The lack of a disposal strategy has the potential to further exacerbate environmental contamination, and there are many products in the aforementioned product categories that contain the chemicals of concern and are currently either on the market or undergoing production. Thus, if S. 25 goes into effect, it will be important to concurrently develop a strategy for safely disposing of these products so that the chemicals of concern are kept under control.[91] The lack of a safe chemical disposal strategy could cause the chemicals of concern to seep directly into waterways and the natural environment, potentially spawning even worse environmental harm than that which would result in the absence of S. 25.[92]

7 HUMAN HEALTH

7.1 IMPACT OF CHEMICALS OF CONCERN ON HUMAN HEALTH

7.1.1 PFAS

People can be exposed to PFAS in several ways. These include working in occupations such as firefighting or chemicals manufacturing and processing; eating certain foods that may contain PFAS, including fish; swallowing or inhaling contaminated soil or dust; breathing in air that contains PFAS; using products that are made with PFAS or packaged in materials containing PFAS; and drinking water that is contaminated.[93] Specifically regarding exposure via products, PFAS are most commonly found in cleaning products, water-resistant fabrics (rain jackets, umbrellas, and tents), grease-resistant paper, nonstick cookware, personal care products (shampoo, dental floss, nail polish, and eye makeup), and stain-resistant coatings typically used on carpets, upholstery, and other fabrics.[94] These products all use PFAS as a fluoropolymer coating, a substance that is notably resistant to heat, oil, stains, grease, and water, and therefore serves as an incredibly comprehensive protective agent for typically sensitive products.[95] These products are also incredibly widespread in their use and presence in households, thus explaining the near ubiquity of human contact with PFAS.[96]

Given this, it is likely that all individuals have some concentration of PFAS in their bodies, and roughly three percent of individuals in the United States (over 10 million people) are thought to harbor concentrations of PFAS that are above safety limits.[97] Current scientific research strongly suggests that exposure to certain PFAS can cause many adverse health outcomes in humans, including cancers, immune deficits, and negative metabolic effects, particularly dyslipidemia (abnormally elevated cholesterol or other lipids in blood).

For one, research has suggested that PFAS are carcinogens. The strongest evidence for this increased cancer risk comes from studies among individuals who have been exposed to high levels of PFOA due to employment in a PFAS-producing chemical plant or residence in a community with contaminated drinking water. These studies have demonstrated a positive association between PFOA levels and kidney and testicular cancer.[98,99,100] Furthermore, among surveyed populations, heightened concern revolves primarily around the elevated cancer risk associated with PFAS exposure, particularly concerning children within affected communities.[101]

Additionally, the immunotoxicity of PFASs has been demonstrated in multiple animal models, including rodents, birds, reptiles, and other mammalian and non-mammalian wildlife. The immunotoxic effects in these laboratory animal models have occurred at serum concentrations comparable to body burden levels for highly exposed humans.[102] Although there are fewer epidemiological studies on humans available, findings from animal models have been corroborated by the existing body of epidemiological work. These studies have shown that health outcomes related to PFAS immunotoxicity occur at both the molecular level (i.e., negative impact on antibody concentrations)[103,104] and organ or system level (i.e., higher rates of infection of the respiratory system).[105] Research has also linked PFAS exposure to immune function deficits in children in particular, with one study reporting that a two-fold increase of major PFASs in child serum was associated with a nearly 50 percent decline in tetanus and diphtheria antibody concentration.[106] Further work has also found similar associations in PFAS exposure and other childhood vaccinations such as rubella and mumps,[107,108] as well as adult influenza vaccinations such as FluMist[109] and anti-H3N2.[110]

Thirdly, many studies have consistently found associations between elevated PFAS levels and detrimental lipid profiles, such as elevated total cholesterol and low-density lipoprotein cholesterol (LDL-C), or reduced high-density lipoprotein cholesterol (HDL-C).[111,112,113] While research has also investigated the impact of PFAS exposure on glucose metabolism, insulin resistance and diabetes, hypertension, and other vascular diseases, thyroid disease, cardiovascular diseases, uric acid metabolism, and body weight, these results have been inconclusive thus far.

Notably, the risk of health effects associated with PFAS depends on exposure factors (e.g., dose, frequency, route, duration), individual factors (e.g., sensitivity and disease burden), and other determinants of health (e.g. access to safe water and quality healthcare).[114] Research is still ongoing to determine how different levels of exposure to different PFAS can lead to a variety of health effects. Research is also underway to better understand the health effects associated with low levels of exposure to PFAS over long periods, especially in children.[115]

7.1.2 Other Chemicals of Concern

General themes of the human health impacts of the 13 chemicals of concern families include those upon the endocrine system and hormones—especially testosterone and those related to pregnancy—child growth and development, cancer growth, and organ damage.[116,117] However, the diversity and number of these compounds ensure that there is no single manner in which the human body is affected by their presence, and therefore only several will be elaborated upon here in detail.

Mercury is most commonly encountered by humans as the compound methylmercury, the form most readily absorbed by shellfish and seafood, the consumption of which is the most common manner of exposure.[118] Methylmercury is a potent neurotoxin that affects distal nerves relating to the hands, feet, and extremity muscles before eventually impacting speech, vision, and audition.[119] Methylmercury also profoundly affects fetal and neonatal development, eventually leading to deficits in cognition, language, memory, fine motor skills, attention, and visuospatial skills.[120]

Triclosan primarily enters the human body via ingestion and skin absorption, especially due to the use of mouthwash and skin care products, generally those with antibacterial properties.[121] The compound acts as an endocrine disruptor, causing excess production and activity of thyroid hormone-clearing enzymes, and interacts in as-of-now unknown manners with genes related to drug processing.[122] It also dramatically localizes to the liver, where it may assist with the development of tumors.[123] Furthermore, triclosan may have specific impacts on pregnant mothers and fetuses in gestation, resulting in low birth weight, decreases in head circumference, pregnancy complications, and impacts on physical growth and neurodevelopment that persist well into childhood.[124]

7.2 Effectiveness of S. 25 in Improving Human Health

The products covered in the jurisdiction of Bill S.25 are those that are common in most households, used by many members of the public, and/or come in direct or close physical contact with people's bodies. Thus, their regulation could be expected to lessen the risk of health issues due to the chemicals of concern.

S. 25 would also be an important step in the broader ongoing process of "turning off the tap" and gradually decreasing people's overall exposure to the chemicals of concern in Vermont.[125] In particular, the bill's regulation of consumer-packaged goods complements recent legislation that has been passed in Vermont to regulate PFAS in drinking water. In 2019, Act 21 (S. 49) required that all public community water systems and all nontransient noncommunity water systems conduct monitoring for the maximum amount of PFAA that can be detected using standard analytical methods. The act legislated that, after initial monitoring, water systems must conduct quarterly monitoring if they were detected to have PFAS contaminants at or above 20 parts per trillion (ppt); conduct annual monitoring if they were detected to have PFAS contaminants at or above 2 ppt but below 20 ppt; conduct monitoring every three years if they were detected to have PFAS contaminants below 2 ppt; and act to implement PFAS-reducing treatment if they were detected to have PFAS contaminants in excess of 20 ppt.[126,127] These two regulations would work together to target both products and drinking water, two of the primary sources through which people are exposed to PFAS and the other chemicals of concern.

8 THE MARKET: BUSINESSES, INDUSTRIES, AND CONSUMERS

8.1 ROLE OF PFAS AND OTHER CHEMICALS OF CONCERN FOR BUSINESSES AND INDUSTRIES

PFAS and other chemicals of concern have been utilized in consumer products and manufacturing processes since around the 1940s. They are useful in various industrial and commercial applications, including but not limited to clothing, cosmetics, cookware, and firefighting foam. PFAS are particularly useful due to the extreme strength of their carbon-fluorine bonds and their water-, stain-, and grease-resistant properties.[128]

The following list is a non-comprehensive highlight of the range of product classes where PFAS and other chemicals of concern can be found:

1. **Fire extinguishing foam:** In aqueous film-forming foams (AFFFs) are used to extinguish flammable liquid-based fires. Such foams are used in training and emergency response events at airports, shipyards, military bases, firefighting training facilities, chemical plants, and refineries.
2. **Manufacturing and chemical production facilities that produce or use PFAS:** For example, chrome plating, electronics, and certain textile and paper manufacturers.
3. **Food:** For example, fish caught from water contaminated by PFAS and dairy products from livestock exposed to PFAS. Moreover, food can also contain PFAS based on the soil, water, and air where the food is grown. In a 2018 study, the FDA assessed 20 samples of produce grown near PFAS manufacturing plants and found that 16 contained PFAS.[129]
4. **Food packaging:** For example, grease-resistant paper, fast food containers and wrappers, microwave popcorn bags, pizza boxes, and candy wrappers.
5. **Household products:** For example, stain- and water-repellents used on carpets, upholstery, clothing, and other fabrics; cleaning products; non-stick cookware; paints, varnishes, and sealants.
6. **Clothing and athletic products:** For example, rain gear, hiking gear and other athletic wear, and athletic turf products.
7. **Personal care products:** For example, certain shampoos, dental floss, waterproof cosmetics, and menstrual products.

8.2 IMPACT OF S. 25 ON AFFECTED BUSINESSES, INDUSTRIES, AND CONSUMERS

8.2.1 Supply-Side Impact on Affected Businesses and Industries

8.2.1.1 Business Concerns

S. 25 places some of the most significant and widely used consumer products in the crosshairs with respect to PFAS and the chemicals of concern. Some regions that are floating similar legislation have already seen difficult battles between manufacturers and environmental regulators. For instance, following the European Union's proposal of a complete ban on PFAS—what could become the bloc's most extensive piece of chemical regulation—the European Federation of Pharmaceutical Industries and Associations provided scientific and technical evidence in a statement in which they warned that the ban would "see medicines' manufacturing in the EU grind to a halt in under three years" and "hobble the production of batteries, semi-conductors, electric vehicles and renewable energy production, among other products." [130] To this end, it is important at an early stage to recognize the criticism to S. 25 and other chemical regulations that may come from businesses that are economically impacted and to incorporate their critiques into a strategic plan.

In general, businesses that use PFAS are often hesitant to support PFAS-limiting legislation because they are apprehensive about their capacity to rapidly find and transition to alternative chemicals in their products. Such a transition poses several challenges. Firstly, identifying alternative chemicals may require significant costly research that falls on the businesses themselves. Secondly, transitioning to the use of these chemicals may require large structural changes to operational and manufacturing practices and machinery.[131] Furthermore, as explained by Chelsea Murtha, the Director of Sustainability for the American Apparel and Footwear Association, perhaps the chief concern for businesses and manufacturers is the lack of a "sell-through" provision in many state bills—including Vermont S. 25. A "sell-through" provision would provide businesses and manufacturers with a duration of time that aligns with production cycles during which they can sell off their products that contain the chemicals of concern. However, in its current state, S. 25 enacts a strict ban on the sale of PFAS-containing products starting on January 1, 2025, without recognizing a sell-through period. Consequently, manufacturers may be left with a "stranded inventory" of banned products that they cannot sell. Moreover, these banned, unsold products will likely end up in landfills, creating the unintended consequence of harmful chemicals leaking into the environment and exacerbating the environmental problem.

8.2.1.2 Business Solutions and Alternatives

There is an overarching consensus among businesses that finding PFAS alternatives is ethically important, and the general trend towards environmentally friendly business practices is conducive to a shift away from PFAS and the other chemicals of concern.[132] Given this, there are well-researched alternatives to the chemicals of concern that businesses can work towards implementing.

For ski wax, textile, cosmetic, and menstrual products, some brands produce these products free of PFAS and other chemicals of concern. For ski wax, brands such as Swix, Toko, and mountainFLOW offer PFAS-free products that can serve as an exemplar for competitor brands.[133] Gore-Tex, the most prevalent name-brand waterproof and breathable membrane used in outdoor apparel such as ski and rain jackets, has a new membrane made of expanded polyethylene (ePE), a PFAS/PFC-free alternative to the more traditionally used expanded polytetrafluoroethylene (ePTFE).[134] This new ePE membrane has similar performance qualities as the old ePTFE and has been adopted by brands such as Mountain Hardwear, Patagonia, and Mammut.[135] Notably, apparel incorporating ePE are no more expensive than their ePTFE counterparts. Additionally, some in-house waterproofing membranes such as Patagonia's "h2no" is free of PFAS.[136] Similarly, most outdoor apparel brands are switching to a PFAS-free durable water-resistant coating (DWR) which allows water to bead on the surface of the clothing, rather than soak in.[137]

In cosmetics, PFAS are currently used in products marketed as "wear or water-resistant" and/or "long-lasting" (mascaras, liquid lip gloss, foundations). In a 2021 study, University of Notre Dame researchers found that 52 percent of 231 cosmetic products sold in North America had high levels of organic fluorine, an indicator of PFAS, while only 8 percent had any PFAS listed on the ingredient label.[138] However, products such as those sold under Ulta Beauty's "Clean Ingredients" group do not contain PFAS and other harmful chemicals, as they comply with the retailer's "Made Without" list.[139] These products are a compelling demonstration of clean alternatives in the cosmetics industry that can serve as a general preliminary blueprint for makeup brands.

There are also artificial turf products on the market that are free of PFAS and other harmful chemicals such as lead, phthalates, and BPA. Companies such as WaterSavers and SYNLawn have produced such products already.[140] Estimates for the cost of SYNLawn are about $5.25 to $7.25 per square foot, which is comparable with other brands, most of which now manufacture PFAS-free turf.[141] There are also cheaper turf options made from polypropylene (ranging from $1.90 to $6.75), however these generally offer lower quality and durability.[142]

These existing alternatives for PFAS and the other chemicals of concern, which have already been implemented in diverse industries and products, are promising evidence that businesses and industries affected by the regulation in S. 25 can successfully transition away from the chemicals of concern and continue to thrive. The State of Vermont could aid in this transition through actions such as curating a comprehensive list of all known alternatives for the chemicals of concern that businesses can refer to. For instance, Safer Choice, an EPA Pollution Prevention program, previously spearheaded research on "safer chemicals" (including PFAS alternatives) and created an extensive list of these chemicals and their applicable uses for businesses.[143] Similar research and resources could be supported and incorporated into Vermont's legislation in order to help ensure that businesses can become environmentally sustainable while also remaining economically sustainable.

8.2.2 Demand-Side Impact on Affected Consumers

On the demand-side, consumers of cosmetic goods, menstrual products, ski wax, textiles, and athletic turf could also be impacted by S. 25. As the shift to alternative chemicals would likely create increased production costs for manufacturers and businesses, this may result in increased prices for consumers. Furthermore, such increased prices could disproportionately impact vulnerable populations that are most price-sensitive and unable to afford or access environmentally friendly alternatives (as further discussed in Section 9). Community-based organizations, including the Campaign for Healthier Solutions, have initiated efforts to address this issue, collaborating with major wholesale and dollar store chains to gradually eliminate harmful chemicals while ensuring continued availability of affordable products.[144]

9 PROTECTING COMMUNITIES OF COLOR AND VULNERABLE POPULATIONS

As mentioned in Section 8.2.2, the manufacture and use of PFAS, PFAS-containing products, and other chemicals of concern disproportionately impact impoverished and vulnerable communities. Sources of pollution and chemical hazards are more likely to be located near disenfranchised groups.[145] Men of color and low socioeconomic status are significantly more likely to suffer from injury and death from air pollution, and indigenous populations are at elevated risk for chemical pollutant exposure due to much of the United States' resource extraction taking place on tribal lands;[146] certain indigenous populations have levels of persistent organic chemical pollutants in their blood and breast milk ten-times higher than those living in urban areas.[147] Twenty-one percent of all people of color, and 19 percent of all houses with incomes below the federal poverty line, are located within three miles of a Superfund site;[148] this logic extends to PFAS, as 40,000 more low-income households and around 300,000 more people of color live within five miles of a contaminated site than expected based upon census data. [149]

These populations also typically face significant barriers when navigating the legislative processes involved with chemical contamination and its potential for resolution. An example from the state of Illinois encapsulates this disparity:

The town of Willowbrook, Illinois is quite affluent and located near the town of Lake County, a majority low-income community with a high Hispanic population.[150] Both were equally affected by the atmospheric contamination of a carcinogenic chemical from a nearby production facility. In Willowbrook, the EPA was directly involved in campaigning on behalf of the residents, as well as sent high-ranking officials to meet with the town and create a website advocating for their wellbeing; this resulted in a 90 percent drop in chemical concentrations.[151] However, Lake County received no EPA attention at all and had to form their own coalition in an attempt to advocate for their community's health; the EPA (at the time of writing this brief) has yet to interact with the community, and no change in the chemical concentration was noted in the article.[152]

If vulnerable communities are not adequately involved in protective measures against chemical hazards by the EPA, the responsibility may shift to state-level authorities and the residents themselves to safeguard community health, particularly as the risks of exposure continue to grow.

10 CONCLUSION

Based on a case study of existing chemical regulations, analysis of current scientific research, and interviews with expert scientists and authorities, we distilled key takeaways for the Vermont House of Representatives as it contemplates Vermont State S. 25, which would ban PFAS and other chemicals of concern in cosmetic, menstrual, textile, and athletic turf products.

PFAS and other chemicals of concern are found in natural environments globally and have a number of negative environmental impacts. These include aquatic systems disruption, soil degradation, and bacteriotoxicity to wildlife and plant life. S. 25 may help to address these challenges by prohibiting the production and circulation of certain products that contain the chemicals of concern. When it comes to human health, PFAS and the other chemicals of concern come with several detrimental health outcomes. These include kidney and testicular cancer, immunotoxicity, high cholesterol, impairments in fetal and neonatal development, and complications for pregnant mothers and gestational infants. S. 25 would help address these concerns by banning the chemicals of concern from a number of products that are used by many people and come in direct or close contact with people's bodies. Additionally, the bill would complement existing state legislation that regulates PFAS in drinking water.

Finally, PFAS and the other chemicals of concern play an important role for businesses and industries that use them in both manufacturing processes and products themselves. While these businesses and industries are often hesitant to support chemical regulations for several reasons such as increased cost, promising alternatives to the chemicals of concern have been implemented by companies in the past and could serve as exemplars for other companies. On the demand side, consumers of products that contain the chemicals of concern could also be affected by S. 25; however, an analysis of "clean products" that are currently on the market shows that these products are functionally and cost-wise comparable to their harmful counterparts.

Ultimately, the move to regulate PFAS and similar chemicals is a recent development worldwide, so the potential effects of policies such as Vermont S. 25 are largely unknown. However, this report comprehensively assembles existing knowledge in confidence that it can help the Vermont House make an informed and responsible policy decision.

REFERENCES

1. EPA, "Our Current Understanding of the Human Health and Environmental Risks of PFAS."
2. The Vermont State House Committee on Human Services, 2023.
3. Campbell, "An Act to Support Manufacturers Whose Products Contain Perfluoroalkyl and Polyfluoroalkyl Substances."; Gramlich, "An Act To Stop Perfluoroalkyl and Polyfluoroalkyl Substances Pollution."; Kallman et al, "Comprehensive PFAS Ban Act of 2023."
4. Mena et al. "Toxic-Free Cosmetic Act."; Glick, "The Safe Personal Care and Cosmetics Act."
5. Nelsen, "EU abandons promise to ban toxic chemicals in consumer products."
6. EPA, "EPA Administrator Regan Establishes New Council on PFAS."
7. EPA, "PFAS Strategic Roadmap: EPA's Commitments to Action 2021—2024."
8. EPA, "Proposed Designation of Perfluorooctanoic Acid (PFOA) and Perfluorooctanesulfonic Acid (PFOS) as CERCLA Hazardous Substances."
9. EPA, "Changes to TRI Reporting Requirements for Per- and Polyfluoroalkyl Substances and to Supplier Notifications for Chemicals of Special Concern."
10. EPA, "Per- and Polyfluoroalkyl Substances (PFAS)."
11. The Vermont State Senate Committee on Health and Welfare, 2021.
12. Ibid.
13. Ibid.
14. Members of the Vermont State House Committee on Human Services, 2023.
15. National Institute of Environmental Health Sciences, "Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS)."
16. "What are PFAS Chemicals?"
17. Ramírez et al., "Presence of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) in Food Contact Materials (FCM) and Its Migration to Food."
18. O'Hagan, "Understanding Organofluorine Chemistry. An Introduction to the C–F Bond."
19. Meegoda et al., "A Review of the Applications, Environmental Release, and Remediation Technologies of per- and Polyfluoroalkyl Substances."
20. Nicole, "Breaking It down: Estimating Short-Chain PFAS Half-Lives in a Human Population."
21. "PFAS — Per- and Polyfluoroalkyl Substances: Physical and Chemical Properties."
22. Maine's median household income (2018-2022): $$68,251. Vermont's (2018-2022): $74,014. Demographically, 93.9% white alone in ME, 93.8% in VT. "Quick Facts: Maine, New Hampshire, Vermont," United States Census Bureau, 2023.
23. "An Act to Stop Perfluoroalkyl and Polyfluoroalkyl Substances Pollution," Maine H.P. 1113, 2021.
24. "An Act to Support Manufacturers Whose Products Contain Perfluoroalkyl and Polyfluoroalkyl Substances," Maine H.P. 138, 2023.
25. Ibid.
26. Ibid.
27. "An Act to Stop Perfluoroalkyl and Polyfluoroalkyl Substances Pollution."
28. Ibid, p. 4.
29. "Comprehensive PFAS Ban Act of 2023," Rhode Island H.B. 5673.
30. Ibid, p. 4.
31. Ibid, p. 5.

32. Chelsea Murtha, interviewed by Nico Ludkowski, January 9, 2024.
33. Safe Personal Care and Cosmetic Act," New York, A6969, 2.
34. Ibid, p. 3.
35. Ibid, p. 1.
36. Ibid, p. 1.
37. Ibid, p. 3.
38. "Concerning the use of toxic chemicals in cosmetic products" Washington State, H.B. 1047, p. 2.
39. Ibid, p. 2.
40. Ibid, p. 3.
41. Ibid, p. 3.
42. Ibid, p.3.
43. "ECHA publishes PFAS restriction proposal," n.p.
44. "Chemicals strategy," European Commission, 2020.
45. "Chemicals Strategy for Sustainability Towards a Toxic-Free Environment," 2020, p. 5
46. Ibid, p. 10.
47. Nelsen, "EU abandons promise to ban toxic chemicals in consumer products."
48. Abercrombie et al, "Larval Amphibians Rapidly Bioaccumulate Poly- and Perfluoroalkyl Substances."
49. Grønnestad et al., "Levels, Patterns, and Biomagnification Potential of Perfluoroalkyl Substances in a Terrestrial Food Chain in a Nordic Skiing Area."
50. Miranda et al., "Bioaccumulation of Per- and Polyfluoroalkyl Substances (PFASs) in a Tropical Estuarine Food Web."
51. Panieri et al., "PFAS Molecules: A Major Concern for the Human Health and the Environment."
52. Goldenman et al., *The Cost of Inaction: A Socioeconomic Analysis of Environmental and Health Impacts Linked to Exposure to PFAS*, p. 23.
53. Ahrens et al., "Distribution of Perfluoroalkyl Compounds in Seawater from Northern Europe, Atlantic Ocean, and Southern Ocean."
54. Jin et al., "PFOS and PFOA in Environmental and Tap Water in China."
55. So et al., "Perfluorinated Compounds in Coastal Waters of Hong Kong, South China, and Korea."
56. Washington et al., "Concentrations, Distribution, and Persistence of Perfluoroalkylates in Sludge-Applied Soils near Decatur, Alabama, USA."
57. Arinaitwe et al., "Spatial Profiles of Perfluoroalkyl Substances and Mercury in Fish from Northern Lake Victoria, East Africa."
58. Banzhaf et al., "A Review of Contamination of Surface-, Ground-, and Drinking Water in Sweden by Perfluoroalkyl and Polyfluoroalkyl Substances (PFASs)."
59. Celia Chen, PhD, interviewed by Aidan Ferrin and Elizabeth Chun, January 8th, 2024.
60. Ibid.
61. Ibid.
62. Ahrens & Bundschuh. 2014. "Fate and Effects of Poly- and Perfluoroalkyl Substances in the Aquatic Environment: A Review."
63. Loos et al., "Polar Herbicides, Pharmaceutical Products, Perfluorooctanesulfonate (PFOS), Perfluorooctanoate (PFOA), and Nonylphenol and Its Carboxylates and Ethoxylates in Surface and Tap Waters around Lake Maggiore in Northern Italy."
64. Eriksson et al., "Perfluoroalkyl Substances (PFASs) in Food and Water from Faroe Islands."

65. Lu et al., "Risk Exposure Assessment of Per- and Polyfluoroalkyl Substances (PFASs) in Drinking Water and Atmosphere in Central Eastern China."
66. Liu et al., "Perfluoroalkyl Acids (PFAAs) in Sediments from Rivers of the Pearl River Delta, Southern China."
67. McDonough et al., "Per- and Polyfluoroalkyl Substances."
68. Schwanz et al., "Perfluoroalkyl Substances Assessment in Drinking Waters from Brazil, France and Spain."
69. Quinete et al., "Specific Profiles of Perfluorinated Compounds in Surface and Drinking Waters and Accumulation in Mussels, Fish, and Dolphins from Southeastern Brazil."
70. Schwanz et al.
71. Ibid.
72. Mastrantonio et al., "Drinking Water Contamination from Perfluoroalkyl Substances (PFAS): An Ecological Mortality Study in the Veneto Region, Italy."
73. Sunderland et al., "A Review of the Pathways of Human Exposure to Poly- and Perfluoroalkyl Substances (PFASs) and Present Understanding of Health Effects."
74. Lindstrom et al., "Polyfluorinated Compounds: Past, Present, and Future."
75. Horst et al., "Water Treatment Technologies for PFAS: The next Generation."
76. "PFAS Treatment in Drinking Water and Wastewater – State of the Science"
77. Cai et al., "Metagenomic Analysis of Soil Microbial Community under PFOA and PFOS Stress."
78. Lechner & Knapp, "Carryover of Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS) from Soil to Plant and Distribution to the Different Plant Compartments Studied in Cultures of Carrots (*Daucus Carota* Ssp. *Sativus*), Potatoes (*Solanum Tuberosum*), and Cucumbers (*Cucumis Sativus*)."
79. Cai et al., "Toxicity of Perfluorinated Compounds to Soil Microbial Activity: Effect of Carbon Chain Length, Functional Group and Soil Properties."
80. Stahl et al., "Carryover of Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS) from Soil to Plants."
81. Lechner & Knapp.
82. "Phthalates and Their Impacts on Human Health."
83. "1,4-Dioxane in Drinking Water."
84. New York State Energy Research and Development Authority, "Mercury, Human Health, and the Environment."
85. Cleveland Clinic, "Mercury Poisoning."
86. Yueh and Tukey, "Triclosan: A Widespread Environmental Toxicant with Many Biological Effects", p. 3.
87. Ibid., p. 2.
88. Ibid.
89. Carey & McNamara, "The Impact of Triclosan on the Spread of Antibiotic Resistance in the Environment."
90. https://www.trccompanies.com/insights/pfas-contamination-environment/
91. Megan Romano, PhD, interviewed by Aidan Ferrin and Nico Ludkowski, February 2, 2024.
92. Ibid.
93. "Our Current Understanding of the Human Health and Environmental Risks of PFAS."
94. Wisconsin Department of Health Services, "Chemicals: Perfluoroalkyl and Polyfluoroalkyl (PFAS) Substances."
95. CDC, "Per- and Polyfluorinated Substances (PFAS) Factsheet."
96. Celia Chen, PhD, 2024.

97. Goldenman et al., p. 11.
98. Barry et al., "Perfluorooctanoic Acid (PFOA) Exposures and Incident Cancers among Adults Living near a Chemical Plant."
99. Vieira et al., "Perfluorooctanoic Acid Exposure and Cancer Outcomes in a Contaminated Community: A Geographic Analysis."
100. Shearer et al., "Serum Concentrations of Per- and Polyfluoroalkyl Substances and Risk of Renal Cell Carcinoma."
101. Megan Romano, PhD, 2024.
102. DeWitt et al., "Immunotoxicity of Perfluorinated Compounds: Recent Developments."
103. Naidenko et al., "Investigating Molecular Mechanisms of Immunotoxicity and the Utility of ToxCast for Immunotoxicity Screening of Chemicals Added to Food."
104. Neagu et al., "Adverse Outcome Pathway in Immunotoxicity of Perfluoroalkyls."
105. Ehrlich et al, "Consideration of Pathways for Immunotoxicity of Per- and Polyfluoroalkyl Substances (PFAS)."
106. Grandjean et al., "Serum Vaccine Antibody Concentrations in Children Exposed to Perfluorinated Compounds."
107. Stein et al., "Perfluoroalkyl and Polyfluoroalkyl Substances and Indicators of Immune Function in Children Aged 12–19y: National Health and Nutrition Examination Survey."
108. Granum et al., "Pre-Natal Exposure to Perfluoroalkyl Substances May Be Associated with Altered Vaccine Antibody Levels and Immune-Related Health Outcomes in Early Childhood."
109. Stein et al., "Perfluoroalkyl Substance Serum Concentrations and Immune Response to FluMist Vaccination among Healthy Adults."
110. Looker et al., "Influenza Vaccine Response in Adults Exposed to Perfluorooctanoate and Perfluorooctanesulfonate."
111. Frisbee et al., "Perfluorooctanoic Acid, Perfluorooctanesulfonate, and Serum Lipids in Children and Adolescents: Results from the C8 Health Project."
112. Nelson et al., "Exposure to Polyfluoroalkyl Chemicals and Cholesterol, Body Weight, and Insulin Resistance in the General U.s. Population."
113. Maisonet et al., "Prenatal Exposures to Perfluoroalkyl Acids and Serum Lipids at Ages 7 and 15 in Females."
114. The Agency for Toxic Substances and Disease Registry, "Potential Health Effects of PFAS Chemicals."
115. "Our Current Understanding of the Human Health and Environmental Risks of PFAS."
116. Wang and Qian, "Phthalates and Their Impacts on Human Health."
117. Minnesota Department of Health-Environmental Health Division, "1,4-Dioxane in Drinking Water."
118. EPA, "Health Effects of Exposures to Mercury."
119. Ibid.
120. Ibid.
121. Yueh and Tukey, "Triclosan: A Widespread Environmental Toxicant with Many Biological Effects," p. 4.
122. Ibid., p. 6.
123. Ibid., p. 7.
124. Megan Romano, PhD, 2024.
125. Ibid.
126. The Vermont State Senate Committee on Natural Resources and Energy, *An Act Relating to the Regulation of Polyfluoroalkyl Substances in Drinking and Surface Waters*.
127. Ibid.

128. "'Forever Chemicals' Called PFAS Show up in Your Food, Clothes, and Home."
129. "Analytical Results for PFAS in 2018 Produce Sampling (Parts Per Trillion)."
130. *Reuters*. 2023. "Pharma Lobby Says EU Ban on 'forever Chemicals' Would Halt Drug Production."
131. "Why Getting PFAS out of Our Products Is so Hard — and Why It Matters."
132. Chelsea Murtha, interviewed by Nico Ludkowski, January 9, 2024.
133. Center for Environmental Health, "PFAS Free Ski Wax"
134. "The New Gore-Tex Products Introduce an Innovative Membrane."
135. Ibid.
136. Ram, "Say Goodbye to 'Forever Chemicals'"
137. Stockwell, "All About PFAS and PFC-Free Waterproofing"
138. Whitehead et al, "Fluorinated Compounds in North American Cosmetics," 540.
139. Ulta, "Made Without List."
140. "PFAS-Free Artificial Turf from Watersavers Turf," "Everything You Need to Know About The Cost of an Artificial Lawn."
141. "Purnell, "Pricing Guide: How Much Does Artificial Grass Cost in 2024?"
142. Ibid.
143. EPA, "Safer Chemical Ingredients List."
144. The Environmental Justice Health Alliance for Chemical Policy Reform, "Campaign for Healthier Solutions."
145. Troutman, "Future Chemicals Are Infiltrating America, and the Nation Is Letting Impoverished and Marginalized Communities Take the Brunt of the Contamination," p. 61.
146. Desikan, et al., *Abandoned Science, Broken Promises: How the Trump Administration's Neglect of Science Is Leaving Marginalized Communities Further Behind*, p. 4.
147. Ibid.
148. Ibid.
149. Ibid., p. 13.
150. Troutman, p. 61.
151. Ibid.
152. Ibid., p. 61-62.