

Communication from Public

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Comments for Public Posting: Comments on artificial turf from PEER.org, Public Employees for Environmental Responsibility. Kyla Bennett, PhD, JD, is one of two researchers who discovered PFAS in synthetic turf.



November 22, 2024

RE: Downsides of Artificial Turf

Public Employees for Environmental Responsibility (PEER) is extremely concerned about the proliferation of artificial turf installations around the country. We are providing comments on the adverse impacts of artificial turf so you can make an informed decision, particularly in regard to per- and polyfluoroalkyl substances (PFAS) and several misstatements of facts/errata that are commonly presented by landscape architects and consultants at various municipal meetings. Our specific comments are set forth below.

What are PFAS? PFAS are a large family of chemicals that number between 6,504¹ and 12,039² human-made chemicals that provide heat, stain, and water resistance. Yet, due to the strong carbon-fluorine bonds that occur in these molecules, PFAS do not easily break down in the environment and are called “forever chemicals.” Well-studied PFAS are toxic to humans in concentrations as small as parts per quadrillion (ppq).³ While the U.S. Environmental Protection Agency (EPA) does not have a consistent definition of PFAS, most states define PFAS as any chemical with at least one fully fluorinated carbon. Regardless of which definition is used, the adverse health impacts of PFAS are undeniable.

Specifically, PFAS are associated with cancer and are linked to growth, learning, and behavioral problems in infants and children; fertility and pregnancy problems, including pre-eclampsia; interference with natural human hormones; increased cholesterol; and immune system problems.⁴ Epidemiological studies have found decreased antibody response to vaccines,⁵ and

¹ <https://www.epa.gov/system/files/documents/2021-10/pfas-natl-test-strategy.pdf>

² ENVTL. PROTECTION AGENCY, *PFAS Master List of PFAS Substances*, https://comptox.epa.gov/dashboard/chemical_lists/pfasmaster

³ CAL. OFFICE OF ENVTL. HEALTH HAZARD ASSESSMENT, *Announcement of Availability of a Draft Technical Support Document and Public Workshop for Proposed Public Health Goals for Perfluorooctanoic Acid and Perfluorooctane Sulfonic Acid in Drinking Water*, (July 22, 2021) <https://oehha.ca.gov/water/crn/announcement-availability-draft-technical-support-document-and-public-workshop-proposed>.

⁴ U.S. Dept. of Health and Human Services, Agency for Toxic Substances and Disease Registry, *Toxicological Profile for Perfluoroalkyls*, (May 2021), <https://www.atsdr.cdc.gov/toxprofiles/tp200.pdf>

⁵ Sunderland, E. M. et. al., *A Review of the Pathways of Human Exposure to Poly- and Perfluoroalkyl Substances (PFASs) and Present Understanding of Health Effects*, 29 JOURNAL

associations between blood serum PFAS levels and both immune system hypersensitivity and autoimmune disorders like asthma and ulcerative colitis.⁶ The negative immune system effects of PFAS are extremely concerning given the ongoing COVID-19 pandemic. Recently, the Centers for Disease Control and Prevention released a “Statement on Potential Intersection between PFAS Exposure and COVID-19,” which recognized the “evidence from human and animal studies that PFAS exposure may reduce antibody responses to vaccines . . . and may reduce infectious disease resistance.”⁷ Most recently, PFAS exposure has been found to be associated with mortality from cardiovascular disease,⁸ and with chemotherapy resistance.⁹

Numerous studies have found toxicity in legacy PFAS, such as PFOS and PFOA. Yet, as scientists study newer replacement PFAS, they are finding similar adverse toxicological outcomes in the new PFAS they test.¹⁰ A compilation of PFAS toxicity studies shows that virtually every PFAS examined is correlated with adverse health outcomes.¹¹ Finally, it is worth noting that a peer-reviewed article from 2023 concludes that “there are cancer risks probability occurs as a result of chemical exposure from artificial turf.”¹²

It is also important to note that several PFAS are subject to California’s Prop 65. One of the PFAS on California’s Prop 65 list is PFOA,¹³ which is found in roughly three-quarters of artificial turf.¹⁴

Routes of exposure for PFAS include ingestion, inhalation, and dermal absorption. While ingestion of PFAS is the most common route of exposure, scientists are finding that inhalation and dermal absorption are important routes of exposure. The federal Agency for Toxic Substances and Disease Registry (ATSDR) states that people working with PFAS “may be exposed to PFAS by inhaling them, getting them on their skin, and swallowing them.”¹⁵ Moreover, recent work shows that firefighters can be exposed to PFAS through “ingestion or inhalation, or direct contact with the skin and dermal absorption.”¹⁶ Recent studies have shown

OF EXPOSURE SCIENCE AND ENVIRONMENTAL EPIDEMIOLOGY, no. 2, (2018),
<https://pubmed.ncbi.nlm.nih.gov/30470793/>.

⁶ See U.S. Environmental Protection Agency, *Drinking Water Health Advisory for Perfluorooctanoic Acid (PFOA)*, 39 (May 2016), https://www.epa.gov/sites/production/files/2016-05/documents/pfoa_health_advisory_final_508.pdf.

⁷ Centers for Disease Control and Prevention and Agency for Toxic Substances and Disease Registry, *Statement on Potential Intersection between PFAS Exposure and COVID-19*, <https://www.atsdr.cdc.gov/pfas/health-effects/index.html> (last visited Mar. 29, 2021).

⁸ <https://link.springer.com/article/10.1186/s12940-024-01074-2>

⁹ <https://www.sciencedirect.com/science/article/pii/S1572100024001807>

¹⁰ U.S. Dept. of Health and Human Services, National Toxicology Program, *Per- and Polyfluoroalkyl Substances (PFAS)*, <https://ntp.niehs.nih.gov/whatwestudy/topics/pfas/index.html>

¹¹ <https://pfasproject.com/pfas-toxic-database/>

¹² <https://doi.org/10.1016/j.heliyon.2023.e14928>

¹³ <https://www.p65warnings.ca.gov/fact-sheets/pfos-perfluorooctane-sulfonate-or-perfluorooctane-sulfonic-acid>

¹⁴ https://curate.nd.edu/articles/thesis/Development_of_Analytical_Methods_for_Highly_Selective_and_Sensitive_Analysis_of_Compounds_Relevant_to_Human_Health_and_the_Environment/24869502

¹⁵ <https://www.atsdr.cdc.gov/pfas/health-effects/exposure.html#:~:text=Workers%20may%20be%20exposed%20to,your%20body%20through%20your%20skin.>

¹⁶ <https://www.sffcpf.org/wp-content/uploads/2020/06/6.23.2020-DR-PEASLEE-STUDY-ANOTHER-PATHWAY-FOR-FIREFIGHTER-EXPOSURE-TO-PFAS-FIREFIGHTER-TEXTILES.pdf>

that some PFAS can migrate from car seat fabric to sweat, showing a potential dermal exposure route.¹⁷ Finally, PEER conducted a preliminary study which indicates that children playing on artificial turf do pick PFAS up on their skin.¹⁸ Additional research is being conducted on this issue.

There are per-and polyfluoroalkyl substances (PFAS) in artificial turf. In 2019, scientists from PEER and The Ecology Center discovered PFAS in the blades and backing of artificial turf. Since then, artificial turf manufacturers and consultants have conceded that PFAS are added to the machines to assist in the extrusion of the hot plastic, but PFAS are also used as “a slip agent that is intentionally added to the molten hydrocarbons to make the plastic grass blades free of defects.”¹⁹ In other words, PFAS *are* used in the base material itself. In fact, every sample of dozens of artificial turf samples, regardless of the manufacturer, shows PFAS²⁰ in the grass blades, the backing, and sometimes the shock pad and the infill. Moreover, Synthetic Precipitation Leaching Procedures (SPLPs) show that these PFAS leach off the fields into surrounding waters; indeed, 12 ppt of just six PFAS will leach off a brand new field.^{21,22}

Landscape architects/consultants often promise that certification from the turf manufacturer shows that PFAS are not used in the manufacturing of the artificial turf system. This is not true. The artificial turf industry claimed for years that they did not use PFAS, and we now know that they do. A bill proposing to ban artificial turf containing PFAS in California led to the Synthetic Turf Council testifying that:

The bill a (sic) ban on the sale of artificial turf containing intentionally added PFAS on January 1, 2024 to certain public entities and by January 1, 2025 for all sales in California. These dates do not provide enough time for manufacturers and suppliers to develop viable alternatives for the market place...²³

This testimony is a clear admission that all artificial turf contains PFAS.

Certification from the industry itself claiming the products are PFAS-free will not protect a town or city from contamination. Landscape architects/consultants also often state one or more of the following:

- the synthetic turf system shall be considered “PFAS free” according to REACH and/or California’s Prop 65;

¹⁷ <https://www.sciencedirect.com/science/article/abs/pii/S0269749120361650?via%3Dihub>

¹⁸ <https://peer.org/pfas-in-artificial-turf-coats-players-skin/>

¹⁹ https://oakbluffs.zoom.us/rec/play/XRPkH-Yd8joprhyIovKEPo3SpdVyri6t5Intk1wSyaXPB10ZXZ6U_IUjX9npl9X4DduJgE7gjIndVKMS.qSRjKd7F9cH_sF-e?continueMode=true&_xzm_rtaid=oO_jk5lWTT-Y7W-V3an6Yw.1652118740167.3adaa7e26df2bb777484f4cc1217465c&_xzm_rhtaid=887

²⁰ Dr. Graham Peaslee and Kristen Mello, NEWMOA Conference, April 6, 2022

²¹ Id.

²² https://www.mvcommission.org/sites/default/files/docs/2021-02-26%20%28TurfAnalysisReport_FINAL%29.pdf

²³ June 21, 2023 letter from Melanie Taylor, President & CEO, Synthetic Turf Council to California Senator Ben Allen; copy available upon request

- the turf system shall be non-detect (ND) for 30 PFAS compounds tested via EPA Method 537 Modified; or
- they will provide a statement from the vendor that the turf does not contain and is not manufactured with PFAS.

These statements show a lack of understanding of PFAS, its regulation, toxicity, and testing regimens. First, REACH and Prop 65 do not regulate the same PFAS chemicals that many states regulate. Second, PFAS chemistry is complicated, and precursor PFAS can have terminal end products that are regulated PFAS themselves; therefore, the best way to protect surrounding soil and water is to prohibit *any* PFAS in the turf materials. To protect themselves, cities and towns should require: 1) *all* components of the turf, including infill, should be tested using the Synthetic Precipitation Leaching Procedure (SPLP) acid treatment before testing for targeted (not total organic fluorine) PFAS²⁴; 2) those tests should be done by an independent laboratory with low detection limits; and 3) *any* amount of targeted PFAS should be prohibited.

Even minute amounts of PFAS are dangerous. In April of 2024, the U.S. Environmental Protection Agency (EPA) issued its final drinking water limits for six PFAS, including PFOA and PFOS.²⁵ The limits are 4 ppt for both PFOA and PFOS individually, but EPA also proposed health-based, non-enforceable Maximum Contaminant Level Goals (MCLGs) of *zero* because “there is no dose below which either chemical is considered safe.”²⁶ Now that these proposed regulations are finalized, all states will have to comply with them.

Given that we are seeing these PFAS leaching off artificial turf, it is important to assess the impacts to the groundwater, surface water, and soils from the PFAS in these products. Indeed, Dr Graham Peaslee of Notre Dame University estimates that one artificial turf field will leach 12 mg of PFAS/year, which in turn will contaminate roughly 800,000 gallons of water. It appears that as a field ages and is subject to ultraviolet light, abrasion, and acidic rain, even more PFAS will leach off. Legal liability issues should be considered, as municipalities can be considered a responsible party in the contamination of drinking water wells, surface water, groundwater, and soils from artificial turf.

Artificial turf does not save water. Proponents of artificial turf, particularly in drought stricken areas, often tout the water-saving properties of artificial turf. A 2017 study in New Mexico concluded that “in order to provide a cool, playable surface, irrigation amounts for artificial turf are *greater* than for natural warm-season turf” (emphasis added).²⁷ This study was confirmed in 2020 when researchers found that “that the amount of water required to maintain [artificial turf] temperatures at levels comparable to irrigated [natural turf] over a 24-h period exceed the water requirements of Bermuda grass [natural turf] in the same environment.”²⁸ In fact, a member of the Synthetic Turf Council claims that irrigation systems for artificial turf must be “over-engineered” and that “a large amount of water has to be dumped evenly across the whole field—

²⁴ SPLP tests measure materials that leach off the field due to rainfall; it measures organic and inorganic compounds present in the artificial turf system, and reveals what will enter the soil, groundwater, or nearby surface waters.

²⁵ https://www.epa.gov/system/files/documents/2024-04/pfas-npdwr_prepubfederalregisternotice_4.8.24.pdf

²⁶ <https://www.federalregister.gov/documents/2023/03/29/2023-05471/pfas-national-primary-drinking-water-regulation-rulemaking>

²⁷ <https://scisoc.confex.com/crops/2017am/webprogram/Handout/Paper106290/Ahmed%20Kanaan.pdf>

²⁸ Kanaan, A. et al., Water Requirements for Cooling Artificial Turf, J. Irrig. Drain Eng., 2020, 146(10): 05020004

and quickly because players will want to play immediately. And the cooling effect only lasts about an hour, maybe less.”²⁹ Therefore, it is important for cities and towns to consider recent scientific studies regarding the necessity of watering artificial turf to maintain cool enough temperatures to play.

So-called “organic” infills are not necessarily safe from a heat or chemical perspective. We are now hearing landscape architects/consultants saying that if they use one of the “organic” infills – like BrockFILL, coconut husks, walnut shells, and the like – the temperature of the field will be 20 to 40 degrees lower than those artificial turf fields with crumb rubber infill. This is not true.

While using infill other than crumb rubber can reduce the temperature of artificial turf by a few degrees, it is not a significant reduction. One recent study concluded that, “High surface temperatures have been attributed to the black crumb rubber infills, and *different alternative infills were tested but with only small changes observed*”³⁰ (emphasis added). Another study concluded that, “synthetic turf infill does not affect surface temperature as much as fibres.”³¹ In addition, another researcher concluded:

Although it is common to blame the sunlight’s interaction with the black crumb rubber for the hot surface, the fibers also significantly contribute to a field’s temperature. Anyone who has spent time working with traditional (non-infilled) AstroTurf-type surfaces can tell you that those fields also got extremely hot and they do not contain any crumb rubber...it is obvious that there is no “magic bullet” available to dramatically lower the surface temperature of synthetic turf. Reductions of five or even ten degrees offer little comfort when temperatures can still exceed 150° F.³²

These “organic” infills are not organic as organic food certified by the United States Department of Agriculture (USDA); while the word “organic” sounds non-toxic, it is not necessarily. Indeed, a 2021 study³³ conducted for Martha’s Vineyard, Massachusetts, found that BrockFILL, one of the more popular organic infills, contained:

- Barium levels of 112 µg/L (ppb);
- Cadmium at a concentration of 0.042 mg/kg (ppm);
- Selenium at concentrations of 0.656 mg/kg (ppm);
- Zinc at concentrations of 85 µg/L (ppb);
- Phenol at a concentration of 6.9 mg/kg (ppm)

²⁹ <https://www.parksandrecbusiness.com/articles/2016/10/part-2-watering-synthetic-turf>

³⁰ Gustin, M., et al, *Modelling Surface Temperatures on 3G Artificial Turf*, Presented at the 12th Conference of the International Sports Engineering Association, Brisbane, Queensland, Australia, 26–29 March 2018. Published: 13 February 2018

³¹ Thomsa, A. W. et al., *Models for predicting surface temperatures on synthetic turf playing surfaces*, *Procedia Engineering* 72 (2014) 895 – 900

³² Serensits, T.J. Is there any way to cool synthetic turf? *SportsTurf* 2011, 27, 20–22.
<https://sturf.lib.msu.edu/article/2011jun20.pdf>

³³ https://www.mvcommission.org/sites/default/files/docs/2021-02-26%20%28TurfAnalysisReport_FINAL%29.pdf

- 2-methylphenol (o-cresol) and 3-methylphenol (m-cresol) at concentrations of 8.8 µg/L and 16 µg/L (ppb), respectively;
- 2,4-dimethylphenol at a concentration of 1.8 µg/L (ppb); and
- Benzyl alcohol at a concentration of 15 µg/L (ppb).

Therefore, it is important to consider that these alternative infills do not significantly reduce the heat island effect, and that they may contain chemicals of concern.

Artificial turf results in greenhouse gas emissions. Recent research shows that “the substitution of artificial grass for natural grass contributes to global warming.”³⁴ Additionally:

...artificial grass reaches significantly greater temperatures than those reached by natural grass under the same meteorological conditions... artificial grass creates an additional amount of energy absorbed by the atmosphere. With the number of nationwide artificial grass installations, a typical result yields an additional energy deposited into the atmosphere during moderately warm summer days of 10 to 20 gigawatts.³⁵

More recent research conducted this year states that artificial turf “can significantly increase ground surface temperatures and consequently increase ambient air temperatures near the ground as well as its surroundings.”³⁶ Indeed, the scientists conclude that, “[c]oncerning climate mitigation, replacing natural ground with heat-absorbent artificial turf may be counter-productive.”³⁷ It is also important to note that EPA considers artificial turf to be an impervious surface,³⁸ which exacerbates runoff and contamination of adjacent waterways. This is especially critical with climate change bringing frequent torrential rain (rain bombs) and other storms.

The majority of existing artificial turf studies focus on the dangers of crumb rubber infill. Most studies often cited by proponents of artificial turf were conducted before PFAS was discovered in the products in 2019, and recent studies showing risk or harm are often not included. Therefore, any study on the health effects of artificial turf conducted prior to 2019 will not assess risks from PFAS.

Artificial turf results in the discharge of microplastics. Both the grass blades of the plastic turf and infill migrate off the field and get into soils and waters. Hundreds of pounds of microplastics shed off these fields each year, despite industry’s claims that they do not break.³⁹ In fact, research from Sweden indicates that microplastics coming off artificial turf fields is the second largest source of microplastics in the environment.⁴⁰ Recent research shows that fibers from artificial grass accounted for 15% of plastic pieces larger than 5 millimeters in all microplastics within 1 kilometer of the shore; they found 213,200 pieces of artificial turf floating

³⁴ Golden, L.M., Sustainability and Climate Change. Dec 2021.436-449. <http://doi.org/10.1089/scc.2021.0038>

³⁵ Id.

³⁶ Shi, Y. and C.Y. Jim, *Developing a Thermal Suitability Index to assess artificial turf applications for various site-weather and user-activity scenarios*, Landscape and Urban Planning, Volume 2017 (2022).

³⁷ Id.

³⁸ <https://www3.epa.gov/region1/npdes/stormwater/ma/2016fpd/appendix-a-2016-ma-sms4-gp-mod.pdf>

³⁹ <https://www.youtube.com/watch?v=A8OLBfWmt7g&t=2s>

⁴⁰ <https://www.diva-portal.org/smash/get/diva2:1549783/FULLTEXT01.pdf>

in water per square kilometer.⁴¹ PFAS and other toxic chemicals will migrate with these microplastics and contaminate nearby soil and waters.

Artificial turf cannot currently be recycled. There are currently no artificial turf recycling facilities in the United States, and old fields are being unceremoniously dumped all over the country.⁴² Recently, landscape architects/consultants are claiming there are artificial turf recycling facilities in Pennsylvania and Texas. The facility in Pennsylvania is not operating, and in fact has been cited for environmental violations.⁴³ The facility in Texas is an “advanced recycling” facility run by Exxon; turf will be “recycled” via pyrolysis, which means it will be burned.⁴⁴ This pyrolysis results in intensive energy and water use, and spews toxic chemicals into the air. It should not be called “recycling.” Artificial turf providers should be required to specifically disclose what will happen to the tons of PFAS-laden plastic at the end of the field’s life.

Artificial turf is more expensive than natural grass. When full lifecycle costs (i.e., installation, maintenance, and disposal/replacement) are considered, artificial turf is more expensive than natural grass. In 2016, the Toxics Use Reduction Institute (TURI) did a comparison of costs of artificial turf versus natural grass, based on real world examples, and concluded that, “In nearly all scenarios, the full life-cycle cost of natural turf is lower than the life-cycle cost of a synthetic turf field for an equivalent area.”⁴⁵

Athletes experience more non-contact injuries on artificial turf. Contrary to industry-funded studies, independent research finds that children and athletes have higher injury rates on artificial turf. For example, a 2024 study examining the risk of concussions found “significantly greater impact deceleration on synthetic turf compared to the natural grass surfaces.”⁴⁶ Scientists concluded that, “natural grass fields are a softer playing surface compared to synthetic turf fields”⁴⁷ which correlates with a higher rate of lower extremity injuries and concussions. It is important to note that these scientists also concluded that:

There is a misconception that one of the benefits of synthetic turf over natural grass is that synthetic turf is maintenance free. Routine maintenance practices such as raising matted-down fibers, infill restoration, and paint and debris removal, may be required *even weekly* depending on field usage⁴⁸ (emphasis added).

⁴¹ <https://www.sciencedirect.com/science/article/pii/S0269749123010965>

⁴² <https://www.theatlantic.com/science/archive/2019/12/artificial-turf-fields-are-piling-no-recycling-fix/603874/>

⁴³ <https://www.phillyburbs.com/story/news/environment/2023/03/20/pa-officials-say-turf-recycler-is-violating-environmental-laws/69995371007/>

⁴⁴ <https://www.theguardian.com/us-news/2023/apr/10/exxon-advanced-recycling-plastic-environment>

⁴⁵

<https://www.turi.org/content/download/10395/173557/file/Cost%20Artificial%20Turf.%20September%202016.pdf>

⁴⁶ Villanueva NC, Chun IKH, Fujiwara AS, Leibovitch ER, Yamamoto BE, Yamamoto LG. *Impact Deceleration Differences on Natural Grass Versus Synthetic Turf High School Football Fields*. Hawaii J Health Soc Welf. 2024 Jan;83(1):4-9. PMID: 38223462; PMCID: PMC10782390.

⁴⁷ Id.

⁴⁸ Id.

Conclusion. Given the PFAS that leaches off artificial turf, the backing, and the infill, together with the migration of microplastics, the inability to recycle the fields at end of life, the contribution to climate change, and the intense water use, cities and towns should seriously consider the installation of grass fields.

It appears that all artificial turf contains PFAS, including one of the most toxic (PFOA). Because we only discovered PFAS in artificial turf three years ago, there have been no studies investigating health impacts to athletes using the fields from these PFAS. This absence of evidence does *not* mean that it is safe for people to use the fields; it merely means it has not yet been studied. However, we do know that even minute quantities of PFAS are dangerous to human health; and we do know that the PFAS in the fields leaches off into groundwater, soils, and drinking water.

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