

# **Recycled Rubber Information Packet**

**May 2016**

## Online Resources



**Safe Fields Alliance**

<http://www.safefieldsalliance.com/>



**RECYCLED  
RUBBER  
COUNCIL**

<http://recycledrubbercouncil.org/>



**ISRI** Institute of  
Scrap Recycling  
Industries, Inc.

*Voice of the Recycling Industry*

<http://www.recycledrubberfacts.org/>



**Synthetic Turf**  
COUNCIL

<http://www.syntheticurfCouncil.org/>

# Answers to Your Questions on Recycled Rubber

**RecycledRubberFacts.org**

*Recycled rubber plays a vital yet largely unseen role in our lives. We interact with it on a daily basis and it enables us to do many of the things we love the most.*



## ■ What is recycled rubber?

Recycled rubber is rubber that has been derived from scrap materials such as used tires.

Recycled rubber gives us innovative ways to reduce waste while solving important challenges – from facilitating softer playground surfaces, to reducing the chance of injuries for athletes, to building lower-impact hospital floors for nurses on their feet all day.

U.S. scrap rubber manufacturers recycle roughly 110 million tires annually – or one tire for every three people in the U.S.



## ■ How is it made?

Recycled rubber is produced from scrap tires through a straightforward process. There are two main ways in which this happens:

- **AMBIENT SHREDDING** uses powerful, interlocking knives to chop tires into smaller pieces.
- **CRYOGENIC PROCESS** uses liquid nitrogen to freeze them at sub-zero temperature. These cold temperatures cause the physical properties of the tire to change, and it becomes very brittle. The tire is then placed in an enclosure in which powerful hammers smash the tire apart.

The non-rubber portions of the tire are also recycled. For example, the steel beads that give the tire its shape and structure are recovered by recyclers and processed into specification grade product used by steel mills for new steel.



## ■ Why should we be recycling scrap tires?

Tires, designed to be virtually indestructible under a variety of conditions, have historically been difficult to dispose of or recycle.

In most cases, old and worn tires were replaced with newer tires and dumped illegally in lakes, empty lots, along the sides of roads, and in nature in potentially sensitive habitats. Others were added to landfills.

Today, thanks to innovations in manufacturing, scrap tire rubber is used to make new tires, playground surfaces, equestrian mats, and rubberized asphalt—among other products.

Tire recycling is an economically sound, environmentally-friendly activity that can contribute to the reduction of a product's overall carbon footprint by anywhere from four to 20 percent when compared to virgin plastic resins.

**RecycledRubberFacts.org**

# Benefits of Recycled Rubber

**RecycledRubberFacts.org**

*Recycled rubber plays a vital yet largely unseen role in our lives. We interact with it on a daily basis and it enables us to do many of the things we love the most.*



## ■ Environmental Benefits:

Recycling rubber tires means that millions of scrap tires are no longer dumped in landfills, or left illegally in lakes, abandoned lots, along the side of the road and in sensitive habitats. Instead, more than 90 percent of these tires are being recycled and reused annually.

Recycling saves impressive amounts of energy, which ultimately reduces greenhouse gas emissions. For example, recycling four tires reduces CO<sub>2</sub> by about 323 pounds, which is equivalent to 18 gallons of gasoline.

Using recycled rubber in molded products, for example, creates a substantially smaller (by a factor of up to 20 times) carbon footprint as compared to using virgin plastic resins



## ■ Economic Benefits:

In addition to being an environmental steward, the rubber recycling industry plays a prominent role as both an economic leader and job creator.

According to a 2015 study conducted by John Dunham and Associates, the rubber recycling industry generates more than **\$1.6 billion annually in economic activity**. This includes, providing nearly **8,000 good paying jobs** (direct and indirect) in all 50 states that generate more than **\$500 million in employee wages** and **\$182 million** in federal, state, and local tax revenues.



## ■ Expanding Opportunity through Design:

Recycled rubber is being used by manufacturers in a wide variety of applications today. Manufacturers prize scrap as a raw material input due in part to cost and energy savings.

**Here are a number of settings where we see recycled rubber most:**

**MEDICAL:** Hospital floors and surgical gloves

– *providing comfort and quiet for medical professionals and patients*

**AGRICULTURE:** Vegetation protectors and windbreaks, sheds, livestock mats, bumpers, and feeders

– *increasing yield and efficiency for the agricultural sector*

**SPORTS:** Infill for synthetic turf fields (of which there are more than 12,000 in the U.S.), indoor and outdoor running tracks, and fitness mats

– *broadening sports and fitness opportunities across the country*

**PLAYGROUND SURFACES:** Mulch and mats

– *cushioning our children's falls*

**INFRASTRUCTURE:** Rubberized asphalt on roadways

– *providing surface durability while lessening traffic noise*

**OTHER:** Landscaping mulch, molded products such as railroad ties, flowerpots, garden hoses, benches, and welcome mats

– *creating useful everyday products*

**RecycledRubberFacts.org**

# Statement from Synthetic Turf Council in Response to Federal Study



“We welcome the announcement of this multi-agency effort and look forward to coordinating with the agencies as well as other stakeholders as this research action plan moves forward.

We have consistently said that we support all additional research. At the same time, we strongly reaffirm that the existing studies clearly show that artificial turf fields and playgrounds with crumb rubber infill are safe and have no link to any health issues. The current body of research is comprised of dozens of reports, including peer-reviewed academic studies and federal and state government analyses.

It’s also important to note that when we talk about crumb rubber infill in synthetic turf, we are also talking about the same recycled rubber that is used in a variety of products that are widely considered to be safe, such as sneakers, garden hoses, hospital floors, surgical gloves, and an array of other uses.

We hope the federal government’s involvement, which we have been encouraging for years, will settle this matter once and for all, put parents’ minds at ease, and validate past and recent due diligence by public officials.”

\*\*\*

## Q&A with a Toxicologist

### **Michael Peterson**

*M.E.M., Environmental Toxicology and Risk Assessment, Duke University  
Diplomate of the American Board of Toxicology*



#### **What is your scientific background?**

- *I'm a board certified toxicologist with nearly twenty years of experience in human health risk assessment and applied toxicology. This includes the development of chemical toxicity profiles, evaluation of the toxicity of novel chemical and commercial products, and assessing microbial and chemical contamination risks associated with various food safety best practices. I earned my Masters of Environmental Management degree at Duke University.*

#### **Have you studied this issue in the past? What did you find?**

- *Yes, I worked with a local health district in Washington state. A group of local parents expressed concern over the safety of artificial turf being installed nearby, which we addressed by conducting a critical review of the peer-reviewed and regulatory literature.*
- *Our study did not find reason for concern related to the exposure of chemicals on these fields. Although some individual studies identified trace levels of chemicals in synthetic turf, the mere presence of a chemical within a product does not mean there is an inherent risk associated with it.*

#### **What are people getting wrong about the science here?**

- *Many of the stories are neglecting to provide information on a very important risk assessment consideration: exposure. Even if a product contains a possibly harmful chemical, if there is no exposure, then there is no risk. Many common everyday products contain chemicals that could be harmful at high exposures (e.g., your iPhone, your computer monitor, even your carpet), but since exposures are low they are considered safe.*
- *In addition, any information on possible chemicals in synthetic turf should be compared with exposures from natural turf. All products, even grass fields, contain chemicals that are potentially toxic, so a proper understanding of exposure is essential.*

#### **How would you explain the list of goalkeepers with cancer that Coach Griffin has compiled?**

- *Obviously, cancer is a very serious illness, and parents have a right to be concerned. However, in regards to this list, the first thing to note is that it has not been subjected to any kind of scientific study, and there has been no epidemiology evaluation of its contents. In fact, the list is not even publicly available.*

- *Reports from some regulators who have seen the list, however, indicate the list includes a fair amount of leukemia and lymphoma cases, each among the most common forms of cancer among young people. Thus, at first glance, the contents of this list are not necessarily unusual. Regardless, until a scientific analysis of the list has determined that the cancer occurrences are abnormal, it should not be considered evidence that synthetic turf is unsafe.*

**What about the people who say that this constitutes a “cluster” of cancer cases?**

- *A cluster analysis is a specific type of epidemiology study, and has not been performed on Coach Griffin's list. In general, when proposed "clusters" are subjected to scientific analysis, they rarely turn out to be true clusters.*

**How would you explain the lack of any comparative “clusters” being identified among football players, who also play on turf? Given the nature of the game, wouldn't they be even more likely to be exposed to crumb rubber?**

- *Given the nature of the game, it would be logical for football players to also have cancer 'clusters' if they existed among soccer players. To my knowledge, no cluster has been found in football players. This is consistent with the finding that exposures to chemicals in synthetic turf are low, and below levels that would raise health concerns.*

**What about the studies that people are mentioning that show turf is not safe?**

- *In the scientific community there is a process called peer-review, which means independent scientists look at the study and ensure that it has been conducted appropriately and the results have been interpreted correctly. As far as I know, in the scientific peer reviewed literature, there are no studies that show synthetic turf is unsafe.*

**What about the Yale study people have read about?**

- *As a toxicologist with nearly two decades of experience in human health risk assessment, I do not believe that the EHHI study, or Yale study, as it is called, provides any scientific evidence that synthetic turf infill poses a risk to children or adults using these surfaces.*
- *The EHHI study looked at tire crumb rubber and tried to determine what chemicals could be extracted by using a chemical commonly found in paint strippers. That is not a realistic way to evaluate exposure based on real-world scenarios.*
- *In addition, the study was never peer-reviewed and there is not a published manuscript of this study. Given that, it is hard to evaluate how relevant the EHHI study is for evaluating health risks.*

**Have current studies looked at ingestion? What about this idea of rubber pellets getting into cuts or abrasions?**

- *A number of current studies, including regulatory risk assessments and peer-reviewed studies, have looked at the potential for ingestion of tire crumb rubber particles.*
- *One peer-reviewed study conducted an extraction analysis using a variety of simulated biological fluids to see what happens when we ingest, or inhale, or generally come in contact with these particles, and whether we absorb any chemicals. This particular study found negligible extraction for the chemicals and the scientists concluded that these chemicals did not present a health risk.*
- *Based on the extraction studies, pellets getting into cuts or abrasions would also be unlikely to present any health risk.*



**One current criticism of the existing body of science is that there are ‘gaps in the research’. Can you address that?**

- *I believe this criticism comes from a limited reading of the existing literature. When evaluated individually, some studies may have limitations or data-gaps (this is true of any individual scientific study in general), and from a scientific perspective, additional research can always be conducted to provide additional evidence. However, existing studies have evaluated many different aspects of safety; they have looked a multitude of chemicals, at all the major exposure pathways (ingestion, inhalation, and skin contact), and have used a variety of methods. When the totality of the evidence is considered, when all of the synthetic turf studies are looked at together, the data gives does not give us reason to believe there are health concerns associated with these products.*

**What about the crumb rubber used in some playgrounds?**

- *From what I understand, the crumb rubber used in playgrounds is exactly the same type of crumb rubber found in synthetic turf fields, and given that, the same conclusion would apply – that there is not a concern for health effects from those products.*

**What do you think has been missing from the recent media reports on the issue? What should parents do?**

- *Parents are worried, and that is certainly understandable. Current media reports have mostly focused on two unpublished data points (Coach Griffin's list and the Yale study) at the expense of the dozens of peer-reviewed and regulatory reports that have found that chemical exposures from synthetic turf present a very low risk. Instead of focusing on these speculative reports, it would be best if the media devoted more time to the actual science.*
- *Parents should assess the facts, which in this case are clear: based on the best available science, exposure to chemicals in recycled rubber are below levels that would present a concern for health effects.*

###

**Michael Peterson serves as Scientific Advisor to the Recycled Rubber Safety Council. For more information, visit: [www.recycledrubbercouncil.org](http://www.recycledrubbercouncil.org)**



## Video

*“The Truth About Artificial Turf and Crumb Rubber”*



### The Truth About Crumb Rubber and Artificial Turf



The Truth About Artificial Turf and Crumb Rubber

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The video is available at this link: <https://www.youtube.com/watch?v=pVZSVhyMv-A>

The video features commentary from a variety of perspectives, including:

- John Boynton, a parent who led an effort to review the existing science and ultimately advocated to install artificial turf fields in his town in Massachusetts
- Jim Dorsey, a longtime high school football coach and current athletic director who touts the benefits of turf fields at his school
- Michael Peterson, a board-certified toxicologist at Gradient, an environmental and risk sciences consulting firm, and a Scientific Advisor to the Recycled Rubber Council

This video was produced by the Safe Fields Alliance and the Recycled Rubber Council, and is endorsed by the Synthetic Turf Council.



EXECUTIVE SUMMARY  
CATALOG OF AVAILABLE RECYCLED RUBBER RESEARCH  
March 3, 2016

In early 2015, in response to increased public interest in the potential health effects of synthetic turf sports fields with recycled rubber infill, the Synthetic Turf Council began compiling a list of available studies and making them more readily accessible to the public.

Since 1990, STC has identified more than 90 technical studies and reports that have delved into various health and human safety questions relating to the use of recycled rubber as an aftermarket product, including its use as infill in synthetic turf sports fields. These studies have involved chemical engineers, toxicologists, epidemiologists, chemists, biologists and other medical professionals. They have estimated whether toxins are present at any level of concern, whether the human body can access them, and if exposure over time increases risk. The majority of the studies were conducted independently by academic institutions and government agencies.

This compelling body of knowledge (to date) includes:

- 34 considering inhalation toxicity
- 45 considering ingestion toxicity
- 27 considering dermal toxicity
- 11 considering links to cancer
- 26 conducted by universities and research institutes
- 29 conducted by city and state agencies
- 15 conducted by US and foreign federal government agencies
- 22 representing consolidated reports of previous studies

This broad-based body of scientific research from academic, independent third party, federal and state government organizations has **unequivocally failed to find any link between recycled rubber infill and cancer or any other human health risk.**

There can always be more research done, and the Synthetic Turf Council encourages and supports any future opportunities for independent, science-based research. We are confident that additional research will corroborate findings to date; namely, that recycled rubber infill does not pose an elevated human health risk to people of any age.

The Synthetic Turf Council and its members are dedicated to providing safe and durable synthetic turf products to millions of users across the country. Since 2007, an estimated 4.5 billion square feet of synthetic turf have been installed around the world, including 800 million square feet in the U.S. Recycled rubber infill is used in over 98% of the 12,000+ synthetic turf sports fields, providing superior shock absorption, traction, foot stability and safety to millions of athletes. These sports field systems also benefit sustainability efforts by: conserving water, reducing fertilizers, pesticides and herbicides, and diverting millions of tires from landfills.

To learn more, a summary of findings, as well as links to all of these studies, can be found on the STC website at: <http://www.syntheticurfCouncil.org>.

## **Appendix: Government Agency Perspectives**

- Letter from the State of Connecticut Department of Public Health
- Connecticut Department of Public Health Environmental and Occupational Health Assessment of Artificial Turf Fields
- Letter from the Commonwealth of Massachusetts Department of Public Health
- Memorandum from the County of Fairfax, Virginia

# STATE OF CONNECTICUT

## DEPARTMENT OF PUBLIC HEALTH



Jewel Mullen, M.D., M.P.H., M.P.A.  
Commissioner

Dannel P. Malloy  
Governor  
Nancy Wyman  
Lt. Governor

**EHS Circular Letter #2015-02  
(Follow up to Circular Letter #2014-26a)**

DATE: January 20, 2015  
TO: Local Health Departments and Districts  
FROM: Brian Toal, Gary Ginsberg  
Environmental and Occupational Health Assessment  
RE: Recent News Concerning Artificial Turf Fields



**Brief Video Clip for Local Health Departments – *Click Here* →**

This letter and video clip are being sent to update you regarding the news story that has circulated since last spring regarding potential cancer risks at artificial turf fields. Various media outlets have continued to run this story and a number of local health departments have inquired as to its validity. Since many Connecticut towns have installed or are considering artificial turf fields an elevated cancer risk would be an important consideration. However, this news story is still based upon very preliminary information and does not change CTDPH's position that outdoor artificial turf fields do not represent an elevated health risk.

The Connecticut Department of Public Health has evaluated the potential exposures and risks from athletic use of artificial turf fields. Our study of 5 fields in Connecticut in 2010-2011 was a comprehensive investigation of releases from the fields during active play. This study was conducted as a joint project with the CT DEEP and the University of CT Health Center and was peer-reviewed by the Connecticut Academy of Science and Engineering. Our study did not find a large amount of vapor or particle release from the fields confirming prior reports from Europe and the US. We put these exposures into a public health context by performing a risk assessment. Our risk assessment did not find elevated cancer risk. These results have been published as a set of 3 articles in a peer review journal and are available on the DPH artificial turf webpage (<http://www.ct.gov/dph/cwp/view.asp?a=3140&q=464068>).

The news story suggests soccer players and especially goalies may have an elevated cancer risk from playing on artificial turf fields. This is based upon anecdotal observations of a university soccer coach (<http://www.komone.com/news/local/Soccer-coach-Could-field-turf-be-causing-cancer-259895701.html>). Reportedly the coach is developing a list of soccer players who have contracted cancer. However, the types of cancer are undocumented and so it is impossible to say whether they



Phone: (860) 509-7740 • Fax: (860) 509-7785 • VP: (860) 899-1611  
410 Capitol Avenue, P.O. Box 340308  
Hartford, Connecticut 06134-0308  
[www.ct.gov/dph](http://www.ct.gov/dph)

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represent a common effect and there has been no reporting on how long the goalies played on artificial turf fields to see if there was plausible exposure and latency. There are many reasons why someone collecting a list of cancer cases may appear to find a cluster including the fact that when you have a single-minded focus on finding cases you do not capture all the non-cases that would tend to disprove the cluster. Documentation of an increased rate in soccer players would require an epidemiological study in which the total number who play on turf fields in a given region was also known so that a cancer rate could be established and compared to those that do not play on artificial turf fields. The current news report does not constitute epidemiological evidence and thus is very preliminary.

Our risk assessment did cover carcinogens that are known to be in recycled tires and the crumb rubber used to cushion fields. Once again, we found there to be very little exposure of any substances, carcinogenic or not, in the vapors and dust that these fields generate under active use, summer conditions. Background levels of chemicals in urban and suburban air from heating sources and automobile traffic are much more significant sources of airborne carcinogens. The fact that we sampled 5 fields (4 outdoor and 1 indoor) of different ages and composition suggests that the results can be generalized to other fields, a conclusion supported by the fact that results were similar to what was found in California, USEPA and European studies. Our study did not evaluate ingestion of the crumb rubber itself as players are unlikely to ingest an entire rubber pellet. However, two studies, one in California and one at Rutgers University did evaluate the cancer risk if children ingested a mouthable chunk of playground rubber (10 gram), using laboratory extraction methods to estimate the amount of chemicals that might become available in the stomach and absorbed into the body. Both studies found very low cancer risk from this scenario (Cal OEHHA 2007; Pavilonis et al. 2014). Thus, CT DPH finds no scientific support for a finding of elevated cancer risk from inhalation or ingestion of chemicals derived from recycled tires used on artificial turf fields. US EPA has a similar position: "At this point, EPA does not believe that the field monitoring data collected provides evidence of an elevated health risk resulting from the use of recycled tire crumb in playgrounds or in synthetic turf athletic fields."

<http://www.epa.gov/epawaste/conservation/materials/tires/health.htm>

In summary, federal and state authorities have taken seriously the concerns that artificial turf fields may present a health risk due to contaminants in recycled rubber. The best way to investigate these concerns is via an exposure investigation. Studies conducted in Connecticut and elsewhere have shown a very low exposure potential, less than from typical outdoor sources of air pollution. The current news reports of a list of soccer players with cancer does not constitute a correlation or causality and thus raises a concern that currently lacks scientific support. Thus, the CT DPH position expressed in 2011 at the conclusion of the Connecticut study, that outdoor artificial turf fields do not represent an elevated health risk, remains unchanged. For further information please contact Brian Toal or Gary Ginsberg at 860-509-7740.

## References

California OEHHA 2007. Evaluation of Health Effects of Recycled Waste Tires in Playground and Track Products. Prepared for the California Waste Management Board, January, 2007.

Pavilonis BT, Weisel CP, Buckley B, Lioy PJ. 2014. Bio accessibility and Risk of Exposure to Metals and SVOCs in Artificial Turf Field Fill Materials and Fibers. Risk Anal. 34: 44-55.

C Suzanne Blancaflor, M.S., M.P.H., Chief  
Environmental Health Section  
Ellen Blaschinski, R.S., M.B.A., Chief  
Regulatory Services Branch



## Environmental and Occupational Health Assessment

### Artificial Turf Fields

#### ***Connecticut Peer Reviewed Journal Publications***

- Simcox NJ, Bracker A, et al. [Synthetic Turf Field Investigation in Connecticut](#). *Journal of Toxicology and Environmental Health, Part A: Current Issues*, 74:17, 1133-1149. 2011.
- Ginsberg G, Toal B, et al. [Human Health Risk Assessment of Synthetic Turf Fields Based Upon Investigation of Five Fields in Connecticut](#), *Journal of Toxicology and Environmental Health, Part A: Current Issues*, 74:17, 1150-1174. 2011.
- Ginsberg G, Toal B, et al. [Benzothiazole Toxicity Assessment in Support of Synthetic Turf Field Human Health Risk Assessment](#). *Journal of Toxicology and Environmental Health, Part A: Current Issues*, 74:17, 1175-1183. 2011.

#### ***Connecticut Report and Fact Sheet***

- [Risk Assessment of Artificial Turf Fields](#) (Final Report) Four state agency reports from the University of Connecticut Health Center (UCHC), The Connecticut Agricultural Experiment Station (CAES), the Departments of Public Health (DPH), and Energy and Environmental Protection (DEEP). Final peer reviewed compilation report from the Connecticut Academy of Science and Engineering (CASE)
- [CT Fact Sheet: Risk Assessment of Artificial Turf Fields](#)





The Commonwealth of Massachusetts  
Executive Office of Health and Human Services  
Department of Public Health  
Bureau of Environmental Health  
250 Washington Street, Boston, MA 02108-4619  
Phone: 617-624-5757 Fax: 617-624-5777  
TTY: 617-624-5286

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Commissioner

Tel: 617-624-6000  
[www.mass.gov/dph](http://www.mass.gov/dph)

March 23, 2015

Stephanie Bacon, Health Agent  
Office of Board of Health  
155 Village Street  
Medway, MA 02053

Dear Ms. Bacon:

Thank you for your letter of February 24, 2015, in which you requested that the Massachusetts Department of Public Health, Bureau of Environmental Health (MDPH/BEH), evaluate health concerns related to the use of crumb rubber infill material for artificial turf fields in Medway, Massachusetts. As you are likely aware, our office had previously evaluated this issue in a series of letters to the Town of Needham Board of Health in 2008, 2011, and 2013.

In response, MDPH/BEH staff have evaluated more recent information on potential exposure opportunities to artificial turf components, including crumb rubber infill, and evaluated health concerns, including cancer, in relation to exposure to such turf. Recent media reports on soccer players, particularly goalies that have played on artificial turf, and the incidence of some cancers have been expressed. These reports raised concerns about the possible association between playing on crumb rubber fields and the development of cancers, notably, non-Hodgkin's lymphoma, Hodgkin Lymphoma, and osteosarcoma. We also evaluated information you provided on the content of the specific products used in Medway. Our review is summarized below.

#### Updated Literature Review

Our previous evaluations noted that crumb rubber infill has been found to contain chemicals, including polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), and metals. We further stated that although these chemicals are in the material itself, information available at that time did not suggest significant exposure opportunities to the chemicals in the materials such that we would expect health effects. We noted that the most relevant study on this topic at the time was a study conducted by the California Office of Environmental Health Hazard Assessment (CA OEHHA).



Since that time, the CA OEHHA conducted additional evaluations of chemical concentrations in air above crumb rubber turf fields under active use (CA OEHHA 2010). Air samples were taken above fields and analyzed for VOCs and metals. Results suggested that adverse health effects were unlikely to occur from inhalation of VOCs or metals in particulates above these fields. To assess the potential for skin infections due to bacteria or to skin abrasions on these fields, tests for bacterial contamination were performed and the frequency of skin abrasions was assessed. Researchers found fewer bacteria detected on the artificial turf compared to natural turf, suggesting that the risk of infection to athletes using these fields was actually lower. However, more skin abrasions were observed in athletes using artificial turf fields than natural turf fields, and the study authors made various recommendations to help prevent skin abrasions (e.g., protective equipment or clothing) and prompt treatment of skin abrasions.

In another study, the state of Connecticut conducted air sampling at four outdoor artificial turf fields with crumb rubber infills (most relevant to Medway) under summer conditions (Simcox et al. 2011). Air measurements were taken using stationary air sampling monitoring devices as well as personal samplers (placed on people using the fields). They concluded that exposure opportunities to turf contaminants were not associated with elevated health risks and suggested that their findings were consistent with other studies available at the time. A letter prepared by the Connecticut Department of Public Health reiterates these conclusions (CTDPH 2015).

A 2014 study by researchers at the Rutgers Robert Wood Johnson Medical School in New Jersey evaluated opportunities for exposures to PAHs, semivolatile organic compounds (SVOCs), and heavy metals from exposures to artificial turf fibers and crumb rubber infills by measuring these constituents in simulated body fluids (digestive fluids, lung fluids, sweat) that represented different routes of exposure (ingestion, inhalation, dermal). This bioaccessibility study aimed to provide a better measure of the actual amount of these contaminants that might be absorbed into the body after exposure. The researchers found that PAHs were routinely below the limit of detection and SVOCs that have environmental regulatory limits to use for comparison were identified at levels too low to quantify. Some metals were detected but at concentrations at which health risks were low, with the exception of lead from the field sample collected. That sample indicated lead at levels in the simulated digestive fluids that the authors reported could result in blood lead levels above the current U.S. Centers for Disease Control and Prevention (CDC) reference value for blood lead in children (5 ug/dL). It should be noted that the lead concentration of the materials used in this study included a sample of turf fiber with a lead concentration of 4,400 mg/kg. This level contrasts with information on the Medway artificial turf components, which reportedly either contained lead at 39 mg/kg (crumb rubber infill) or had no lead (turf fibers) (see discussion later in this letter). Based on the lead result from this one field sample, the authors suggested that components of artificial turf fields should be certified for low or no lead content prior to use. Overall, however, the authors concluded that opportunities

for exposure to constituents in these fluids presented very low risk among all populations that would use artificial turf fields (Pavilonis et al. 2014).

A study conducted in 2010 in the Netherlands assessed the exposure of soccer players to PAHs after playing sports on a rubber crumb field. Urine testing in participants indicated that uptake of PAHs by the participants following exposure to artificial turf with rubber crumb infill was minimal. If there is any exposure, the authors reported, uptake is minimal and within the normal range of uptake of PAHs from environmental sources and/or diet observed in healthy individuals (van Rooij and Jongeneelen 2010).

It is probably worthwhile to also note that MDPH/BEH reviewed testing data for artificial turf for the Town of Needham, as reported in our letters of 2011 and 2013 to the Needham Board of Health. The Town of Needham contracted with an environmental testing firm to conduct environmental tests including, air measurements of volatile organic compounds taken in the laboratory and heavy metals (arsenic, cadmium, chromium, lead, mercury, selenium, zinc) content of crumb rubber materials. Our review and conclusions for that testing, did not indicate exposures of health concern.

#### Material in Medway

MDPH/BEH reviewed available information provided by the Medway Board of Health regarding the specific materials used in the Medway fields. These included the APT Gridiron turf system and Liberty Tire Recycling 10+20 BM Rubber Crumb Brantford, ON. Among the materials provided for these products were statements or test results for various constituents in these products.

APT submitted a written statement dated October 29, 2014, that reported that the APT Gridiron turf systems (essentially the grass fibers of the artificial turf) are manufactured and installed without the use of any lead or heavy metals. They reported that this included all materials used for the turf fibers and backings. No other documentation about this product, including any testing results, was provided to support this statement.

With respect to the 10+20 BM Crumb Rubber infill product, laboratory testing results were provided for this product, although it is not clear whether the testing was for the materials specifically used in turf applied in Medway. Testing was conducted for metals content as well as emissions of volatile organic compounds (VOCs). It appears that testing included the following: (1) testing for VOCs emitted into a confined air space in the laboratory after heating the product to 73 degrees F; and (2) content testing for eight heavy metals, including lead. The laboratory compared results to criteria established by the Greenguard certification program, part of Underwriters Laboratory, that uses among its criteria for certification health-based levels derived by the CA OEHHA.

Testing results for metals content of the product indicated a lead concentration of 39 mg/kg, which is less than the current Consumer Product Safety Improvement Act (CPSIA) limit of 100 mg/kg for lead in children's products (Ulirsch et al. 2010). No other metals were detected.

Test results measuring emissions off-gassing from heated material were provided in measurements that cannot be compared to any health-based standards or guidelines and thus, MDPH/BEH did not further evaluate this information. Typically, when certain products raise health concerns, health agencies review Material Safety Data Sheets (MSDS). An MSDS provides information on health risks associated with use of the product. An industry group, Synthetic Turf Council, provides a sample template MSDS for crumb rubber infill material (Synthetic Turf Council 2014). Although this sample MSDS is not specific to any particular product, it appears to be applicable to crumb rubber infill in general. In the section under "Hazardous Ingredients," the MSDS notes that the product can contain fine fibers that may cause irritation symptoms (e.g., itching, irritation of mucous membranes, eye irritation). The MSDS notes that the crumb rubber material is generally thought to be a nuisance dust.

### Concerns About Cancer Among Soccer Players

As noted earlier in this letter, some recent news reports suggested that the incidence of cancers among soccer players, particularly goaltenders exposed to artificial turf, might be atypical. These reports included many cancer types, but some focused specifically on NHL, Hodgkin Lymphoma, and osteosarcoma in three individuals. We thought it would be helpful to provide additional information on cancers in general and known risk factors for NHL, Hodgkin Lymphoma, and osteosarcoma.

### Cancer in General

Understanding that cancer is not one disease, but a group of diseases, is very important. Research has shown that there are more than 100 different types of cancer, each with separate causes, risk factors, characteristics and patterns of survival. A risk factor is anything that increases a person's chance of developing cancer and can include hereditary conditions, medical conditions or treatments, infections, lifestyle factors, or environmental exposures. Although risk factors can influence the development of cancer, most do not directly cause cancer. An individual's risk for developing cancer may change over time due to many factors and it is likely that multiple risk factors influence the development of most cancers. In addition, an individual's risk may depend on a complex interaction between their genetic make-up and exposure to environmental agents, including infectious agents and/or chemicals. This may explain why some individuals have a fairly low risk of developing a particular type of cancer as a result of an environmental exposure, while others are more vulnerable.

Cancers in general have long latency or development periods that can range from 10 to 30 years in adults, particularly for solid tumors. In some cases, the latency period may be more than 40 to 50 years. It is important to note, however, that latency periods for children and adolescents are significantly shorter than for adults.

## Hodgkin Lymphoma

Hodgkin Lymphoma is most common in young adults between the ages of 15 and 40, especially in individuals in their 20s. Among adolescents, it is the most common type of cancer.

Hodgkin Lymphoma occurs specifically in a type of B lymphocyte (or white blood cell) called the Reed-Sternberg cell while other lymphomas (non-Hodgkin's types) occur in different cells.

Established risk factors for Hodgkin Lymphoma include: exposure to the Epstein-Barr virus (EBV); a previous diagnosis of mononucleosis (mono is caused by the EBV); family history; and certain hereditary conditions (such as ataxia telangiectasia) associated with a weakened immune system. The Epstein-Barr virus is very prevalent in the general population. Even though most of us have been exposed to the virus (which remains latent in our bodies), most people do not develop mononucleosis or Hodgkin Lymphoma. EBV is thought to account for about 20% or 25% of the diagnoses of classical Hodgkin's in the US.

Higher socioeconomic status is also a possible risk factor. This is thought to be due to delayed infectious exposures in childhood.

Occupational exposures as risk factors have been studied extensively and none have emerged as established risk factors. Likewise, there is very little evidence linking the risk of Hodgkin Lymphoma to an environmental exposure, other than the EBV.

## Non-Hodgkin Lymphoma (NHL)

NHL refers to a diverse group of cancers that are characterized by an increase in malignant cells of the immune system. Each subtype of NHL may have different risk factors associated with its development. The specific cause of NHL in most individuals is unknown.

Although some types of NHL are among the more common childhood cancers, more than 95% of diagnoses occur in adults. Incidence generally increases with age, and most diagnoses occur in people in their 60s or older.

Established risk factors for NHL include a weakened immune system, associated with various medical conditions, and exposure to various viruses. An increased risk is faced by individuals taking immunosuppressant drugs following organ transplants; individuals with autoimmune disorders, such as rheumatoid arthritis and lupus; and individuals who have taken certain chemotherapy drugs for other cancers. Several viruses have been shown to play a role in the development of NHL, including the human immunodeficiency virus (HIV), the human T-cell leukemia/lymphoma virus (HTLV-1), and the Epstein-Barr virus.

Exposure to high-dose radiation (for example, by survivors of atomic bombs and nuclear reactor accidents and possibly by patients who have received radiation therapy for a previous cancer) may pose an increased risk. Some studies have also suggested that exposure to chemicals such as benzene and certain herbicides and insecticides may be linked with an increased risk of NHL. Smoking has been associated in some studies with certain types of NHL.

### Osteosarcoma

Osteosarcoma is a type of malignant bone cancer which accounts for about 2% of childhood cancers in the United States. It is the most common type of cancer that develops in bone and comprises about 66% of malignant bone tumors in children in Massachusetts. Most osteosarcomas occur in children and young adults between the ages of 10 and 30. Teenagers comprise the most commonly affected age group and are at the highest risk during their growth spurt. However, osteosarcoma can occur in people of any age, with about 10% of all osteosarcomas occurring in people over the age of 60.

Established risk factors for osteosarcoma include certain inherited syndromes (such as retinoblastoma, the Li-Fraumeni syndrome, and others) and certain bone diseases (such as Paget disease of the bone and hereditary multiple osteochondromas). Individuals with these syndromes and bone diseases have an increased risk of developing osteosarcoma. People who have received radiation treatment for a previous cancer may have a higher risk of later developing osteosarcoma in the area that was treated. Being treated at a younger age and with higher doses of radiation both increase the risk. Because the risk of osteosarcoma is highest between the ages of 10 and 30, especially during the teenage growth spurt, experts believe that there may be a link between rapid bone growth and the risk of a bone tumor. Children with osteosarcoma are often tall for their age, which supports the link with rapid bone growth. Other than radiation, there are no known lifestyle or environmental risk factors associated with osteosarcoma. Besides from these risk factors, the causes of most osteosarcomas are unknown.

### Summary

In summary, the scientific literature continues to suggest that exposure opportunities to artificial turf fields are not generally expected to result in health effects. Testing results on the crumb rubber infill indicated lead content less than CPSIA statutory limits established for children's products. For the turf fibers, APT provided a statement that this material did not have lead used in its manufacture, but no additional documentation was provided.

With respect to cancer concerns reported in media stories, it is important to note that the reports of cancers were of a wide variety of different types, each with its own set of risk factors. In addition, our staff reviewed cancer incidence data for the Town of Medway. The Massachusetts Cancer Registry (MCR) is a population-based surveillance

system that began collecting information in 1982 on Massachusetts residents diagnosed with cancer in the state. All newly diagnosed cancer cases among Massachusetts residents are required by law to be reported to the MCR within six months of the date of diagnosis (MGL, c.111, s.111B). This information is kept in a confidential database and reviewed for accuracy and completeness.

Available information on the occurrence of cancers in children living in Medway indicates no diagnoses of Hodgkin Lymphoma, NHL, or osteosarcoma have been reported to the MCR in a search of their files from 2006 to the present. Although it is possible that a very recent diagnosis may not yet have been reported to the MCR, the fact that there are no reports of such cancers is reassuring.

Although available resources cannot support MDPH conducting environmental testing of this material, we would be happy to assist the Town of Medway in developing a sampling and analysis plan as well as provide technical support in interpreting results, similar to the assistance that we provided to the Town of Needham.

As we stated in our letters to Needham officials, while available information does not indicate exposure opportunities of health concern, MDPH/BEH continues to recommend common sense ways to minimize any potential exposure to chemicals that may be contained in synthetic turf fields made of crumb rubber. MDPH/BEH suggests washing hands after playing on the field and before eating, particularly for younger children with frequent hand-to-mouth activity, and taking off shoes before entering the house to prevent tracking in any crumb rubber particles. Also, there are studies that indicate heat levels on artificial turf fields may rise as outdoor temperatures increase (New York State 2009). Thus, for protection of the players, MDPH/BEH recommends increasing hydration, taking frequent breaks, and watering down the field to cool it on hot days to prevent the potential for burns or heat stress. Finally, based on recent work in California, MDPH/BEH recommends that steps be taken to minimize the potential for skin abrasions (e.g., protective equipment) and that skin abrasions be treated promptly to prevent potential infections.

We hope this information is helpful to you and Medway residents. If you have any questions, please feel free to contact us at 617-624-5757.

Sincerely,

A handwritten signature in black ink, appearing to read "Suzanne K. Condon". The signature is fluid and cursive, with a long horizontal stroke extending to the right.

Suzanne K. Condon, Associate Commissioner  
Director, Bureau of Environmental Health

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# County of Fairfax, Virginia

## MEMORANDUM

DATE: MAY 03 2016

TO: Board of Supervisors

FROM: Edward  Long Jr.  
County Executive

SUBJECT: Update of County Actions to Date Regarding Synthetic Turf Fields

As you are well aware, there have been growing community concerns about the use of crumb rubber as infill for turf fields. The county takes these concerns very seriously and has taken a number of actions to better understand any potential health risks from exposure to crumb rubber to help inform county policy and decision-making.

I would like to provide you with an update on actions taken since my last memo of June 17, 2015, and the rationale for the county's position on continuing to use crumb rubber as synthetic turf infill.

#### Actions taken:

- The county did an extensive review of existing peer-reviewed scientific papers in 2012 and again in 2015 in response to renewed community concerns. The Virginia Department of Health was engaged to assess the appropriateness and rigor of methodologies used in synthetic turf field-related research reports and found them to be sound.
- In response to community concerns about the limitations of existing studies, the county contacted state and federal public health agencies about engaging in more comprehensive studies to better characterize the compounds found in crumb rubber and the exposures of individuals who use fields with crumb rubber infill. As a result, the county is under consideration as a potential study site for the newly-announced federal research study.
- The county sought the assistance of the Virginia Department of Health to perform a review of cancer rates in Northern Virginia from 2002-2012 to establish trends and compare rates before and after the installation of crumb rubber playing fields in 2007. Although the Virginia Cancer Registry analysis did not specifically include exposure to crumb rubber as an independent variable, the data did not show an increase in childhood cancers in Northern Virginia since the installation of synthetic turf fields with crumb rubber infill.
- The county considered the merits of reconvening the Synthetic Turf Task Force, a group chartered in 2012 to provide recommendations to the Board of Supervisors, School Board, Park Authority, and Athletic Council regarding the development, maintenance,

and replacement of turf fields in Fairfax County. The task force completed its work in July 2013 and, while it is recognized for its quality work, the decision was made to focus on ongoing efforts to leverage state and federal resources to take advantage of their capability and capacity to comprehensively address knowledge gaps and evaluate the new concerns about health risks. At this time the county does not believe that reconvening the task force will be helpful.

Based on existing science and the information acquired through the action steps listed above, the county has determined that there is no need to change the infill product used in synthetic turf fields.

The county's position is based on the following:

- To date, the concerns about increased risk of negative health effects due to the chemicals in crumb rubber turf fields have not been substantiated in the scientific literature.
- No study exists that has shown an elevated health risk from playing on fields with crumb rubber. The general conclusion for all the studies reviewed is that health effects are unlikely from exposure to the levels of chemicals found in synthetic turf with crumb rubber infill and that these fields do not pose a serious public health concern.
- There has been no evidence of an occurrence of a greater than expected number of cancers in children associated with crumb rubber.

As the county continues to proactively engage state and federal partners in ongoing research efforts, as well as monitor all available science and guidance on crumb rubber, it will reassess its position as new information becomes available.

Attachment: June 17, 2015, Memo to the Board Regarding Synthetic Turf Fields

cc: Pat Hynes, Chairman, Fairfax County School Board  
Dr. Karen Garza, Superintendent, Fairfax County Public Schools  
Patricia D. Harrison, Deputy County Executive  
Robert A. Stalzer, Deputy County Executive  
Dr. Gloria Addo-Ayensu, Director, Health Department  
Tony Castrilli, Director, Office of Public Affairs  
Kirk W. Kincannon, Director, Fairfax County Park Authority  
Christopher A. Leonard, Director, Department of Neighborhood and Community Services



# County of Fairfax, Virginia

## MEMORANDUM

**DATE:** JUN 17 2015  
**TO:** Board of Supervisors  
**FROM:** Edward L. Long Jr.  
County Executive  
**SUBJECT:** Synthetic Turf Fields

In 2012, in response to community concerns about the safety of the use of crumb rubber as infill for synthetic turf in athletic fields, the Fairfax County Park Authority, in consultation with the Health Department, Risk Management Division and Fairfax County Public Schools prepared a fact sheet on the use of crumb rubber synthetic turf based on a literature review of scientific research conducted by numerous state and national organizations who have studied the issue. The general conclusion for all the studies is that health effects are unlikely from exposure to the levels of chemicals found in synthetic turf with crumb rubber infill and that these fields do not pose a serious public health concern. The fact sheet was made available to the public through the Park Authority website and is available at:  
<http://www.fairfaxcounty.gov/parks/plandev/syntheticurf.htm>

Last fall, in response to renewed concerns by community members as a result of an NBC report of cancers in soccer players, the Health Department conducted another extensive review of the scientific literature related to the potential health effects from the use of these fields. No new findings showing a link between crumb rubber and any health risk were identified, and available information concluded that the use of synthetic turf in athletic fields remains safe.

Recently, new concerns have been raised by some community members who are requesting a ban on crumb rubber on all county fields and playgrounds; the use of only plant-derived alternatives (cork, coconut, risk husk) as infill; the remediation of all existing fields within two years; and consideration of new grass technologies or keeping some fields as natural grass.

The county's decision to allow use of crumb rubber as infill for synthetic turf fields is based on extensive review of scientific papers conducted by state and national organizations over the last decade. However, as a result of the recent concerns, the county has requested (and is receiving) assistance from state and federal public health partners to perform further review of recent and ongoing scientific investigations and the methodologies used to determine health and safety risks of using crumb rubber infill. To further our understanding about exposures to users of these fields, the county has requested additional studies be made by appropriate federal agencies and include county involvement, if possible. In addition, the county, with assistance from the Virginia Department of Health, will be performing a review of cancer rates in the county over the last decade to establish trends and identify any associations that may exist between the use of existing turf fields and cancer rates.

Board of Supervisors  
Synthetic Turf Fields  
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While this extensive effort continues, it is important to note that there is no established scientific evidence of the occurrence of a greater than expected number of cancers in children associated with crumb rubber. As such, the county will continue to use crumb rubber infill for turf fields until findings of these review efforts or peer-reviewed published scientific data support the need to change the infill product.

cc: Patricia D. Harrison, Deputy County Executive  
Robert A. Stalzer, Deputy County Executive  
Gloria Addo-Ayensu, M.D., Health Department  
Christopher A. Leonard, Director, Neighborhood and Community Services  
Kirk Kincannon, Director, Fairfax County Park Authority

## **Appendix: Refutation of EHHI Report**

- Memorandum from Laura Green, Ph. D., D.A.B.T.

## Memorandum

To: Report Responder for the CPSC



From: Laura C. Green, Ph.D., D.A.B.T.

Date: June 29, 2015

Subject: Comment on CPSC Report #20150608-22F81-2147431268  
Assessment of the risk of cancer posed by rubber mulch used in playgrounds

As a toxicologist, I have been asked by Rubberecycle (a company that manufactures, among other products, rubber mulch for playgrounds) to comment on CPSC Report #20150608-22F81-2147431268. This CPSC Report provides the following comment and request made by Dr. Debra Lay, Principal of the Jonesport Elementary School, in Jonesport Maine:

*There have been a few reports lately about rubber mulch causing cancer in children. We have rubber mulch on our playground and we are interested in getting accurate information in order to make an informed decision on whether we should remove this substance. Please advise.*

As explained below, I have examined the relevant evidence, and have found that rubber mulch is neither known nor reasonably expected to cause cancer, and is otherwise safe for use in playgrounds. I know of no reason that this mulch should be removed from the playground at Jonesport Elementary School.

### **Reports of cancer in soccer players and other athletes who play on synthetic turf fields**

To begin, I note that there are no reports that rubber mulch causes cancer (either in children or others). I believe that Principal Lay may be referring instead to news reports of a *possibly* elevated incidence of cancer among soccer players who play (at least some of their games) on synthetic turf fields, some of which are “infilled” with crumb rubber.



In particular, in May of last year, a Seattle, Washington TV station broadcast a story, "Toxic Turf? UW coach draws connection between turf and cancer." The TV story noted:

*University of Washington assistant soccer coach Amy Griffin sees a troubling connection between the turf and cancer among soccer players. Griffin [said] . . . that 13 players from the state of Washington were all diagnosed with rare types of cancer. Of those 13, 11 were goalkeepers. Griffin can't say why goalkeepers are getting cancer but she wonders if it could be caused by the crumb rubber, a kind of filler in turf fields. . . . 'Everyone says it's just a coincidence and kind of walks away, but the ratio of goalkeepers to field players is 15 to 1, 16 to 2, and I know plenty of goalkeepers that have cancers and I don't know many field players,' Griffin said . . .*

Other news reports followed, with additional cancers reported; but, to my knowledge, no systematic or scientific study of these cases has been performed or published.

For example, in February of this year, the nonprofit group, Environment and Human Health, Inc. (EHHI; at [http://www.ehhi.org/turf/cancer\\_cases\\_grow\\_0115.shtml](http://www.ehhi.org/turf/cancer_cases_grow_0115.shtml) ), reported:

***Cancer cases among student athletes playing on synthetic turf continue to grow***

*Amy Griffin, Assistant Women's Soccer Coach at the University of Washington, has been keeping a list of athletes who have developed cancer after playing on turf fields containing waste tires.*

*So far she has identified 126 athletes, 109 of which are soccer players, 10 were football players, and six were field hockey and lacrosse players, who have developed different forms of cancer.*

*The reported cancers are:*

*51 lymphomas  
19 leukemias  
10 Brain  
9 Testicular*





*9 Sarcoma  
6 Thyroid*

*The rest are rare forms of cancer.*

*It is important to note the predominance of lymphomas and leukemias. 1,3 butadiene is connected to lymphoma and benzene is connected to leukemia. Both of these chemicals are present in rubber tires.*

### **What is *not* known regarding these cancers in soccer players**

As noted above, these cancer-cases have not been reported on in any scientific journal, and no details have been reported – we do not even know if the reports are completely accurate. We do not know, for example, the ages, sexes, or races of any of the cases, nor do we know the specific forms of leukemia, lymphoma, or other cancer-type for any individual soccer-player. Nor do we have any idea the extent to which any of these athletes have played on fields containing “waste tires”, nor how “waste tires” is here defined.

Lacking this information, it is not possible to determine whether these cases constitute an actual cluster — that is, whether, as a group (and exactly what group is being examined is unclear), they have experienced a significantly larger incidence of cancer-cases than would be expected, based on rates in the general population. EHHI notes a “predominance of lymphomas and leukemias,” but these are among the most common types of cancer that develop in children and adolescents (Ward *et al.*, 2014), and so are not necessarily noteworthy.

Moreover, although cancers in young people (I am assuming, but do not know, that most of these 126 cases are in relatively young athletes) are not common, in 2014 in the U.S., almost 16,000 children and adolescents (from 0 to 19 years of age) were expected to have been diagnosed with some form of cancer (Ward *et al.*, 2014). Thus, learning about many cancer diagnoses in adolescents (again, I am assuming that most of these cases are among adolescents) would be entirely expected.

Suppose that these 126 cases do represent a cluster — that there are indeed significantly more cases of cancer among soccer players and other young athletes than one would “expect.” Does this mean that the cluster has an identifiable cause? In fact, no. As explained below, a great



many cancer clusters have been evaluated in great detail, and for almost none has a cause ever been found.

### **Results of prior investigations of cancer clusters**

For several reasons, unusual coincidences of cancers among groups of younger people are noteworthy, and many of these have been extensively investigated. However, exhaustive study of such clusters in young people has never established an environmental or other exogenous cause: these clusters appear to be due instead to randomness (Caldwell, 1990; Gawande, 1999; Trumbo, 2000; Connecticut Department of Health, 2012).

Here, for example, is what noted epidemiologist Glynn Caldwell (1990) wrote toward the end of his long career:

*Beginning in 1961, the Centers for Disease Control investigated 108 cancer clusters and reported the findings in Epidemic Aid Reports. The clusters studied were of leukemia (38%), leukemia and lymphoma (30%), leukemia and other cancer combinations (13%), and all other cancer or combinations (19%). These clusters occurred in 29 states and five foreign countries . . . Eight different data collection methods were used, often in combinations, and four types of laboratory methods on four different specimen types. Although 14 different categories of associations were reported, no clear cause was found for any cluster.*

*A priori*, then, an apparent association between playing soccer (or other sports) on synthetic turf fields and risk of leukemia and lymphoma may be reported, but that does not mean that the association is causal, as opposed to coincidental.

Of course, some clusters of cancer in communities *are* due to shared environmental and carcinogenic exposures, so one cannot and should not over-generalize.

For example, clusters of skin cancer (and other diseases) have been repeatedly reported among groups of people who drink water that has been (naturally) contaminated with high concentrations of arsenic, and this is because such exposures are genuinely carcinogenic (IARC, 1980). Similarly, clusters of lung cancer and of mesothelioma occur in communities plagued by



naturally large amounts of erionite (a mineral similar to asbestos) in local rocks and soils, and, again, these associations are known to be causal (IARC, 1987).

Importantly, however, no community-based cluster of any of the cancers *at issue here* has been found to have an identifiable, external, chemical cause.

Another reason to doubt an external, chemical cause for adolescent cancers is this: the type of leukemia prevalent in childhood (namely, acute lymphocytic leukemia, or ALL), lymphomas, and brain tumors are *not known to be caused by cigarette smoking* (IARC, 2004). Of course, cigarette smoke is the most chemically complex and important cause of cancers of several tissues and organs (not only the lung) in the U.S. (Surgeon General's Report, 2014; IARC, 2004). Since chronic exposure to such a potent mixture of carcinogenic chemicals does not cause the cancers at issue, then on what reliable basis could it be suggested that the much smaller doses of some of the same chemicals (potentially) emanating from rubber particles could cause these cancers? I can think of none.

### **Some salient features of lymphomas, leukemias, and other cancers that occur in adolescents**

As noted above, EHHI reports that of the 126 cases of cancer in athletes, 51 are cases of lymphoma. Lymphomas are not uncommon cancers: in 2014, more than 760,000 Americans were diagnosed with a form of lymphoma (Leukemia & Lymphoma Society, 2015). Indeed, among adolescents who develop cancer, lymphomas are *the most common type* (IARC, 2008). Interestingly, dogs are also prone to developing lymphoma, with some breeds more likely to develop this cancer than other breeds (Teske, 1994).

I would note that there are many different types of lymphomas, and these vary substantially with regard to their prevalence, genetic pre-dispositions, other risk-factors, and clinical courses (Swerdlow *et al.*, 2008; Morton *et al.*, 2014). (This is one reason that the lack of detail about these cases in athletes makes causal interpretations impossible). As suggested by the patterns of lymphomas in dog-breeds, and in some human families, some lymphoma-types have a strong genetic component (Bassig *et al.*, 2015); while others appear to be due to the significant alterations in the immune systems of people (i) infected with H.I.V., (ii) afflicted with various autoimmune diseases, or (iii) on immunosuppressant drug-therapies (Cáceres *et al.*, 2010; Liang *et al.*, 2014). Although many hypotheses have been raised and investigated, to date, no community-based exposures have been established to cause lymphoma (IARC, 2008).



Leukemias also vary according to type, prevalence, etiologies, and clinical courses (Jandl, 1996). Although not specified by EHHI, as noted above, I suspect that most of the leukemias in the soccer players (at least, in the younger players) are the type known as acute lymphocytic leukemia (ALL). This is important because ALL — as opposed to a major leukemia-type in adults, namely acute myelogenous leukemia (AML) — is *not* known to be caused by overexposures to chemicals, such as benzene, nor by chronic exposure to the chemicals present in cigarette smoke (IARC, 2004).

More generally, no type of cancer in adolescents is known to be caused by overexposure to chemicals. Instead, many of these cancer-cases are known or believed to occur spontaneously, or to be caused by factors common to us all (Lynch, 2010; Matés *et al.*, 2012; Tomasetti *et al.*, 2013; Tomasetti and Vogelstein, 2015). Some cases of cancers in adolescents appear to be due to infections with viruses such as Epstein-Barr virus (EBV); and some are apparently due to inherited genetic mutations (IARC, 2008).

#### **EHHI's causal hypothesis with regard to crumb rubber (and rubber mulch) and cancer**

Turning back to EHHI's apparent hypothesis with regard to rubber and cancer, I begin by noting that tires are industrial products made with various potentially hazardous chemicals; and that although tires *per se* are essentially inert, crumbled or shredded tires can release small amounts of various chemicals. In particular, synthetic rubber products tend to have a distinctive smell, caused primarily by release of trace amounts of volatile amines and organic sulfur compounds (Ambelung, 1963). These compounds are more odorous than they are toxic, and they are certainly not known or reasonably expected to pose a risk of cancer, regardless of the level of exposure.

EHHI suggests, however, that two other chemicals (i) emanate at significant concentrations from rubber and (ii) might pose a significant risk of cancer.

As quoted above, EHHI writes:

*It is important to note the predominance of lymphomas and leukemias. 1,3 butadiene is connected to lymphoma and benzene is connected to leukemia. Both of these chemicals are present in rubber tires.*



These statements are misleading in several ways. First, there is nothing surprising about a “predominance of lymphomas and leukemias” among young people: as noted above, these are the most common cancers in adolescents. Indeed, it would be striking if these cancer types were *not* prevalent in any random group of adolescents with cancer.

Second, the implication that crumb rubber (and/or rubber mulch) is a significant source of people’s exposures to the chemicals 1,3-butadiene and benzene is simply incorrect. It is true that 1,3-butadiene is *used* to make synthetic rubber (for tires and other products), but it is also essentially all *used up* in this process, in that it reacts with another chemical, styrene, to form a stable polymer, styrene-butadiene rubber. This stable polymer is no more a significant source of exposure to 1,3-butadiene than, say, a thoroughly baked cake is a significant source of exposure to raw eggs.

Nor would tires be expected to contain anything more than perhaps trace amounts of benzene. While it is the case that some tire building-machine operations rely on solvents that do contain small amounts (less than 1%) of benzene, there is neither evidence nor reason to maintain that tires would absorb, retain, and then release any significant amounts of benzene.

It is not surprising, then, that studies of ambient air in contact with crumb rubber in-filled synthetic turf fields have reported either (i) no detectable concentrations of 1,3-butadiene or benzene, or (ii) only the very low-level concentrations found in air throughout suburban and urban environments (Dye *et al.*, 2006; Norwegian Pollution Control Authority, 2006; Moretto, 2007; Denly *et al.*, 2008; Lim and Walker, 2009; Li *et al.*, 2010; Schilirò *et al.*, 2012). As noted by researchers Schilirò *et al.* (2012), for example, “On the basis of environmental monitoring, artificial turf football fields present no more exposure risks than the rest of the city.” Their conclusions were based on measurements in ambient air of benzene and the related compounds, toluene and xylenes, as well as on measurements of inhalable particles (in the size ranges of PM<sub>10</sub> and PM<sub>2.5</sub>) and of polycyclic aromatic hydrocarbons (PAHs).

Third, as just suggested, all of us are exposed to very small amounts of both 1,3-butadiene and benzene via ordinary outdoor (and indoor) air, every day. This is because both chemicals are present in the exhaust from automobiles and from several other common sources. However, the evidence that benzene can cause leukemia (and again, only AML, and not ALL of childhood, and not lymphoma) does not come from these common, low-level, environmental exposures, but instead from massive exposures experienced by workers inside poorly ventilated factories,



prior to the institution of modern industrial hygiene (Graham *et al.*, 1988). It is entirely misleading to conflate these genuinely dangerous, historical, occupational settings with any outdoor environments, even on heavily trafficked roads, for example, let alone on playing fields or on playgrounds surfaced with rubber mulch.

Finally, although EHHI claims that 1,3-butadiene “is connected to lymphoma,” in fact it, like benzene, is known to cause leukemia (AML) and not lymphoma; and, again, it is known to do so in over-exposed factory workers (Delzell *et al.*, 1996), but not known to do so in the public at large, which routinely experiences vastly smaller, environmental exposures.

### **Theoretical risks of cancer from crumb rubber in-filled synthetic turf fields**

Because some potentially carcinogenic chemicals are present in crumb rubber (as they are in ordinary dirt and other media), several studies have sought to estimate the degree of theoretical health-risk associated with these chemicals. Although these studies have focused primarily on crumb rubber, they are relevant for rubber mulch as well.

For example, Van Rooij and Jongeneelen (2010) studied young-adult male soccer players following intensive contact with crumb rubber-infilled synthetic turf. The researchers sought to determine whether this contact would lead to increased exposures to polycyclic aromatic hydrocarbons (PAHs). The researchers found that it did not. They concluded, “If there is any exposure, then the uptake is very limited and within the range of uptake of PAH from environmental sources and/or diet.” This was the case despite the fact that the athletes “had black residue of crumb dust on knees, hand palms and elbows . . . [confirming] that skin contact had occurred to dust of the tire crumb rubber.”

A recently published study from New Jersey’s state medical school (The Robert Wood Johnson Medical School) provides additional information. In particular, Pavilonis and colleagues (2014) subjected samples of both new and turf field-aged crumb rubber to extractions with solutions of synthetic sweat, synthetic lung fluid, and synthetic digestive fluid. They analyzed the types and amounts of chemicals that appeared in these synthetic biofluids, and then assessed whether children’s and adults’ exposures to these chemicals would be risky. Their data indicated that health risks to children and adults from extensive contact with crumb rubber ranged from none to negligible. Small amounts of potentially carcinogenic metals were detected in the crumb rubber-extracts, but the theoretical lifetime risks associated with these



were all less than one in one million, and, *per* the authors, “therefore risk was considered negligible.”

Earlier scientific studies and health risk-assessments have reported similar results. For example, in 2003, Birkholz and colleagues published their study, “Toxicological evaluation for the hazard assessment of tire crumb for use in public playgrounds.” Aggressive extraction of crumb rubber and testing of that extract revealed no significant toxic or mutagenic activity. (Mutagenic activity is an *in vitro* surrogate for ability to initiate cancer). Based on these and other results, the authors wrote, “We conclude that the use of tire crumb in playgrounds results in minimal hazard to children and the receiving environment.”

In 2006, the Norwegian Institute of Public Health published their report, “Artificial turf pitches – an assessment of the health risks for football players.” These researchers focused on indoor fields, because this is the setting in which air emissions would be much more concentrated, relative to outdoor fields. The investigators reported:

*Worst case calculations based on air measurements carried out by NILU [Norwegian Institute for Air Research] and exposure values from the Norwegian Institute of Public Health indicate that training in sports halls does not cause any increased risk of leukaemia as a result of benzene exposure or any elevated risk as a result of exposure to polycyclic aromatic hydrocarbons.*

*On the basis of the exposures which have been calculated in connection with the use of indoor halls with artificial turf in which recycled rubber granulate is used, there is no evidence to indicate that the use of such halls causes an elevated health risk. . . . It has been concluded that exposure to benzene and PAHs in the quantities in which they have been measured in the halls will not cause any increased risk of cancer in people using the halls.*

In 2007, the Dutch researcher Hoftstra published his report, “Environmental and Health Risks of Rubber Infill. Rubber Crumb from Car Tyres as Infill on Artificial Turf.” His analysis was based on an extensive review of prior studies, as well as on the generation of new test data from fresh and weathered samples of rubber infill. Hofstra wrote:

*Based on the available literature on exposure to rubber crumb by swallowing, inhalation and skin contact and our experimental investigations on skin contact*



*we conclude that there is not a significant health risk due to the presence of rubber infill for football players on artificial turf pitch with rubber infill from used car tyres.*

Finally, the Connecticut Department of Public Health (CT DPH) has published three peer-reviewed studies of synthetic turf fields (Ginsberg *et al.*, 2011a and 2011b; Simcox *et al.*, 2011), and recently (January 20, 2015) issued a memorandum to local health departments and districts in the State. In this, CT DPH (2015) affirms its “position that outdoor artificial turf fields do not represent an elevated health risk.” The Department notes:

*. . . CT DPH finds no scientific support for a finding of elevated cancer risk from inhalation or ingestion of chemicals derived from recycled tires used on artificial turf fields. . . . federal and state authorities have taken seriously the concerns that artificial turf fields may present a health risk due to contaminants in recycled rubber. The best way to investigate these concerns is via an exposure investigation. Studies conducted in Connecticut and elsewhere have shown a very low exposure potential, less than from typical outdoor sources of air pollution. The current news reports of a list of soccer players with cancer does not constitute a correlation or causality and thus raises a concern that currently lacks scientific support. Thus, the CT DPH position expressed in 2011 at the conclusion of the Connecticut study, that outdoor artificial turf fields do not represent an elevated health risk, remains unchanged.*

#### **Data from a recent, unpublished study by EHHI at Yale University**

Earlier this month, EHHI (at [http://www.ehhi.org/turf/new\\_study\\_jun2015.shtml](http://www.ehhi.org/turf/new_study_jun2015.shtml)) posted this press release:

##### ***New Study – Many carcinogens found in Yale analysis of crumb rubber infill and playground mulch surfacing***

*North Haven, Conn., June 11, 2015—Environment and Human Health, Inc. (EHHI), an organization of physicians and public health professionals, is releasing its study done at Yale University showing that the analysis found 96 chemicals in the rubber tire infill used in synthetic turf and*



*rubber tire mulch used as surfacing in toddler playgrounds.*

*Of the 96 chemicals detected – a little under a half have had NO toxicity assessments done on them for their health effects - therefore nothing is known about them. The other half have had SOME toxicity testing done on them - but even many of those chemicals had incomplete toxicity testing and therefore all health effects are not fully known. Of the half that have had toxicity assessments, 20% are probable carcinogens. . . .*

### **Comments on the EHHI/Yale study**

For many reasons, the EHHI/Yale study does not demonstrate that rubber mulch or crumb rubber pose a significant risk of cancer (or other diseases).

First, the study has not been published (or released in any complete form) nor, to my knowledge, has it been peer reviewed. In fact, contrary to the press release, the study does not appear to have been written up in even an unpublished manuscript. At my request, Nancy Alderman of EHHI was kind enough to supply me with a summary of some of the methods and a spreadsheet of the results to date: I have attached these materials to this memorandum.

Second, as far as I can tell, the summary results presented are entirely non-quantitative: there is no indication of the concentrations of any of the detected chemicals, let alone is there any attempt to assess levels of exposure or doses potentially received by children or others playing on or near rubber mulch or crumb rubber. Accordingly, there is no way to judge *the degree to which* any such exposures might be risky. Since all of us eat, drink, breathe, and otherwise contact at least trace levels of many carcinogens daily, it is crucial to be quantitative when assessing cancer-risks (and then acting wisely upon those assessments). Absent at least semi-quantitative estimates of risk, informed judgments simply cannot be made.

Third, according to the summary of the study-methods, the chemicals were detected in methylene chloride extracts of a mixture of ground and unground crumb rubber or rubber mulch — but methylene chloride extraction is not a relevant or reliable means of assessing how rubber mulch in playgrounds might become solubilized or otherwise release chemicals that could then be absorbed across a child's skin, for example, or across a child's digestive tract (were he or she to ingest some rubber). For purposes of human health risk assessment, instead



of using a non-biological solvent such as methylene chloride, one should use simulated sweat or simulated gastric fluid, as was used in the published, peer-reviewed study by Pavilonis *et al.*, 2014, for example, cited above.

Fourth, EHHI reports that eight of the chemicals detected in the methylene chloride extracts of at least one of the nine samples of mulch are “probable carcinogens” (there were another five samples of “infill” that are not considered here) — but none of these eight chemicals is so categorized by authoritative bodies, such as the International Agency for Research on Cancer (IARC), the U.S. National Toxicology Program (NTP), or the U.S. Environmental Protection Agency (EPA). Moreover, not one of the putative “probable carcinogens” is consistently detected in the samples of mulch.

For example, EHHI lists pyrene (detected in seven of the nine samples) as a carcinogen, but no rodent bioassays of pyrene are in fact positive; and, *per* U.S. EPA, “Overall, the database for pyrene is substantial, and the weight of evidence suggests that this PAH is not carcinogenic” (EPA-635-R-08-012A). Not surprisingly, then, neither IARC nor NTP lists pyrene as either a known or a probable human carcinogen (See <http://www.cancer.org/cancer/cancercauses/othercarcinogens/generalinformationaboutcarcinogens/known-and-probable-human-carcinogens#> for complete lists of carcinogens compiled by IARC and NTP).

Similarly, EHHI lists heptadecane (detected in one of the samples) as a carcinogen, but no rodent bioassays indicate that heptadecane is carcinogenic, and it is not listed as a carcinogen by either IARC or NTP. EHHI lists phthalamide as a carcinogen, but the NTP bioassays for phthalamide yielded negative results in male and female rats and mice, and it is not listed as a carcinogen by either IARC or NTP.

And EHHI lists 9,10-dimethylanthracene, fluoranthene, phenanthrene, 4-(1,1,3,3-tetramethylbutyl)-phenol, and 1-methylpyrene as carcinogens; but, again not one of these five chemicals is listed as a carcinogen by either IARC or NTP.

Finally, I would note that the chemicals butadiene and benzene were *not* detected in this EHHI/Yale study. Recall that these two chemicals are indeed established causes of cancer in humans, and that EHHI had hypothesized that both are present — and presumably bioavailable — at significant concentrations in crumb rubber and rubber mulch. I would add that the elevated temperatures used to dry and to analyze the samples would likely have obscured the



presence of either compound, but it remains the case that the causal hypothesis raised by EHHI has yet to be supported by actual data or other reliable evidence.

Overall, then, the evidence on crumb rubber and rubber mulch does not suggest, let alone demonstrate, that rubber mulch poses a significant risk to the health of children or others. As such, I believe that Principal Lay can rest assured that the mulch in her playground has not put her students at risk of developing cancer.

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