



GREEN SCIENCE  
POLICY INSTITUTE

# Reducing Harm from PFAS For a Healthier Environment

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Green Science Policy Institute &  
Chemistry, University of California, Berkeley

30 November 2020



# GREEN SCIENCE POLICY INSTITUTE

RESEARCH & INFORMATION (2022) 48(6), 738-755

**Building insulation: China codes**

**Novel and High Volume Use Flame Retardants in US Couches**

**U.S. Fast Food Packaging**

**Detection of Poly- and Perfluoroalkyl Substances (PFASs) in U.S. Drinking Water Linked to Industrial Sites, Military Fire Training Areas, and Wastewater Treatment Plants**

**Fluorin**

**Supporting Information**

**ABSTRACT:** Drinking water contamination with poly- and perfluoroalkyl substances (PFASs) poses risks to the developmental, immune, metabolic, and endocrine health of consumers. We present a spatial analysis of 2013–2015 national drinking water PFAS concentrations from the U.S. Environmental Protection Agency's (USEPA) third Unregulated Contaminant Monitoring Rule (UCMR3) program. The number of industrial sites that manufacture or use these compounds, the number of military fire training areas, and the number of wastewater treatment plants are all significant

**Hydrological units with detectable PFASs**



Convene business, government, NGO, academic scientists

**Chicago Tribune**

TRIBUNE WATCHDOG

**Playing with fire**

A deceptive campaign by industry brought toxic flame retardants into our homes and into our bodies. And the chemicals don't even work as promised.

**By PHYLLIS CLEGGAN AND DAN RICE**

**D**a Paula Heilbrich knows how to tell a story. Before California lawmakers last year the usual from regions three gangs from the coast as he described a woman who had given her name to a fire started by a candle while she lay on a pillow that lacked flame retardant chemicals.

"This fire is a fire like parties, no bigger than my kitchen, grounded at home," said Heilbrich, gesturing to appreciate the baby's case. "But if her body was covered in flame retardants, she wouldn't die after about three weeks of pain and misery in the hospital."

Heilbrich's passionate testimony about the baby's death made the long-term health concerns about flame retardants raised by doctors, environmentalists and even firefighters sound abstract and scary.

But there was a problem with his testimony: It wasn't true. Heilbrich never there was no diagnosis given or made for the baby he described didn't exist.

Heilbrich did not even exist. Instead the public's fear of fire and helped corporate and industry lawyers build for a an awareness of the fire industry's deceptive marketing campaign.

These scientists know the more flame retardants, the more people die. They're trying to get the manufacturers of flame retardants to stop.

**These Chemicals in Pizza Boxes and Carpeting Last Forever**

More than 200 scientists around the world document the threats of perfluorinated compounds and call for more government control.

By Lindsey Konkel, National Geographic

**NATIONAL GEOGRAPHIC**

Scientific Research

Communicate

# Government Policy & Business Purchasing Change





# Brominated Tris Flame Retardant

Tris (2,3-dibromopropyl) phosphate

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- In children's sleepwear 1975 to 1977
- Up to 10% of the weight of fabric
- In children's urine
- Mutagen and possible carcinogen



















**THE  
MUTANTS**

*Science*, January 7, 1977

## Flame-Retardant Additives as Possible Cancer Hazards

The main flame retardant in children's pajamas is a mutagen and should not be used.

Arlene Blum and Bruce N. Ames

Thousands of chemicals to which humans have been exposed have been introduced into the environment without adequate toxicological testing. The toxicological and biological properties of food additives and drugs have been monitored by the U.S. Food and Drug Administration and now pesticides are monitored by the U.S. Environmental Protection Agency, but most other new substances are tested only superficially.

Some chemical flame retardants provide a good example of a technological innovation where adverse environmental effects may outweigh some of the benefits. Recent federal regulations, requiring

persal of these potentially hazardous flame-retardant compounds should also be taken into account.

Until recently, little attention was paid to the long-term biological effects of these flame-retardant compounds. The main organic chemicals used in flame retardants contain bromine or chlorine or they are phosphate esters. Some have chemical structures (discussed below) that are closely related to compounds known to cause cancer or to be toxic to animals. Several compounds previously used as flame retardants have been shown to be teratogenic, carcinogenic, mutagenic, or highly toxic (4). In this

property damage. A general wearing apparel standard, effective 1 July 1954, established minimum flammability standards to keep highly flammable apparel out of the marketplace. The act was amended in 1967 to allow flammability standards to be set for many additional consumer products. Standards for carpets and rugs became effective in 1971, and for mattresses and mattress pads in 1973. The first children's sleepwear standard (DOCF3-71) for sizes 0 to 6X became effective on 28 July 1972. Children's sleepwear fabric exposed to a gas flame along its bottom edge for 3 seconds is required to exhibit a char length no greater than 7 inches (1 inch = 2.54 cm), even after the fabric has been laundered 50 times.

In 1972, the Consumer Product Safety Commission was established and assumed jurisdiction over the regulation of flammable fabrics. A children's sleepwear standard for sizes 7 to 14 became effective on 1 May 1975. The requirements of this standard are similar to, but slightly less stringent than those for the sleepwear sizes 0 to 6X.

The Consumer Product Safety Commission is in the process of establishing uniform federal standards for upholstered furniture and tents. The National Bureau of Standards has carried out feasibility studies for a standard (based on





U.S. Consumer Product  
Safety Commission

# CPSC Bans TRIS-Treated Children's Garments

April 7, 1977

Chlorinated Tris (TDCPP) replaced Brominated Tris

- removed from children's PJ's in 1977
- used furniture until 2012

# ANNAPURNA

Die erste Frauenexpedition  
auf einen der höchsten Gipfel der Erde



**Arlene Blum**

Orac  
Pietsch



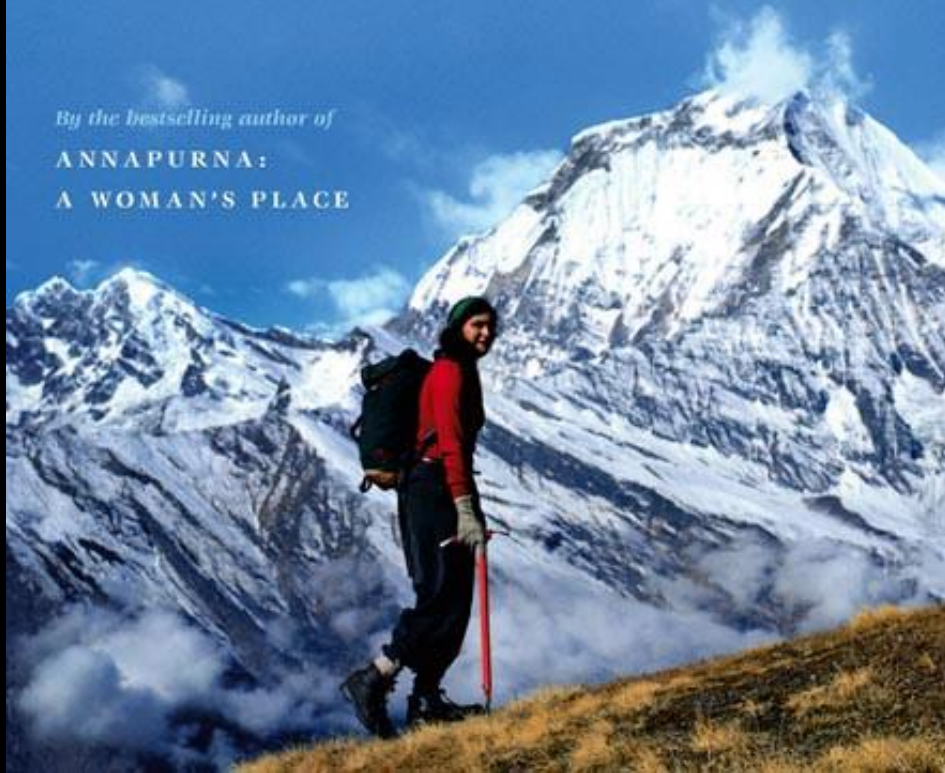
Arlene Blum

# BREAKING TRAIL

*A Climbing Life*

*By the bestselling author of*

**ANNAPURNA:  
A WOMAN'S PLACE**







**EVALUATING TENS OF THOUSANDS OF  
INDIVIDUAL CHEMICALS IS UNWORKABLE**





BUT ADDRESSING **SIX GROUPS** OF  
CHEMICALS OF CONCERN IS MANAGEABLE



# Six Classes Videos

1  
PFAS

2  
Anti-  
microbials

3  
Flame  
Retardants

4  
Bisphenols  
+  
Phthalates

5  
Some  
Solvents

6  
Certain  
Metals



[www.SixClasses.org](http://www.SixClasses.org)

Healthier products, healthier people in four minutes!



Is it necessary?

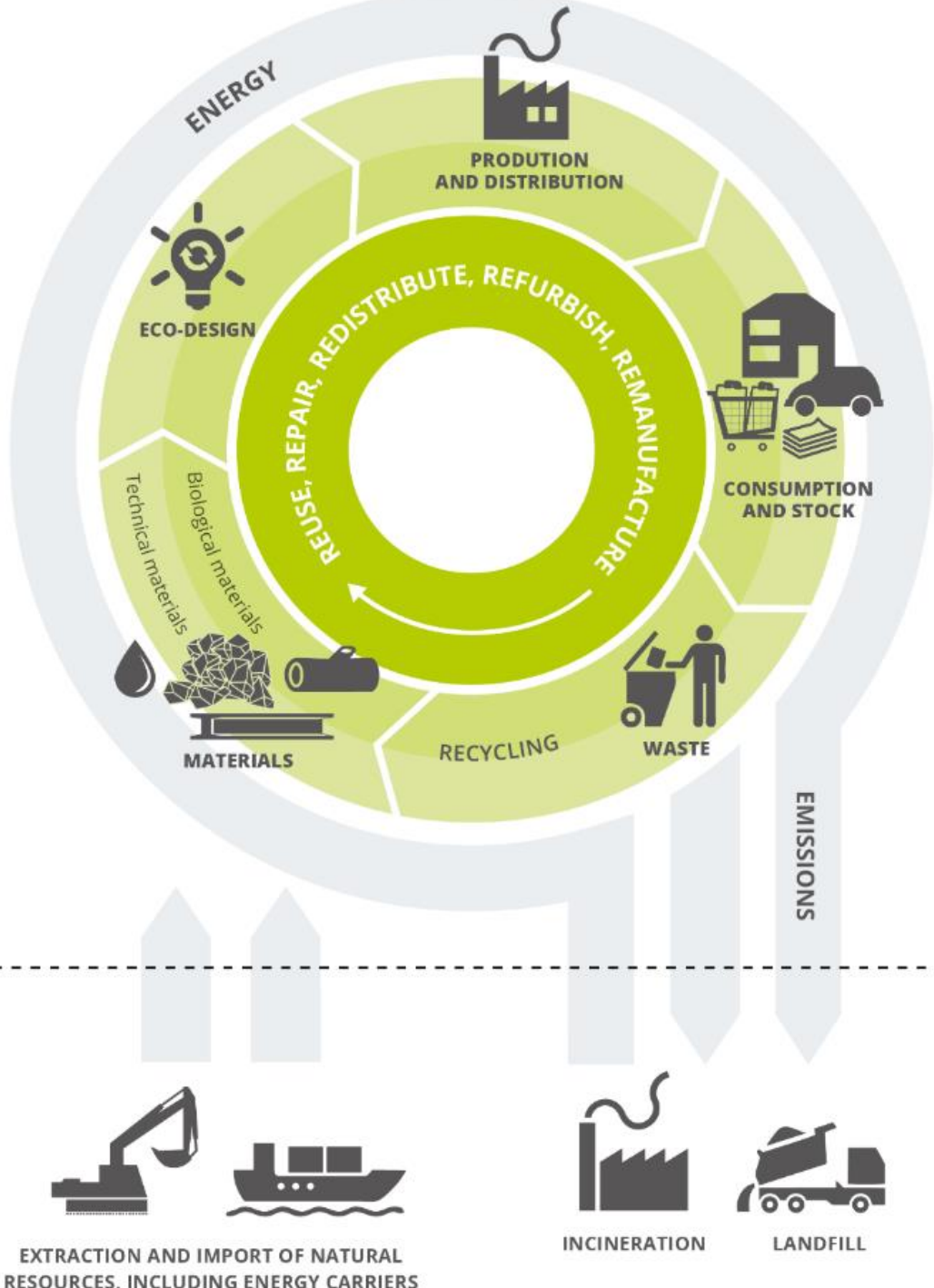
Is it worth it?

Is there a safer alternative?

# For a Circular Economy, Avoid Hazardous Substances

Products with  
toxics should be  
land filled or  
destroyed.

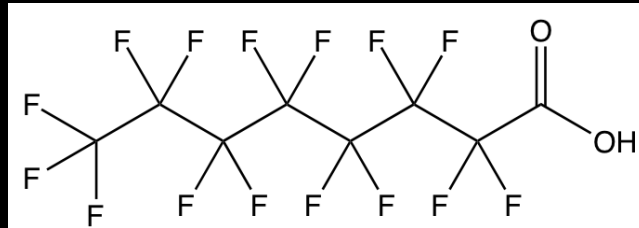
Courtesy European  
Environment  
Agency 2015



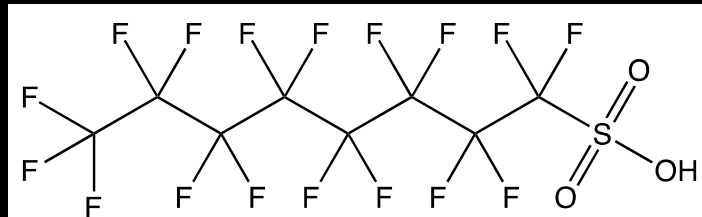
# Class 1 PFAS

(Per- and polyfluoroalkyl substances)

PFOA  
(C8)



PFOS  
(C8)



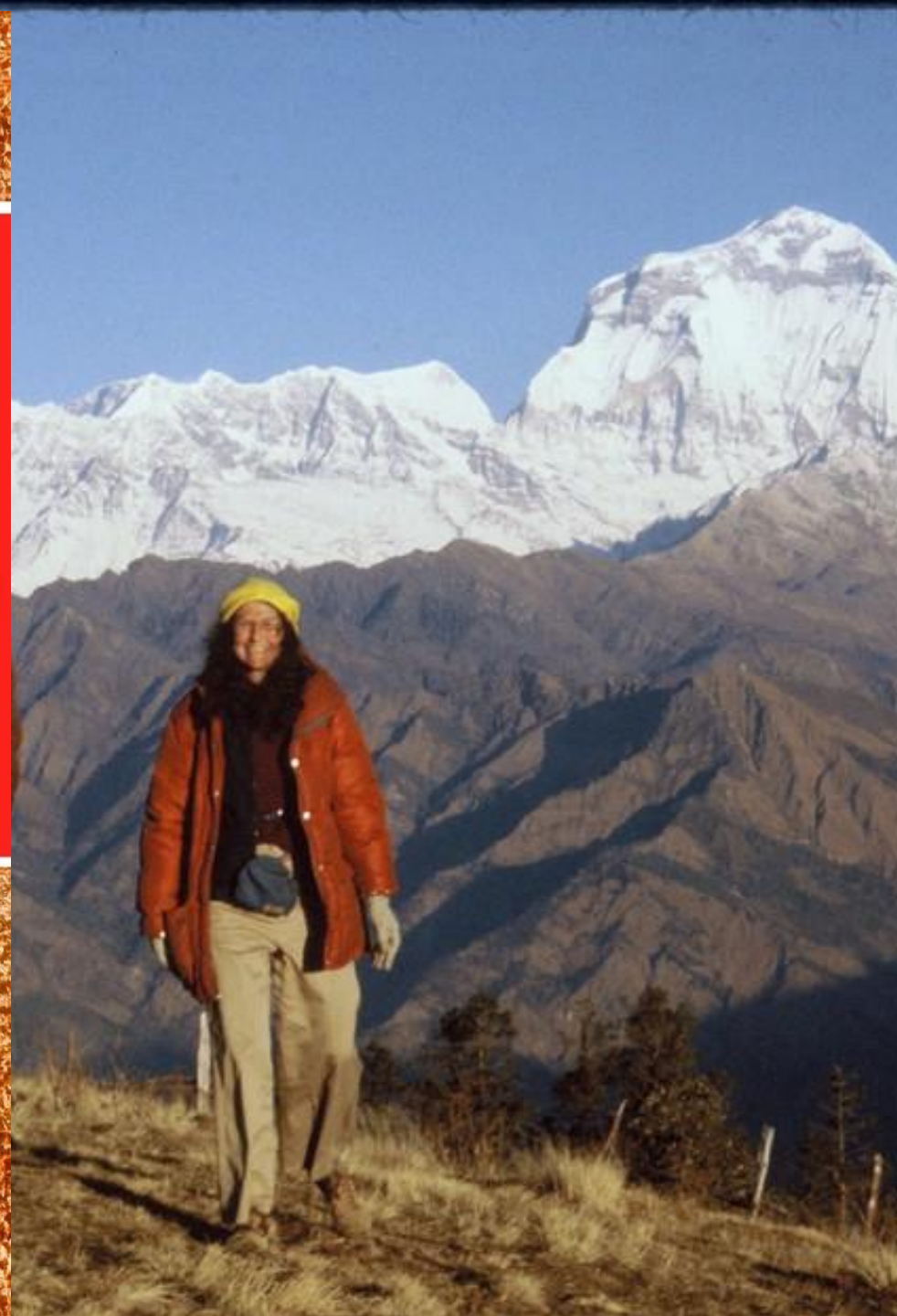
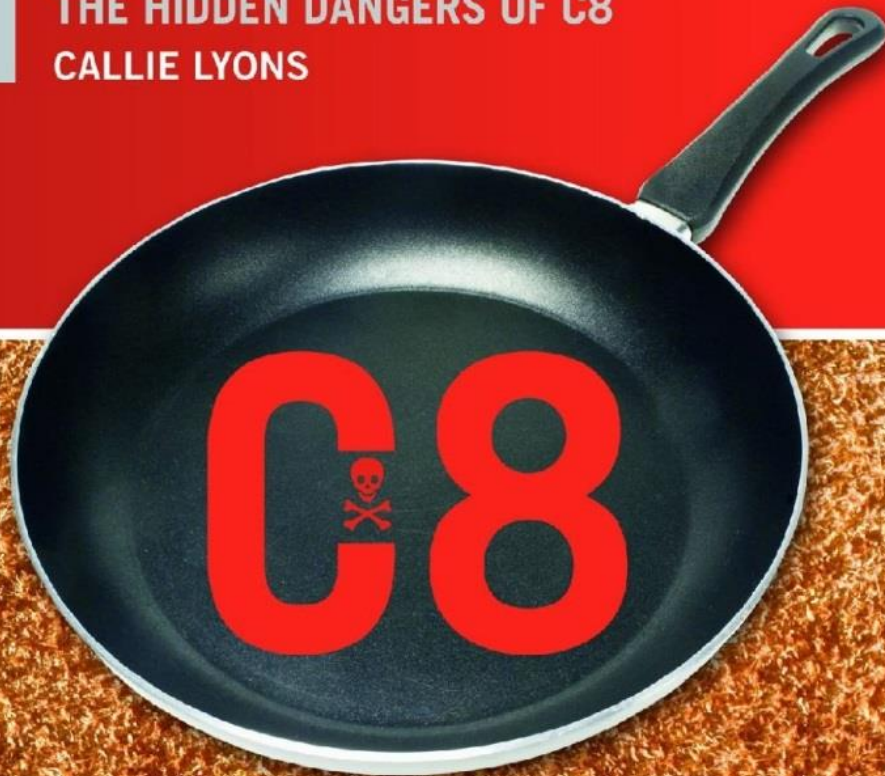
Carbon-Fluorine bond strength:

- Leads to oil and water repellency
- “Forever chemicals” -- last for geologic time!



**STAIN-RESISTANT,  
NONSTICK, WATERPROOF,  
AND LETHAL**

**THE HIDDEN DANGERS OF C8  
CALLIE LYONS**



# May 2000

## 3M Employee Bulletin

Date: 05/16/2000

### 3M Phasing Out Some of its Specialty Materials

3M will phase out of the perfluorooctanyl chemistry in certain repellents and surfactant products by the end of this year. We thank the people in these business units for their hard work. They have consistently given the company and our customers their best efforts. For more information, below is a news release issued this morning:

-----  
**ST. PAUL, Minn -- May 16, 2000** -- 3M today announced it is phasing out of the perfluorooctanyl chemistry used to produce certain repellents and surfactant products.



# Watch Dark Waters film

- The story of attorney Rob Bilott, who uncovered massive PFOA contamination from a DuPont factory in WV





# PFAS exposure is a health concern

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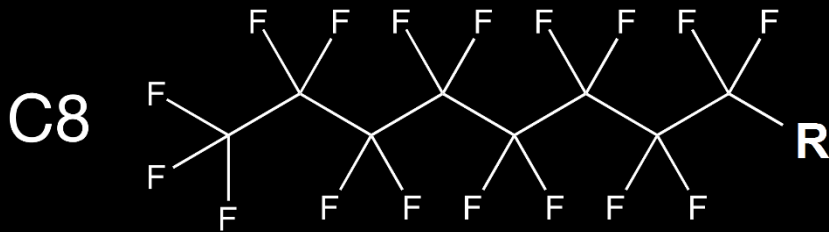
Exposure linked to health risks:

Cancer, elevated cholesterol, obesity, immune suppression, and endocrine disruption

Courtesy, Cindy Hu, Harvard University

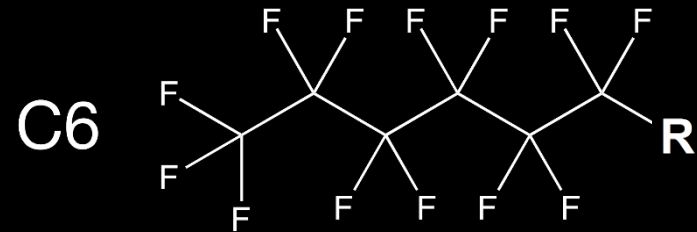
(Ref: Lewis et al., 2015; Grandjean et al., 2012; Braun et al., 2016; Barry et al., 2013)

# “Regrettable” Substitution?



## Long chain:

- Extreme persistence
- Bioaccumulation
- Toxicity



## Short chain:

- Extreme persistence
- Less bioaccumulation in humans
- Build-up in plants
- Suspected toxicity
- More mobile
- Clean up more difficult
- Harder to measure & monitor



# 2014 Helsingør Statement on Poly & Perfluorinated Alkyl Substances

## 2015 Madrid Statement on Highly Fluorinated Chemicals



“We call on the international community to cooperate in limiting the production and use of PFAS and in developing safer non-fluorinated alternatives.”

Signed by 230 scientists from 40 countries

2015: Environmental Health Perspectives

# 2015-16

The Opinion Pages | OP-ED COLUMNIST

The New York Times

## Chemicals in Your Popcorn?

JUNE 4, 2015



Nicholas Kristof

What do a pizza box, a polar bear and you have in common?

[All carry a kind of industrial toxicant](#) called poly- and perfluoroalkyl substances, or PFASs, that do two things: They make life convenient, and they also appear to increase the risk of cancer.

## These Chemicals in Pizza Boxes and Carpeting Last Forever

More than 200 scientists around the world document the threats of perfluorinated compounds and call for more government control.

By **Lindsey Konkel**, National Geographic  
PUBLISHED MAY 01, 2015



The Intercept

## THE TEFLON TOXIN

DuPont and the Chemistry of Deception



Sharon Lezner

Aug. 11 2015, 3:35 p.m.



133

Home

The New York Times Magazine

## The Lawyer Who Became DuPont's Worst Nightmare

Rob Bilott was a corporate defense attorney for eight years. Then he took on an environmental suit that would upend his entire career — and expose a brazen, decades-long history of chemical pollution.

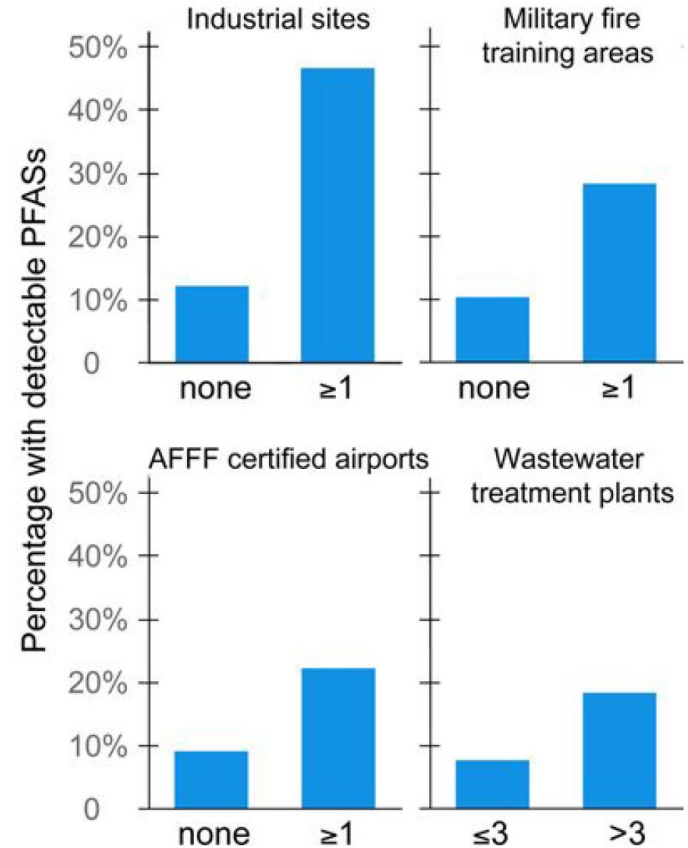
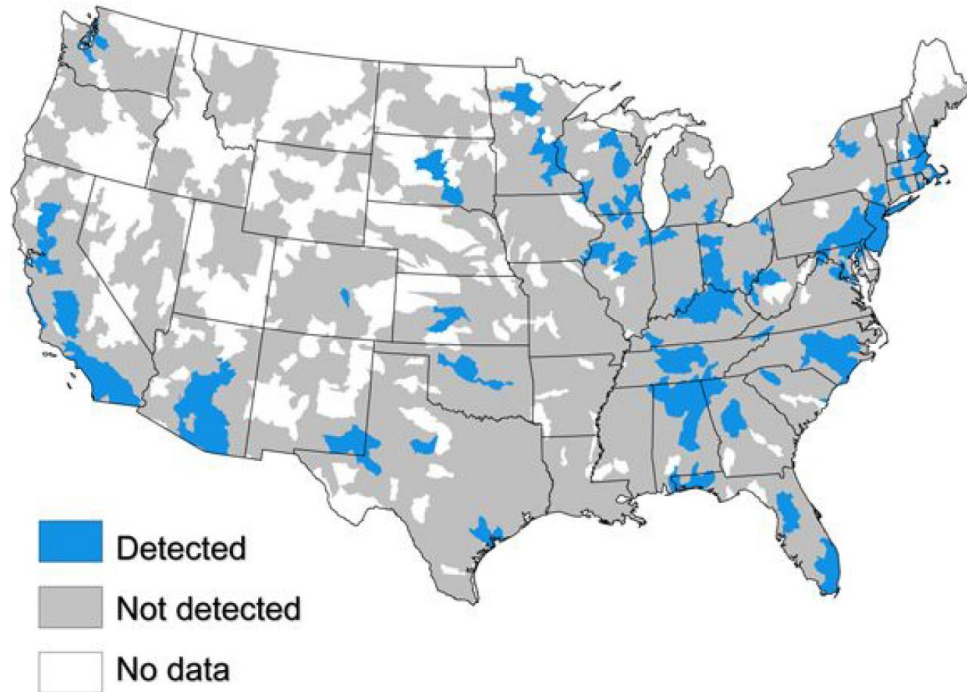
By NATHANIEL RICH JAN. 6, 2016





# EPA Lifetime Health Advisory Level: 70 ng/L PFOA + PFOS

## Hydrological units with detectable PFASs



# Drinking Water Health Guidelines for PFOA

(parts per trillion)

DuPont  
5000

DuPont  
1000

U.S. EPA  
400

U.S. EPA  
70

NJ: 14  
MN: 35

MI, NH, WA  
Ranging 8-20

1987

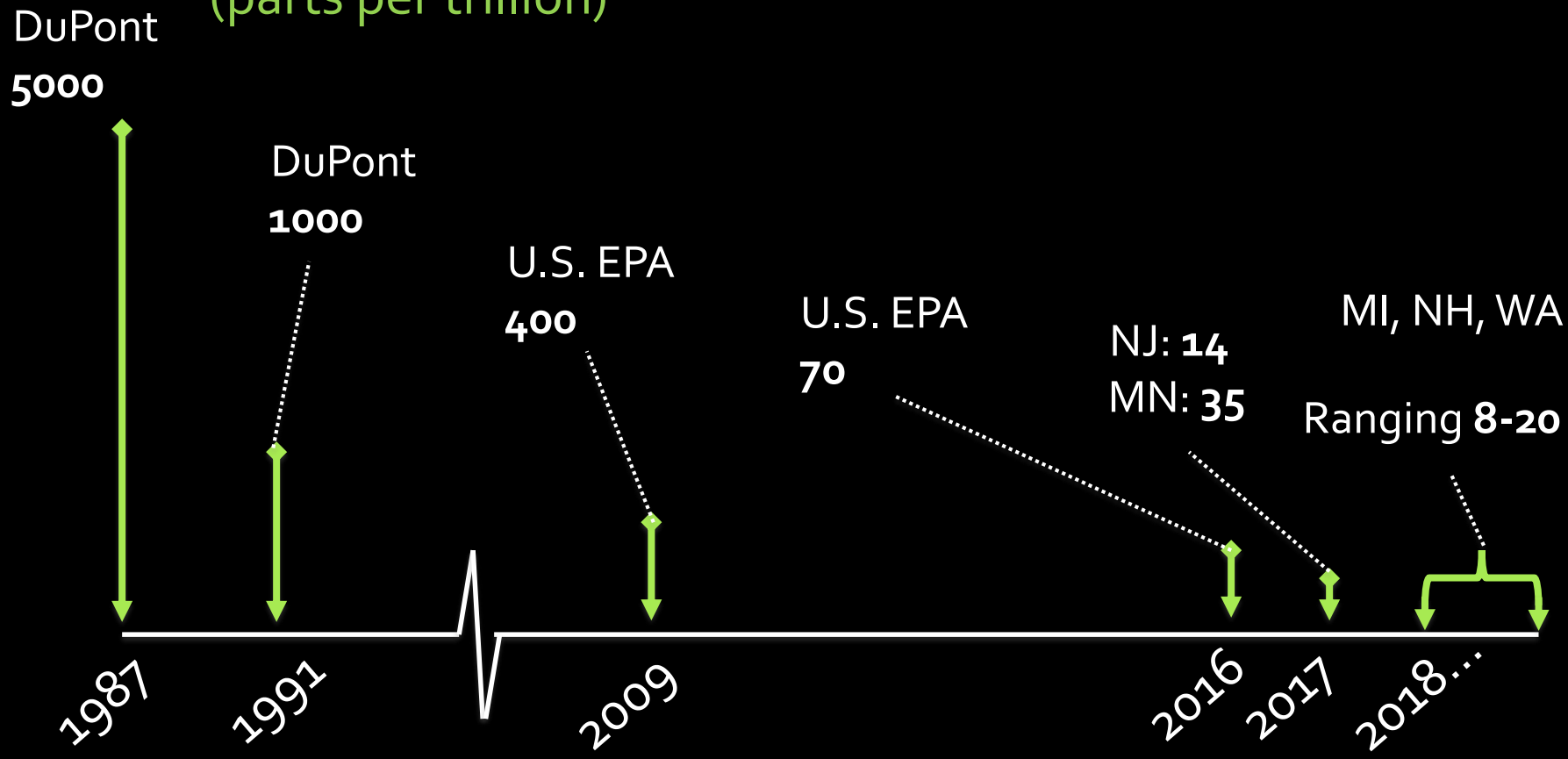
1991

2009

2016

2017

2018...



# Michigan

- Wolverine treated leather with Scotchguard (PFOS)
  - Leather scrap dumped
  - Sludge applied to fields
- PFOA + PFOS up to 58,000 ppt  
842 times EPA health advisory level!

Feb. 2020:

- Wolverine to pay Michigan \$69.5 million
- 3M to pay Wolverine \$55 million





# New Mexico

- Cannon Air Force Base

- Firefighting foam entered groundwater
- PFAS migrated from base to dairy wells to cows to milk

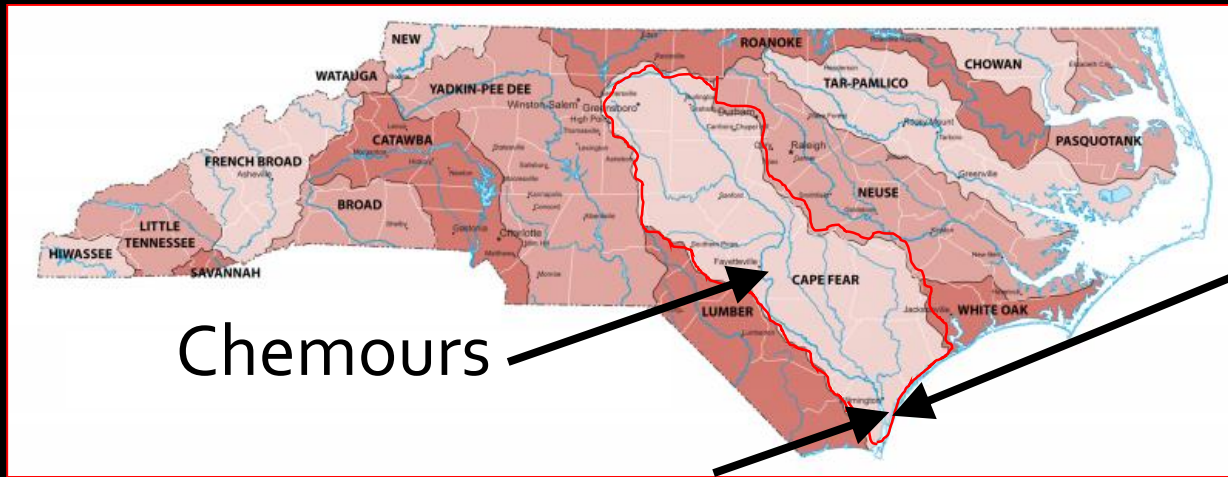


- PFOS level up to 12,000 ppt

- 171 times EPA health advisory level!

- Feb. 10, 2020: discovered in Clovis drinking water

# Water Treatment Costs: North Carolina



Chemours

Brunswick County:  
reverse osmosis  
filtration for 25,000  
customers:  
-\$99M to build  
-\$2.9M to operate

Cape Fear Public Utility Authority activated  
carbon filtration plant:

-\$46M to build

-\$2.7M to operate each year

Wilmington Star News,  
May 9<sup>th</sup> and 10<sup>th</sup>, 2018

PFAS are Problematic  
& Difficult to Clean Up

Prevention is Preferable!



## Fluorinated Compounds in U.S. Fast Food Packaging

Laurel A. Schaidler,<sup>\*,†</sup> Simona A. Balan,<sup>‡</sup> Arlene Blum,<sup>§,||</sup> David Q. Andrews,<sup>⊥</sup> Mark J. Strynar,<sup>#</sup> Margaret E. Dickinson,<sup>∇</sup> David M. Lunderberg,<sup>∇</sup> Johnsie R. Lang,<sup>○</sup> and Graham F. Peaslee<sup>@</sup>

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<sup>‡</sup>California Department of Toxic Substances Control, Sacramento, California 95814, United States

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<sup>||</sup>Department of Chemistry, University of California at Berkeley, Berkeley, California 94720, United States

<sup>⊥</sup>Environmental Working Group, Washington, D.C. 20009, United States

<sup>#</sup>National Exposure Research Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711, United States

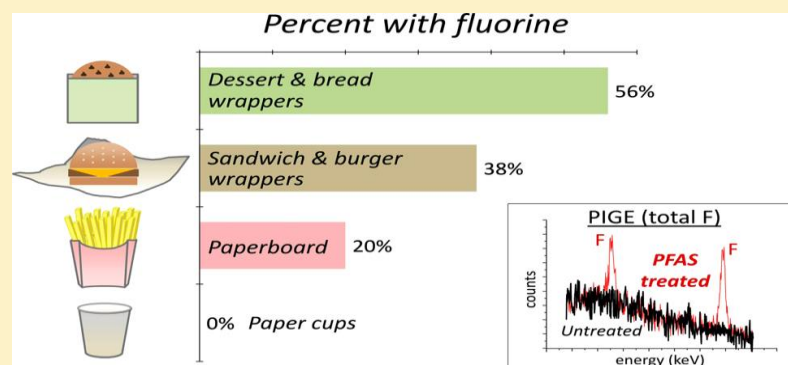
<sup>∇</sup>Chemistry Department, Hope College, Holland, Michigan 49423, United States

<sup>○</sup>Oak Ridge Institute for Science and Education, Oak Ridge, Tennessee 37831, United States

<sup>@</sup>Department of Physics, University of Notre Dame, Notre Dame, Indiana 46556, United States

### **S** Supporting Information

**ABSTRACT:** Per- and polyfluoroalkyl substances (PFASs) are highly persistent synthetic chemicals, some of which have been associated with cancer, developmental toxicity, immunotoxicity, and other health effects. PFASs in grease-resistant food packaging can leach into food and increase dietary exposure. We collected ~400 samples of food contact papers, paperboard containers, and beverage containers from fast food restaurants throughout the United States and measured total fluorine using particle-induced  $\gamma$ -ray emission (PIGE) spectroscopy. PIGE can rapidly and inexpensively measure total fluorine in solid-phase samples. We found that 46% of food contact papers and 20% of paperboard samples contained detectable fluorine ( $>16$  nmol/cm<sup>2</sup>). Liquid chromatography/high-resolution mass spectrometry analysis of a subset of 20 samples found perfluorocarboxylates, perfluorosulfonates, and other known PFASs and/or unidentified polyfluorinated compounds (based on nontargeted analysis). The total peak area for PFASs was higher in 70% of samples (10 of 14) with a total fluorine level of  $>200$  nmol/cm<sup>2</sup> compared to six samples with a total fluorine level of  $<16$  nmol/cm<sup>2</sup>. Samples with high total fluorine levels but low levels of measured PFASs may contain volatile PFASs, PFAS polymers, newer replacement PFASs, or other fluorinated compounds. The prevalence of fluorinated chemicals in fast food packaging demonstrates their potentially significant contribution to dietary PFAS exposure and environmental contamination during production and disposal.



**CNN** @CNN Follow

Researchers found fluorinated chemicals in one-third of the fast food packaging they tested, according to a report [cnn.it/2jWU6Rw](http://cnn.it/2jWU6Rw)



RETWEETS 237 LIKES 205

6:20 AM - 1 Feb 2017

47 237 205

**Washington Post** @washingtonpost Follow

Researchers find "another reason" to avoid fast food: Chemicals in the packaging



Researchers find 'another reason' to avoid fast food: Chemicals in the packa...  
Substances with links to health problems have been found in wrappers and containers, where they can leach into food.  
[washingtonpost.com](http://washingtonpost.com)

RETWEETS 141 LIKES 106

**Mother Jones** @MotherJones Follow

The Nasty Ingredient in Fast-Food Wrappers  
[mojo.ly/2jCPzA4](http://mojo.ly/2jCPzA4)



RETWEETS 19 LIKES 22

5:09 AM - 1 Feb 2017

19 22

**United States Senate**  
WASHINGTON, DC 20510

March 9, 2017

Mr. Daniel S. Schwartz  
Chief Executive Officer  
Restaurant Brands International Inc.  
226 Wycroft Road,  
Oakville, Ontario L6K 3X7,  
Canada

Dear Mr. Schwartz:

We write to inquire about Burger King's use of potentially harmful fluorinated chemicals in food wrappers, bags, boxes, or other kinds of food packaging. Per and polyfluoroalkyl substances (PFASs) represent a class of chemicals sometimes used in fast food packaging to prevent grease and sauces from seeping through packaging. These chemical compounds have been

# Food Packaging: Policy & Regulation

## Bans:

- 2018 - Washington state
- 2019 – Maine
- 2020 – San Francisco
- 2020 – US Congress: no PFAS in military meals-ready-to-eat (MREs)





# Denmark bans all PFAS in paper and paperboard food packaging

- “I do not want to accept the risk of harmful [PFAS] migrating from the packaging and into our food. These substances represent such a health problem that we can no longer wait for the EU.”

- Danish Food Minister Mogens Jensen



• <https://www.cnn.com/2019/09/04/health/denmark-pfas-food-packaging-ban-intl/index.html>

# PFAS and Carpet

- PFAS-treated carpet linked to high PFAS blood levels

## Exceptionally High Serum Concentrations of Perfluorohexanesulfonate in a Canadian Family are Linked to Home Carpet Treatment Applications

Sanjay Beesoon,<sup>†</sup> Stephen J. Genuis,<sup>‡</sup> Jonathan P. Benskin,<sup>†,§</sup> and Jonathan W. Martin<sup>\*,†</sup>

<sup>†</sup>Division of Analytical and Environmental Toxicology, Department of Laboratory Medicine and Pathology, University of Alberta, Edmonton, AB, Canada

<sup>‡</sup>Department of Medicine, University of Alberta, Edmonton, AB, Canada

**S** Supporting Information

# Major manufacturers phase out PFAS from carpets & rugs by January 1, 2020

## Home Depot plans to phase out selling rugs and carpets containing PFAS

By VIRGINIA GORDAN • SEP 17, 2019

[Share](#) [Tweet](#) [Email](#)



CREDIT ANDREI / ADOBE STOCK

The Home Depot announced Tuesday that it will stop buying from its suppliers any rugs and carpets that contain [PFAS chemicals](#).

"Excluding PFAS from the carpets and rugs we sell is another example of our shared commitment to building a better future for our customers and the planet,"

Ron Jarvis, The Home Depot's vice president for environmental innovation, said in a written statement.

Michigan Radio,  
September, 2019



# Keen's PFAS-Free Journey

- PFAS found to 101 places in Keen shoes
- 70 place PFAS were not necessary and removed
- Years of work to find replacements for other 31
- Success!



**Do we need it?**



**67% REDUCTION**  
*Precautionary Principle*



# BRANDS ARE ELIMINATING HIGHLY FLUORINATED CHEMICALS

IKEA

H&M

Crate&Barrel

LEVI STRAUSS & CO.

PUMA

benetton

ESPRIT

adidas

MARKS &  
SPENCER

MANGO

BURBERRY<sup>®</sup>  
LONDON

ZARA

# 2020 National Defense Authorization Act



- Require military to phase PFAS out of firefighting foams
- USGS nationwide water sampling
- Authorize Air Force to compensate for contaminated agricultural lands
- No PFAS in packaging in meals ready to eat



# Biden agenda prioritizes PFAS

- Environmental justice plan calls for:
- Designating PFAS as a hazardous substance
- Setting enforceable drinking water limits
- Prioritizing substitutes through procurement
- Accelerating PFAS research



<https://joebiden.com/environmental-justice-plan/#>

# Moving away from PFAS



CARPETS



CARPET CLEANING PRODUCTS



FOOD PACKAGING



FURNISHINGS



COSMETICS



OUTDOOR GEAR



CLOTHING



ADHESIVES AND SEALANTS



PROTECTIVE COATINGS



NON-STICK COOKWARE



CARSEATS



FIREFIGHTING FOAM





## PFAS Central: sharing notable news, scientific papers & events



NEWS

### PFAS Chemicals to be Banned in Firefighting Foam Used on Military Bases

U.S. Senator Kirsten Gillibrand today announced that a provision she cosponsored to prohibit the Department of Defense from procuring firefighting foam that contains per- and polyfluoroalkyl substances (PFAS) passed the Senate Armed Services Committee as part of the annual National Defense Authorization Act (NDAA).

[LEARN MORE](#)



SCIENCE

### Larval amphibians rapidly bioaccumulate poly- and perfluoroalkyl substances.

Toxic frogs lead to bioaccumulation in predator species.

[LEARN MORE](#)



POLICY

### The Cost of Inaction: A socioeconomic analysis of environmental and health impacts linked to exposure to PFAS

A recent Nordic Council study, The Cost of Inaction: A socioeconomic analysis of environmental and health impacts linked to exposure to PFAS, estimates the very high cost of harm to human health and the environment from PFAS exposure in Europe.

[LEARN MORE](#)

Although useful, PFAS or highly fluorinated chemicals are associated with serious health harm and can remain in the environment forever.

[LEARN MORE](#)



# PFAS-Free Products

We will be adding many more products to this list.

For more information about these products, click links and see footnotes.

## Outdoor Gear



### Rain Gear:

- Columbia (Outdry Ex Eco products, [policy](#))
- Deuter (all products, [policy](#))
- Didriksons (all products, [policy](#))
- Endura (select products, [policy](#))<sup>10</sup>
- Jack Wolfskin (all products, [policy](#))
- Marmut (select products, [policy](#))<sup>9</sup>
- Marmot (EvoDry rainwear products, [policy](#))
- Nau (all products, [policy](#))
- Páramo (all products, [policy](#))
- prAna (select products, [policy](#))<sup>8</sup>
- Royal Robbins (select products, [policy](#))<sup>11</sup>
- Vaude (all apparel products, [policy](#))

### Other:

- DetraPel (all products, [policy](#))
  - Green Oil (all products, [policy](#))
  - Nikwax (all products, [policy](#))
  - Swix Sport, (PURE Marathon Glide Wax, [policy](#))
  - The Tent Lab (all tents, [policy](#))
  - Toko Wax (select products, [policy](#))
- 

## Apparel



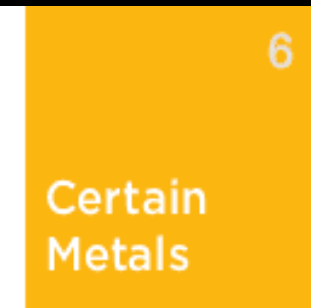
- Benetton<sup>1</sup>
  - Burberry (all products, [policy](#))
  - Esprit<sup>1</sup>
  - Helmut Lang (all products, [policy](#))
  - H&M (all products, [policy](#))
  - J Brand (all products, [policy](#))
  - L Brands<sup>1</sup>
  - Levi Strauss & Co. (all products, [policy](#))
  - Marmut (select products, [policy](#))<sup>9</sup>
  - Otter Wax (all leather and fabric care products, [policy](#))
  - prAna (select products, [policy](#))<sup>8</sup>
  - Royal Robbins (select products, [policy](#))<sup>11</sup>
  - Theory (all products, [policy](#))
  - UNIQLO (all products, [policy](#))
  - Vaude (all apparel products, [policy](#))
  - Zara (all products, [policy](#))
- 

## Shoes




- Adidas (all products, [policy](#))<sup>2</sup>
- AllBirds (Mizzle products, [policy](#))
- H&M (all products, [policy](#))
- Keen (select products, [policy](#))<sup>3</sup>

# Six Classes Videos



[www.SixClasses.org](http://www.SixClasses.org)

Healthier products, healthier people in four minutes!



For monthly e-newsletters:  
[SixClasses.org/Newsletter](http://SixClasses.org/Newsletter)

**Questions:**  
[Arlene@GreenSciencePolicy.org](mailto:Arlene@GreenSciencePolicy.org)





GREEN SCIENCE  
POLICY INSTITUTE

Science + Communication  
+ Government & Business Stakeholders  
=Change

A Healthier Future  
With Reduced Use of PFAS