Trouble in the Grass

How PFAS, Microplastics, and Excess Nitrogen in Lawn Fertilizers Threaten Long Island's Drinking Water, Ecosystems, and Human Health

Introduction

Long Island's aquifers constitute one of the most environmentally sensitive drinking water systems in the United States. Unlike most regions of the country, residents of Long Island rely entirely on groundwater drawn from a **sole-source aquifer system**, meaning there is no practical alternative water supply should contamination occur. These aquifers supply drinking water for nearly three million people and are hydrologically connected to the Island's rivers, lakes, estuaries, and coastal bays. These surface water bodies are critical to fishing and tourism economies of the Island.

Increasing evidence suggests that **synthetic lawn fertilizers represent an underrecognized pathway through which several classes of environmental contaminants enter Long Island's environment**, including:

1. Micro- and nanoplastics
2. Per- and polyfluoroalkyl substances (PFAS)
3. Excess nitrogen

Each of these contaminants has been independently associated with environmental degradation and adverse human health effects. When introduced simultaneously through fertilizer products and land-management practices, they create a **"triple threat" to environmental quality and public health**.

Once applied to lawns, these substances do not remain where they are placed. They can:

- **Leach through soil**, eventually reaching drinking water sources.
- **Run off with stormwater** into streams, ponds, estuaries, and coastal waters.
- **Become airborne** and disperse widely through atmospheric transport.

Because Long Island's soils are predominantly sandy and highly permeable, the transport of soluble chemicals and fine particles into groundwater is particularly efficient. Consequently, pollutants introduced at the land surface can migrate rapidly into the aquifer system (Scorca & Monti, 2001).

This report reviews the scientific evidence regarding these three contaminant classes and examines the environmental and human health risks associated with their presence in commonly used lawn fertilizers. It also outlines practical policy and consumer strategies that could substantially reduce these risks.

Section One: The Microplastic Problem

Sources of Microplastics in Wastewater and Biosolids

Microplastics—plastic particles smaller than 5 millimeters—and nanoplastics—particles smaller than 1 micrometer—have emerged as a major global environmental contaminant. These particles originate from a wide range of sources, including:

- synthetic textile fibers released during wear and laundering
- degradation of plastic packaging and consumer products
- abrasion of car and truck tires
- personal care products containing plastic microbeads
- fragmentation of larger plastic debris

Wastewater treatment plants receive substantial quantities of these materials. Studies estimate that **a single laundry load of synthetic clothing may release hundreds of thousands to millions of microfibers** into wastewater (Napper & Thompson, 2016).

Conventional wastewater treatment facilities were not designed to remove microplastics. Although some particles are captured during treatment, many remain in the effluent or accumulate in sewage sludge. Globally, **the majority of microplastics entering treatment plants ultimately concentrate in biosolids** (Sun et al., 2019).

> *Scientists at UCLA have discovered that there are more microplastics leaving a water treatment facility than came in. This suggests that the various mechanical and chemical processes used to treat wastewater are actually exacerbating the breakdown of plastic pieces into smaller and smaller particles, some of which are too small to measure.*

Biosolids are frequently processed and sold as agricultural or landscaping fertilizers due to their high nitrogen and phosphorus content. As a result, the land application of biosolids represents one of the largest pathways by which microplastics enter terrestrial ecosystems.

In the United States alone, millions of tons of biosolids are applied to agricultural land and suburban landscapes each year, potentially resulting in the introduction of billions of microplastic particles in a single acre.

Microplastics in Fertilizer Products

Biosolids are not the only source of plastic in fertilizers. Many commercial fertilizers contain **polymer-coated "slow-release" granules**. These coatings are typically composed of olefin, polyethylene, or other petroleum-derived polymers designed to control nutrient release.

While these coatings improve fertilizer efficiency, they also degrade into **secondary microplastics** through mechanical abrasion, ultraviolet radiation, and environmental weathering (Bhattacharjee et al*, 2025*).

Thus, fertilizer products may introduce plastic particles into the environment through two mechanisms:

1. Biosolid-derived microplastics already present in sewage sludge
2. Polymer coatings intentionally added to fertilizer granules

Both sources contribute to the accumulation of plastic particles in soils.

***Figure 1**: The fertilizer on the left is coated with a polymer (plastic) coating. The fertilizer on the right is a naturally slow-release fertilizer without a plastic coating.*

Environmental Transport of Microplastics

Microplastics are highly mobile in the environment. Because many particles are extremely small and lightweight, they can be transported by:

- wind erosion
- stormwater runoff
- groundwater movement

Research conducted at the **University of California, Los Angeles** has demonstrated that microplastics can become airborne from agricultural soils treated with biosolids and may travel long distances via atmospheric transport.

Atmospheric studies have detected microplastics in remote environments including:

- Arctic snow
- high-altitude mountain regions
- deep ocean sediments

These findings suggest that plastic particles can circulate globally through the atmosphere and hydrologic cycle (Allen et al., 2019).

Microplastics can also act as **vectors for other pollutants**. Because plastic surfaces readily adsorb hydrophobic chemicals, they can carry:

- pesticides
- heavy metals
- persistent organic pollutants
- PFAS compounds

This capacity to carry toxic chemicals may amplify their environmental and health impacts (Rochman et al., 2013).

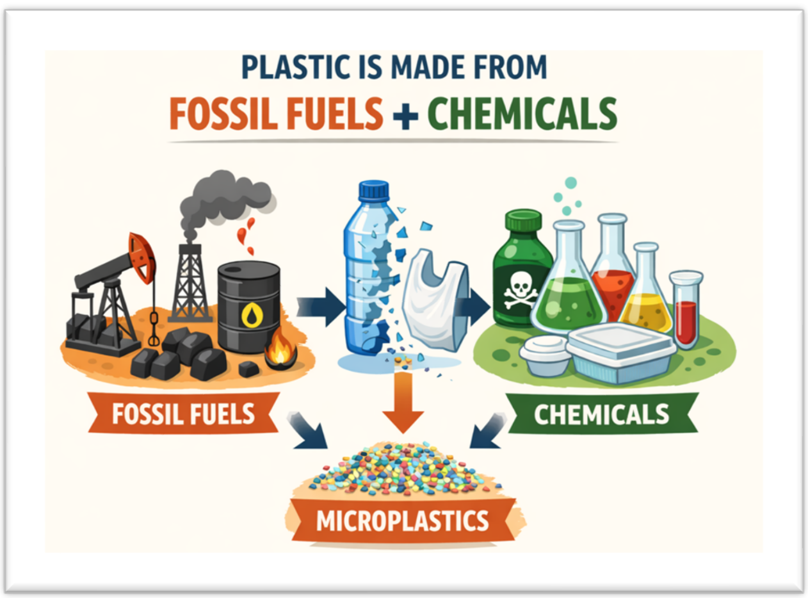

Figure 2*: Plastic is manufactured from fossil fuels (mostly natural gas) and chemicals, many of which are toxic to humans. Eventually all plastic remaining in the environment breaks down into micro- and nanoplastics.*

Human Health Risks

Human exposure to microplastics occurs through ingestion, inhalation, and dermal absorption. Airborne particles are of particular concern because they can penetrate deep into lung tissue.

Recent studies have identified microplastics in:

- human lung tissue
- blood samples
- placental tissue
- arterial plaque

A 2024 study published in the **New England Journal of Medicine** reported that patients whose arterial plaques contained microplastics were **4.5 times more likely to experience heart attack, stroke, or death** compared with patients whose plaques did not contain plastic particles (Marfella et al., 2024).

Other studies suggest links between chronic microplastic exposure and:

- respiratory inflammation
- asthma
- chronic obstructive pulmonary disease (COPD)
- oxidative stress and cellular damage (Prata, 2018)
- cancer (Goswami et al, 2024)

Children may be particularly vulnerable because their respiratory systems are still developing and they inhale larger volumes of air relative to body weight.

Ecological Impacts

Microplastics have now been documented in nearly all marine ecosystems and in a wide range of freshwater bodies. Fish, shellfish, and other aquatic organisms ingest plastic particles either directly or through contaminated prey.

These particles can accumulate in digestive tissues, gills, and in some cases edible muscle tissue. Consequently, microplastics are increasingly entering human bodies through seafood consumption.

Section Two: The PFAS Problem

Persistence and Environmental Behavior

Per- and polyfluoroalkyl substances (PFAS) are a large class (approximately 15,000 unique formulations) of synthetic chemicals characterized by extremely strong carbon-fluorine bonds. This chemical structure makes them **extraordinarily resistant to degradation**, earning them the nickname "forever chemicals."

PFAS have been widely used since the mid-20th century in products that require resistance to water, grease, and stains, including:

- non-stick cookware
- water-resistant textiles
- food packaging
- firefighting foams
- industrial coatings

Because of their persistence and mobility, PFAS are now found globally in air, soil, surface waters, and human blood samples.

Figure 2*: Harmful PFAS chemicals are found in a variety of consumer products, including lawn fertilizer.*

PFAS in Biosolids and Fertilizers

Wastewater treatment plants receive PFAS from household and industrial sources. Conventional treatment processes are largely ineffective at removing these chemicals. As a result, PFAS accumulate in sewage sludge (biosolids). Studies have detected **dozens of PFAS compounds in biosolids used as fertilizer** (Venkatesan & Halden, 2013).

When these biosolids are applied to land, PFAS can:

- migrate through soil into groundwater
- be transported by runoff into surface waters
- accumulate in food crops and livestock

Some PFAS may also originate from polymer coatings used in fertilizer manufacturing or from contaminated compost feedstocks.

Toxicity and Health Effects

Exposure to PFAS has been associated with numerous adverse health outcomes. According to the **United States Environmental Protection Agency**, epidemiological studies link PFAS exposure to:

- increased cholesterol levels
- immune system suppression
- decreased vaccine response
- thyroid disease
- pregnancy complications
- kidney and testicular cancers

In 2024 the EPA established a national drinking water standard of **4 parts per trillion** for the PFAS compounds PFOA and PFOS, reflecting their extreme toxicity and persistence. A number of water districts on Long Island currently exceed these limitations.

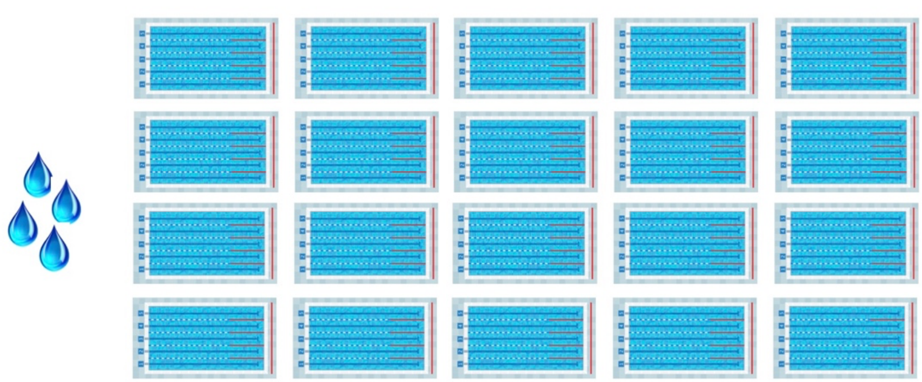

Figure 3: Four parts per trillion is the equivalent of four drops of water in 20 Olympic-sized swimming pools

Even at extremely low concentrations, PFAS can accumulate in human tissues over time because the body eliminates them very slowly.

Unfortunately, this is not new science. As early as the 1960s, manufacturers understood these "miracle" chemicals had a dark side, but little was disclosed to the public about the toxicity of PFAS for the first 50 years of their use.

> *"DuPont had evidence of PFAS toxicity from internal animal and occupational studies that they did not publish in the scientific literature and failed to report their findings to EPA as required under TSCA [the Toxic Substances Control Act]. These documents were all marked as 'confidential.'"*
>
> - The Devil They Knew: Chemical Documents Analysis of Industry Influence on PFAS Science, University of California at San Francisco (2023)

Environmental Transport

PFAS are highly soluble and mobile in water. Once introduced into soil, they can migrate rapidly into groundwater systems.

This is particularly concerning for Long Island because its **sole-source aquifer lies directly beneath permeable sandy soils**, which allow contaminants to move relatively quickly into groundwater.

PFAS can also become airborne, primarily from erosion, physical disturbance, and chemical processes.

Because PFAS degrade extremely slowly, contamination introduced today may persist for decades or longer.

Section Three: Excess Nitrogen

Nitrogen in Fertilizers

Nitrogen is an essential plant nutrient required for protein synthesis, chlorophyll production, and cellular metabolism. In lawns and agricultural systems, nitrogen is commonly applied in fertilizers to promote rapid plant growth.

Nitrogen fertilizers fall into two broad categories:

1. **Organic or natural sources** – compost, manure, grass clippings, animal manure, fish emulsion, plant-based fertilizers
2. **Synthetic fertilizers** – typically manufactured through the Haber-Bosch process, which converts atmospheric nitrogen into ammonia using natural gas

Synthetic fertilizers frequently contain **urea or ammonium compounds** that are highly soluble in water. In the environment, they become one of Long Island's primary sources of water pollution.

Organic v. Synthetic fertilizers

Organic and synthetic fertilizers work differently in the soil. The nitrogen in most organic fertilizers is water insoluble, and is broken down by microbial action, supplying plants with nutrients as they are needed.

The nitrogen in synthetic fertilizer is released on contact with moisture, whether the plants need it or not. The result is that much of the synthetic nitrogen is not taken up by plants, but instead enters the environment, leaching past the plant's root zone or running off with stormwater.

Since the organic product stays where it is applied and nutrients are released naturally over time, far less fertilizer is required to produce high quality results.

Nitrogen Losses to the Environment

Plants typically absorb only a portion of applied synthetic nitrogen in fertilizer. Scientific studies estimate that **30–50% of nitrogen applied to soils may be lost to the environment** through leaching, runoff, or atmospheric emissions (Galloway et al., 2008).

On Long Island, these losses are particularly problematic because soluble nitrogen can move quickly through sandy soils into groundwater.

Impacts on Surface Waters

Nitrogen runoff into rivers, lakes, and estuaries stimulates excessive growth of algae and even cyanobacteria (blue-green algae). This process, known as **eutrophication**, can produce large algal blooms that consume oxygen as they decompose.

Low-oxygen conditions, or **hypoxia**, can lead to:

- fish kills
- loss of shellfish habitat
- degradation of coastal ecosystems
- closing of public beaches

Nitrogen pollution has been identified as a major contributor to water quality problems in many coastal regions, including Long Island's estuaries.

> **How much nitrogen in a bag of fertilizer is too much?**
> *High-nitrogen lawn fertilizer is not the only source of excess nitrogen loading on Long Island, but it's one factor that can be easily controlled. Fertilizers with more than 12% nitrogen (the first of the three numbers on a bag of fertilizer) may produce a quick "green up," but they can contain more water-soluble nitrogen than plants can use, leading to water pollution. Consumers have many choices when it comes to lawn fertilizers, including many naturally slow-release lawn fertilizers containing less than 12% nitrogen.*

Human Health Effects

High nitrate concentrations in drinking water are associated with **methemoglobinemia**, commonly called "blue baby syndrome," a potentially life-threatening condition in infants.

Research also suggests possible associations between long-term nitrate exposure and increased risk of several cancers, including colorectal and ovarian cancer, thyroid disease, neural tube defects, and adverse reproductive outcomes (Ward et al., 2018).

Climate Impacts

Nitrogen fertilizers also contribute to climate change through emissions of **nitrous oxide (N_2O)** during microbial soil processes.

Nitrous oxide is a powerful greenhouse gas with a global warming potential approximately **273 times greater than carbon dioxide over a 100-year period** (IPCC, 2021).

Conclusion & Strategic Solutions

The combined presence of **microplastics, PFAS, and excess nitrogen in some popular lawn fertilizers represents a complex and interconnected environmental challenge**.

Each of these contaminants:

- are persistent in the environment
- spread beyond the point of application
- pose documented risks to ecosystems and human health

This report outlines several practical strategies that local governments, organizations, and communities can implement to reduce contamination risks associated with lawn care products.

1. Consumer Education

Consumer education is a key component of reducing the use of harmful lawn care products.

Town and village governments, working together with local civic, environmental, and sustainability organizations, can inform homeowners about the environmental and health risks associated with certain lawn products. Outreach efforts may include:

- Educational information on municipal websites and social media platforms
- Articles or informational inserts in municipal newsletters and mailed communications
- Distribution of printed educational materials at public venues such as:
    - Farmers' markets
    - Street fairs
    - Environmental events, such as Earth Day

These outreach activities help homeowners understand the risks associated with certain lawn products and encourage the use of safer, non-polluting alternatives.

---

2. Municipal Action

Local governments can also lead by example through policy and practice.

Cities, towns, and villages may adopt regulations or internal policies governing the use of lawn care products on municipal properties. Such policies could prioritize the use of environmentally safe and non-polluting fertilizers in public parks, recreational areas, and other municipal lands.

Municipalities can further promote these practices by informing residents through:

- Yard signs placed on municipal properties
- Notices in municipal newsletters
- Public announcements encouraging residents to adopt similar practices

By modeling environmentally responsible lawn care, municipalities can help shift community norms and reduce pollution risks.

---

3. Retailer Education

Retailers play an important role in shaping consumer choices.

Copies of this report can be mailed or delivered directly to lawn care retailers in local communities. Retailers can be encouraged to help inform customers about potential environmental and health concerns associated with certain lawn care products.

Products that meet stricter environmental standards could be identified using a recommended labeling approach. For example, lawn care products could be labeled **"Long Island-Friendly"** if they meet the following criteria:

- Do not contain biosolids from any source
- Contain no measurable amounts of PFAS chemicals
- Contain nitrogen levels no greater than 12%, as certified by the manufacturer

Such labeling would help consumers make informed purchasing decisions and encourage retailers to promote safer products.

---

4. County Legislation

County governments have the obligation and authority to implement broad regulatory measures that support groundwater protection. Legislation should mandate that lawn care products sold within the county must not contain:

- Biosolids from any source
- Any measurable amounts of PFAS (whether intentionally or unintentionally added)
- Nitrogen levels exceeding 12%

County laws could also authorize products meeting strict environmental standards to carry prominent county-approved labels indicating that the product helps protect water on Long Island by complying with environmental guidelines designed to reduce drinking and surface water contamination.

Conclusion

The problem of polluting lawn products sold and used on Long Island needs immediate attention. Because Long Island's drinking water comes entirely from a sole-source aquifer, proactive measures are required ***now*** to prevent further contamination. Education, local government leadership, retailer engagement, and county-level legislation together can significantly reduce the environmental risks posed by certain lawn care products.

By adopting these strategies, communities across Long Island can help safeguard groundwater resources and protect public health for future generations.

Acknowledgements

This report was produced for the Long Island Water Coalition by Grassroots Environmental Education, a science-based non-profit organization located in Port Washington, New York. The report was funded by a grant from the Park Foundation and Friends of Grassroots.

We would like to acknowledge the important contributions and assistance of the following experts who appeared in a webinar on this subject on March 4, 2026:

Sanjay Mohanty*, PhD, Associate Professor, Department of Civil and Environmental Engineering, UCLA*

Kyla Bennett, *PhD, JD,* *Director of Science Policy at Public Employees for Environmental Responsibility (PEER)*

Omanjama Goswami*, PhD, Interdisciplinary Scientist with the Food and Environment Program at the Union of Concerned Scientists*

Peer-reviewed References

Allen S, Allen D, Phoenix, VR, *et al*. Atmospheric transport and deposition of microplastics in a remote mountain catchment. *Nature Geosci*ence 12, 339–344 (2019).

Amato-Lourenço LF, *et al*. Presence of airborne microplastics in human lung tissue. Journal of hazardous materials. https://pubmed.ncbi.nlm.nih.gov/34492918/.(2021)

Bhattacharjee L, *et al*. Mechanisms of microplastic generation from polymer-coated controlled-release fertilizers (PC-CRFs), *Journal of Hazardous Materials*, Volume 486, (2025)

Bergmann M, *et al*. White and wonderful? Microplastics prevail in snow from the Alps to the Arctic. *Science Advances* (2019).

Buck RC, *et al*. Perfluoroalkyl and polyfluoroalkyl substances in the environment: Terminology, classification, and origins. *Integrated Environmental Assessment and Management*, 7: 513-541 (2011)

Buxton HT, and Smolensky, D.A., Simulation of the effects of development of the ground-water flow system of Long Island, New York: *U.S. Geological Survey Water Resources Investigations* Report 98-4069, 57 p. (1999)

Corradini F, *et al*. Evidence of microplastic accumulation in agricultural soils from sewage sludge disposal, *Science of The Total Environment*, Volume 671 (2019)

Diaz R, Rosenberg R. Spreading Dead Zones and Consequences for Marine Ecosystems. *Science* 321,926-929 (2008).

Dris R, *et al*. Synthetic fibers in atmospheric fallout: A source of microplastics in the environment? *Marine Pollution Bulletin*, Volume 104, Issues 1–2, 290-293 (2016)

Erisman J, Sutton M, Galloway J. *et al*. How a century of ammonia synthesis changed the world. *Nature Geoscience* 1, 636–639 (2008).

Galloway J, *et al*. Transformation of the Nitrogen Cycle: Recent Trends, Questions, and Potential Solutions. *Science* 320,889-892 (2008)

Goswami S, *et al*. The alarming link between environmental microplastics and health hazards with special emphasis on cancer, Life Sciences, Volume 355, (2024)

Grandjean P, Clapp R. Changing interpretation of human health risks from perfluorinated compounds. *Public Health Rep*. Nov-Dec;129 (6):482-5. (2014)

Intergovernmental Panel on Climate Change, Assessment Report 2021, accessed at https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM_final.pdf

Leslie H, *et al.* Discovery and quantification of plastic particle pollution in human blood. *Environment International*, Volume 163 (2022)

Marfella R, *et al*. Microplastics and Nanoplastics in Atheromas and Cardiovascular Events. *New England Journal of Medicine*. Mar 7;390(10):900-910 (2024)

Napper I, Thompson R. Release of synthetic microplastic plastic fibres from domestic washing machines: Effects of fabric type and washing conditions. *Marine Pollution Bulletin*, Volume 112, Issues 1–2, 39-45 (2016)

Prata JC. Airborne Microplastics: Consequences to Human Health? *Environmental Pollution,* 234, 115-126 (2018)

Ragusa A *et al*. Plasticenta: First Evidence of Microplastics in Human Placenta. *Environment International*, 146 (2021)

Scorca M, Monti J. Estimates of Nitrogen Loads Entering Long Island Sound from Ground Water and Streams on Long Island, New York, 1985-96. *U.S. Geological Service* (2001), accessed at https://pubs.usgs.gov/wri/2000/4196/wri20004196.pdf

Sun J, *et al.* Microplastics in wastewater treatment plants: Detection, occurrence and removal. *Water Research*, Volume 152, Pages 21-37 (2019)

Venkatesan AK, Halden RU. National inventory of perfluoroalkyl substances in archived U.S. biosolids from the 2001 EPA National Sewage Sludge Survey. *Journal of Hazardous Materials* May 15; 252-253 (2013)

Ward M, *et al.* Drinking water nitrate and human health. *International Journal of Environmental Research and Public Health* (2018)