PUBLIC COMMENTS SUBMITTED AT HIGHLANDS COUNCIL MEETING ON APRIL 16, 2015

RUTGERS
Edward J. Bloustein School
of Planning and Public Policy

# Sustainability As Partner to Economic Regeneration: The Impact Assessment of the New Jersey State Plan


- **Economy**
- **Environment**
- **Infrastructure**
- **Community Life**
- **Intergovernmental Coordination**

*Prepared by:*

Robert W. Burchell, PhD
William R. Dolphin, MA
Jon Erickson, PhD

CENTER FOR URBAN POLICY RESEARCH
Edward J. Bloustein School of Planning and Public Policy
Rutgers, The State University of New Jersey
33 Livingston Avenue
New Brunswick, New Jersey 08901-1982

*Prepared for:*

State Planning Commission
Office of Smart Growth

NEW JERSEY DEPARTMENT OF COMMUNITY AFFAIRS
101 South Broad Street
P.O. Box 204
Trenton, New Jersey

Fishing at Longport.
Jon Erickson

## INTERGOVERNMENTAL COORDINATION ASSESSMENT

The State Plan is the result of a long negotiation process. County planning directors have credited State Plan procedures and processes with improving both the quantity and the quality of various types of governmental interaction. Planning directors report significant increases in the number of contacts between most governmental agencies and an improvement in the quality of contact between county and local agencies. The study team concludes that intergovernmental coordination is improved as a result of the State Plan endeavor.

## COMMUNITY LIFE ASSESSMENT

Quality of life in New Jersey, to the extent that it can be measured, will improve in the future. Housing demand will be basically met by housing supply over the next twenty years. Both housing costs and income will rise very slowly into the future. Housing affordability under the State Plan will be better than under TREND conditions because of somewhat less expensive housing and a greater variety of housing choice in urban communities, in communities with more densely developed planning areas, and in communities with urban, regional, and/or town centers. In general, quality of life will improve in New Jersey under both TREND and PLAN over time. Households that move to redeveloping areas will, in the short term, experience a lower quality of life than they would have experienced in the rural fringe areas. This is due to conditions currently found in the redeveloping neighborhoods (housing deterioration, higher crime rates, lower graduation rates in schools, and so on). However, those conditions will gradually improve over time.

## SUMMARY

No impact assessment can measure every variable, but overall, the assessment has carefully and consistently measured all relevant areas for which it has been charged, and the results are clear. The goals, policies, and strategies of the State Plan will produce noticeable improvements in the state's economy, environment, infrastructure, community life, and intergovernmental coordination.

(1)

I am Hank Klumpp, and I own 150 acres in the Highlands Preservation Area.

I'm still standing here, 11 years later, before a council that has had many, many members leave, without saying good-by to me and new ones arriving and not saying Hello, how can I help you? Those of you who have been here for the long haul Know that I ask the same questions every month with no answers. My number one question has been Where is the scientific study that put my property in the

(2)

Highlands Preservation Area. I finally have the answer, but not from this council. There was no scientific study. I believe you have always known that. You were given many documents outlining the evidence of scientific misconduct from Pat Moffitt which seems to be ignored and never addressed. Doesn't the Council have an on going duty to consider and comment on public input when the concerns are backed by supporting evidence?

3

Last month, I asked why this council isn't lobbying for funds. Senator Smith is standing before the Environment Committee meeting trying to pass bills for Green Acres, farmland preservation, Blue Acres, and historic preservation. What about compensation for the 859,358 acres that were taken under the Highlands Act? Smith promised full compensation. Where is it? We still have no compensation and no equity.

(4)

I know - after 11 years - that you will not answer my questions. Who on this Council is trying every way possible to help harmed landowners? Maybe a show of hands?

Guess my 3 minutes for the month are up!

Hank Klumpp

24 Longview Road
Lebanon, NJ 08833

Ken Dolsky, 21 Winfield Drive, Parsippany

I want to speak about the Pilgrim Pipeline and in particular about a letter printed in the Daily Record by George Bochis VP Development at PP on April 3, 2015.

In case you didn't read it, Mr. Bochis made three claims that deserve a response.

Claim 1: "The project would not be cutting through 'large swaths of environmentally sensitive land,' but would rather be sited almost entirely along existing rights of way where other pipelines and transmission lines are already in place. "
Answer: The use of existing rights of way does not make an environmentally sensitive area less sensitive. Yes, using the ROW may lessen or prevent fresh tree cutting (not clear at this time) but nothing else becomes less sensitive. On Saturday we hiked the Spectra gas line, path of the proposed PP from Mahwah to Skyline Drive, a total of 7 to 8 miles. We counted 14 streams that cross the ROW on their way down to Stag Brook, the Ramapo River, Lake Henry, Scarlet Oak Pond, MacMillan Reservoir, Dators Pond, Ramapo Lake and Bear Swamp Lake. Some were small and seasonal but all were flowing and by cutting across the ROW, were definitely in harms way if there is a leak. In fact practically the entire route we hiked is designated watershed management. I should not have to tell you that the Ramapos are home to many endangered species of plants and animal life. Using the existing ROW does nothing to ameliorate the risks to them, our drinking water, recreational areas in Ramapo Reservation, property value along polluted streams and the health of anyone unfortunate enough to breath oil fumes as they are toxic and carcinogenic.

Claim 2: "Like it or not, Bakken crude is already coming through the region via less safe modes of transportation. By any statistical analysis, pipelines are the safest form of petroleum transportation."
Answer: Mr. Bochis failed to present or reference any statistical analysis but we would like to present one to you in your package that shows very clearly that when you compare pipelines, barges and trains on a standard metric, in this case billion ton miles, pipelines leak 3 to 4 times more than barges and trains. This is a chart from a study done by the Congressional Research Service that appeared in a Forbes article comparing the different risks from different forms of oil transportation. The title was Pick Your Poison, the point being that no form is safe and clean.
So when you hear them say pipelines are the safest, remember this chart.

I should mention that PHMSA has stated that when it comes to death and property destruction that pipelines are safer than some other forms of transportation, but when it comes to spills only trucks are worse than pipelines.

Claim 3: "Pilgrim has never tried to 'intimidate' landowners. Had the *Daily Record* taken the time to read the letter in question, it would understand that Pilgrim requests access to property in order to conduct surveys to help better understand the potential route — hardly an 'outrageous stunt' and, as it happens, entirely consistent with New Jersey law."

Answer: I quote from the letter sent by one of Pilgrim's law firms, DeCotiis, to my neighbor: *"Pilgrim is a pipeline company established under New Jersey Law, and because of that status it has the power to condemn private property."* I will pause here because not only is this a blatant lie that has been exposed but think about what it says. They have the power to condemn your home, just because. And they are not even a utility.

It goes on, *"Part of the power to condemn is the ability to enter on private land to perform surveys and investigations."* Translation - So, we're not kicking you out of your home but we are entering your property whether you like it or not, you have no rights.

It ends, *"If you continue to decline to allow Pilgrim to enter your property, Pilgrim will have no choice but to ask a court to issue an order allowing it to enter the property for this purpose. Please let us hear from you about entry onto your property no later than October 31, 2014. If we are unable to obtain your agreement for initial inspections by that date, Pilgrim has instructed our law firm to apply to the Superior Court for an Order to allow entry for initial inspections. Thank you again in advance for your anticipated reconsideration and cooperation."* (now that we've scared the crap out of you we hope you cooperate). This letter was dated October 17, so the homeowner had two weeks to decide to engage a lawyer and fight this or just give in. Fortunately, my neighbor and I knew they were bluffing and he just ignored it.

This is what Pilgrim considers to be entirely consistent with New Jersey law.

One last point. We want to make it clear that Pilgrim has said that their plan is to provide a better solution for oil that is currently being transported by barge from Albany to Linden, being refined and being transported back to Albany by barge. In a Star Ledger article (5/20/14)[1] Pilgrim execs were quoted as saying:

"The pipeline would in no way increase the amount of oil and refined products currently transported between Linden and Albany," Bochis said.

Paul Nathanson, a Pilgrim spokesman, pointed out, "The region can only consume so much of the product."

We assume this means that this project will not bring more oil and oil products to NJ or New York or surrounding states and it has nothing to do with energy independence. It is simply a financial venture for the owners of Pilgrim Pipeline.

---

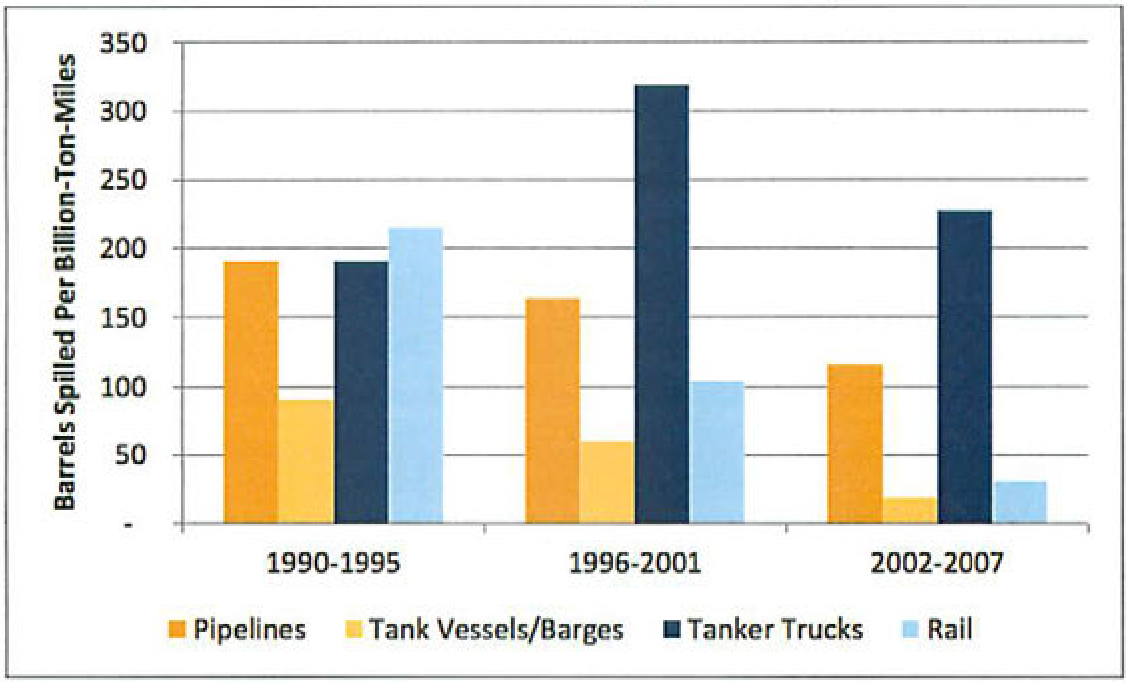
[1] http://www.nj.com/morris/index.ssf/2014/05/environmentalists_detail_opposition_to_proposed_pipeline_between_albany_and_linden.html

# Pick Your Poison For Crude -- Pipeline, Rail, Truck Or Boat

http://www.forbes.com/sites/jamesconca/

4/26/2014 @ 10:35AM

Crude Oil and Petroleum Products during Domestic Transportation




**Source:** Prepared by CRS; oil spill volume data from Dagmar Etkin, *Analysis of U.S. Oil Spillage*, API Publication 356, August 2009; ton-mile data from Association of Oil Pipelines, *Report on Shifts in Petroleum Transportation: 1990-2009*, February 2012.

**Notes:** Pipelines include onshore and offshore pipelines. The time periods were chosen based on the available annual data for both spill volume and ton-miles. The values for each time period are averages of annual data for each six-year period.

Crude oil is moving around the world, around our country, around pristine wilderness, around our cities and towns. It's going to keep moving, will undoubtedly increase during our new energy boom, so what is the safest way to move it?

The short answer is: *truck worse than train worse than pipeline worse than boat* (Oilprice.com). But that's only for human death and property destruction. For the normalized amount of oil spilled, it's *truck worse than pipeline worse than rail worse than boat* (Congressional Research Service). Different yet again is for environmental impact (dominated by impact to aquatic habitat), where it's *boat worse than pipeline worse than truck worse than rail*.

So it depends upon what your definition is for *worse*. Is it death and destruction? Is it amount of oil released? Is it land area or water volume contaminated? Is it habitat destroyed? Is it CO2 emitted?

Table 44: **Summary of water quality conditions at 21 NJDEP/USGS sites sampled in the Raritan River basin from 1991-97**

[Green Cells = the 3 sites with most samples meeting the standard or 3 sites with lowest median values for each constituent (highest median DO and alkalinity values); Red Cells = the 3 sites with most samples not meeting standards or 3 sites with highest median values (lowest median DO and alkalinity values); Alkalinity, biochemical oxygen demand, total ammonia + organic nitrogen (TKN) and total organic carbon do not have a standard; Ratings for pH and hardness are based on percent of samples meeting or not meeting both a high and low standard; *, trout maintenance; ** trout production; # coastal plain waters have naturally low alkalinity]

| Station Number | Nutrients | | | | | Inorganics | | | | | | Other Constituents | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ammonia + Organic Nitrogen | Ammonia, Un-ionized | Nitrite plus Nitrate | Organic Carbon, Total | Phosphorus, total | Alkalinity | Chloride | Dissolved solids, total | Hardness | Sodium | Sulfate | Biochemical Oxygen Demand | Dissolved Oxygen | Fecal coliform | pH | Suspended solids, total | Water temperature |
| South Branch Raritan River Sub-basin | | | | | | | | | | | | | | | | | |
| **01396280 – South Branch, Middle Valley | | | | | | | | | | | | | | | | | |
| *01396535 – South Branch, High Bridge | | | | | | | | | | | | | | | | | |
| **01396588 – Spruce Run | | | | | | | | | | | | | | | | | |
| *01396660 – Mulhockaway Cr. | | | | | | | | | | | | | | | | | |
| *01397000 – South Branch, Stanton | | | | | | | | | | | | | | | | | |
| 01397400 – South Branch, Three Bridges | | | | | | | | | | | | | | | | | |
| 01398000 – Neshanic River | | | | | | | | | | | | | | | | | |
| North Branch Raritan River Sub-basin | | | | | | | | | | | | | | | | | |
| **01398260 – North Branch, Chester | | | | | | | | | | | | | | | | | |
| 01399120 – North Branch, Burnt Mills | | | | | | | | | | | | | | | | | |
| **01399500 – Lamington River, Pottersville | | | | | | | | | | | | | | | | | |
| 01399700 – Rockaway Creek | | | | | | | | | | | | | | | | | |
| 01399780 – Lamington River, Burnt Mills | | | | | | | | | | | | | | | | | |

| Station Number | Nutrients | | | | | Inorganics | | | | | | Other Constituents | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ammonia + Organic Nitrogen | Ammonia, Un-ionized | Nitrite plus Nitrate | Organic Carbon, Total | Phosphorus, total | Alkalinity | Chloride | Dissolved solids, total | Hardness | Sodium | Sulfate | Biochemical Oxygen Demand | Dissolved Oxygen | Fecal coliform | pH | Suspended solids, total | Water temperature |
| **Millstone River Sub-basin** | | | | | | | | | | | | | | | | | |
| 01400540 – Millstone River, Manalapan | | | | | | # | | | | | | | | | | | |
| 01400650 – Millstone River, Grovers Mill | | | | | | | | | | | | | | | | | |
| 01401000 – Stony Brook, Princeton | | | | | | | | | | | | | | | | | |
| 01401600 – Beden Brook | | | | | | | | | | | | | | | | | |
| 01402000 – Millstone River, Blackwells Mills | | | | | | | | | | | | | | | | | |
| **Raritan River Mainstem** | | | | | | | | | | | | | | | | | |
| 01400500 – Raritan River, Manville | | | | | | | | | | | | | | | | | |
| 01403300 – Raritan River, Bound Brook | | | | | | | | | | | | | | | | | |
| **South River Sub-basin** | | | | | | | | | | | | | | | | | |
| 01405302 – Matchaponix Br. | | | | | | # | | | | | | | | | | | |
| 01405340 – Manalapan Brook | | | | | | # | | | | | | | | | | | |

The Fenimore Water Committee was created to study the environmental impact of the Fenimore Landfill in Roxbury Township on the water downstream from the landfill including Ledgewood Brook and ground water. Ms. Carluccio, who has requested to be on the committee but was denied, would be an invaluable asset to study the affects of Fenimore on the water.

Ms. Carluccio is currently the Deputy Director of the Delaware Riverkeeper Network. Previously, she was the Executive Director of the Neshaminy Water Resources Authority. Her educational background includes a B.A. in Sociology from the University of North Carolina and courses at Rutgers University Cook College in Environmental Science. She worked in the social service field for 12 years, where she was responsible for administering large grants. She has served on a total of ten community, government and service group boards.

This petition has nothing to do with the three appointed members to the Fenimore Water Committee. We support and respect all of the members and look forward to them doing a thorough investigation of the impacts from the Fenimore Landfill. However, we feel that the addition of Ms. Carluccio would be a great asset to the committee.

Ms. Carluccio is a strong supporter of the environment and someone the people of Roxbury trust. Since the Fenimore project is a political hot potato filled with controversy, lack of transparency, and rules that were not followed, the residents of Roxbury ask that an Ms. Carluccio, who has a vast array of experience with water, be added to the committee.

# Signatures

| Name | Location | Date |
|---|---|---|
| Bob Schultz | Succasunna, NJ, United States | 2015-04-01 |
| Marguerite Gargiulo | Flanders, NJ, United States | 2015-04-14 |
| Brenda Isherwood | Rockaway, NJ, United States | 2015-04-14 |
| Diane Weinpel | Succasunna, NJ, United States | 2015-04-14 |
| Lisa Riggiola | Pompton Lakes, NJ, United States | 2015-04-14 |
| Clark Paddock | Yorktown Heights, NY, United States | 2015-04-14 |
| Judy Decker | Ledgewood, NJ, United States | 2015-04-14 |
| Karen Guerra | Ledgewood, NJ, United States | 2015-04-14 |
| Leonora Emery | Ledgewood, NJ, United States | 2015-04-14 |
| carl panetta | Budd Lake, NJ, United States | 2015-04-14 |
| kerry smith | Otego, NY, United States | 2015-04-14 |
| Maureen Castriotta | Landing, NJ, United States | 2015-04-14 |
| Doreen Fiebel | Succasunna, NJ, United States | 2015-04-14 |
| Phyllis Yue | Denville, NJ, United States | 2015-04-14 |
| Maureen Leuszler | Roxbury Township, NJ, United States | 2015-04-14 |
| Aaron Markworth | Flanders, NJ, United States | 2015-04-14 |
| Michelle Oliveira | Ledgewood, NJ, United States | 2015-04-14 |
| Renee Paddock | Ledgewood, NJ, United States | 2015-04-14 |
| Sharon Lemoncelli | Dover, NJ, United States | 2015-04-14 |
| Barbara Conover | Montclair, NJ, United States | 2015-04-14 |
| Brenda Parr | Ledgewood, NJ, United States | 2015-04-14 |
| elizabeth balogh | riegelsville, PA, United States | 2015-04-14 |
| Rob O'Connell | Budd Lake, NJ, United States | 2015-04-14 |
| Mary Rodriguez | Ledgewood, NJ, United States | 2015-04-14 |
| C.Bob Mederos | Legewood, NJ, United States | 2015-04-14 |
| Nancy Boyle | Butler, NJ, United States | 2015-04-14 |
| Samantha Smith | Succasunna, NJ, United States | 2015-04-14 |
| Laurel Whitney | Succasunna, NJ, United States | 2015-04-14 |
| jake kovalcik | Yorktown Heights, NY, United States | 2015-04-14 |
| Betty Ann Weaver--Shaver | Tunkhannock, PA, United States | 2015-04-14 |

| Name | Location | Date |
|---|---|---|
| Debbie O'Brien | Roxbury Township, NJ, United States | 2015-04-14 |
| Kathy Panetta | Ledgewood, NJ, United States | 2015-04-14 |
| Marion Emery | Ledgewod, NJ, United States | 2015-04-14 |
| Dr. Washington Irving McLelland, Ed.D | Edison, NJ, United States | 2015-04-14 |
| joann stark | Ledgewood, NJ, United States | 2015-04-14 |
| Diane Sudo | Ledgewood, NJ, United States | 2015-04-14 |
| JP WIlson | Succasunna, NJ, United States | 2015-04-14 |
| Linda Keane | Ledgewood, NJ, United States | 2015-04-14 |
| Amy Tummino | Succasunna, NJ, United States | 2015-04-14 |
| Christine Stires | Flanders, NJ, United States | 2015-04-14 |
| Lyric LaCeile | Dallas, TX, United States | 2015-04-14 |
| Smara Voglesong | Medford, NJ, United States | 2015-04-14 |
| Brian Voglesong | Medford, NJ, United States | 2015-04-14 |
| cheryl deering | Dunkirk, NY, United States | 2015-04-14 |
| L Keurian | Ledgewood, NJ, United States | 2015-04-14 |
| Michael Lella | Kissimmee, FL, United States | 2015-04-14 |
| Jan Weaver Lawrence | Tunkhannock, PA, United States | 2015-04-14 |
| susan schnaidt | pompton lks, NJ, United States | 2015-04-15 |
| Debbie Watson | Yorktown Heights, NY, United States | 2015-04-15 |
| MARGARET JOHNSON | PHILLIPSBURG, NJ, United States | 2015-04-15 |
| Laura Lella | Lake Hopatcong, NJ, United States | 2015-04-15 |
| Donna Schaab | Succasunna, NJ, United States | 2015-04-15 |
| Brenda Acquisto | Budd Lake, NJ, United States | 2015-04-15 |
| Madeline solano | Ledgewood, NJ, United States | 2015-04-15 |
| Angela Johnson | Ledgewood, NJ, United States | 2015-04-15 |
| Angela Harrigan | Ledgewood, NJ, United States | 2015-04-15 |
| Rachel Young | carlstadt, NJ, United States | 2015-04-15 |
| Susan Meacham | Milford, NJ, United States | 2015-04-15 |
| Shannon Caccavella | Yorktown Heights, NY, United States | 2015-04-15 |
| Mike Lang | Ledgewood, NJ, United States | 2015-04-15 |
| jennifer olives | Landing, NJ, United States | 2015-04-15 |

| Name | Location | Date |
|---|---|---|
| Gordon Ashworth | Succasunna, NJ, United States | 2015-04-15 |
| Clyde McCutcheoin | Flanders, NJ, United States | 2015-04-15 |
| Sally Jane Gellert | Woodcliff Lake, NJ, United States | 2015-04-15 |
| Scott Mount | Ledgewood, NJ, United States | 2015-04-15 |
| Gutowski Kimberly | Succasunna, NJ, United States | 2015-04-15 |
| Joyce Puluse | Landing, NJ, United States | 2015-04-15 |
| Donna Zimmer | Succasunna, NJ, United States | 2015-04-15 |
| John Leuszler | Ledgewood, NJ, United States | 2015-04-15 |
| Michele Stone | Ledgewood, NJ, United States | 2015-04-15 |
| Sharon D'Agostino | Succasunna, NJ, United States | 2015-04-15 |
| Jeff Stone | Ledgewood, NJ, United States | 2015-04-15 |
| JoEllen Falco | Succasunna, NJ, United States | 2015-04-15 |
| Evelyn Latella | Succasunna, NJ, United States | 2015-04-15 |
| Susan shsw | Mountain Lakes, NJ, United States | 2015-04-16 |
| Katie marino | Washington, NJ, United States | 2015-04-16 |
| Tony Grant | Newton, NJ, United States | 2015-04-16 |
| Joanne Longo | Succasunna, NJ, United States | 2015-04-16 |
| Rose Letizia | Ledgewood, NJ, United States | 2015-04-16 |
| Samantha mikus | Ledgewood, NJ, United States | 2015-04-16 |
| Jessica rispoli | Orlando, FL, United States | 2015-04-16 |
| Joann Stormo | Ledgewood, NJ, United States | 2015-04-16 |
| Gene Drake | Amherst, VA, United States | 2015-04-16 |
| Ann Marie Nutto | Hopatcong, NJ, United States | 2015-04-16 |
| Wendie Goetz | Newton, NJ, United States | 2015-04-16 |
| Phil Lane | Landing, NJ, United States | 2015-04-16 |
| Jennifer raggi | Ledgewood, NJ, United States | 2015-04-16 |
| Diane Ramage | Ledgewood, NJ, United States | 2015-04-16 |
| maria guglielmo | Succasunna, NJ, United States | 2015-04-16 |
| Jeff Pichat | Succasunna, NJ, United States | 2015-04-16 |
| lisa perez | nj, NJ, United States | 2015-04-16 |
| John Mastandrea | Succasunna, NJ, United States | 2015-04-16 |
| Sheryl Bogardus | Succasunna, NJ, United States | 2015-04-16 |

| Name | Location | Date |
|---|---|---|
| Richard Serpa | Landing, NJ, United States | 2015-04-16 |
| Henry Hascup | Flanders, NJ, United States | 2015-04-16 |
| Kenneth Messer | Ashland, KY, United States | 2015-04-16 |
| Susan Williams | Sparta, NJ, United States | 2015-04-16 |
| Linda Moakler | Warwick, NY, United States | 2015-04-16 |
| Kevin Osetec | Ledgewood, NJ, United States | 2015-04-16 |
| Kelly berman | Succasunna, NJ, United States | 2015-04-16 |
| Patricia Conlin | Ashland, KY, United States | 2015-04-16 |
| Dr. Kathleen Pereillo | Rockaway, NJ, United States | 2015-04-16 |
| Donna Rein | Yorktown Heights, NY, United States | 2015-04-16 |
| Lisa Melchers | Succasunna, NJ, United States | 2015-04-16 |
| David Ramage | Ledgewood, NJ, United States | 2015-04-16 |
| Andrea Scalfani | Succasunna, NJ, United States | 2015-04-16 |
| Maureen Jasiecki | Ledgewood, NJ, United States | 2015-04-16 |
| Laura Lappine | Wind Gap, PA, United States | 2015-04-16 |
| Greg Damell | Rockaway, NJ, United States | 2015-04-16 |
| Anna Tolerico | Succasunna, NJ, United States | 2015-04-16 |
| Janet lemma | Cape Coral, FL, United States | 2015-04-16 |
| robyn denicola | Flanders, NJ, United States | 2015-04-16 |
| Dan Masi | Roxbury Township, NJ, United States | 2015-04-16 |
| Richard Rein | Succasunna, NJ, United States | 2015-04-16 |
| Beth Glazer | Succasunna, NJ, United States | 2015-04-16 |
| Sara' Diskin | Landing, NJ, United States | 2015-04-16 |
| Joan Damell | Roxbury Township, NJ, United States | 2015-04-16 |
| Patti Sibel | Flanders, NJ, United States | 2015-04-16 |
| Pat Miller | Succasunna, NJ, United States | 2015-04-16 |
| Richard Cadogan | Ledgewood, NJ, United States | 2015-04-16 |
| Michelle Motzer | Ledgewood, NJ, United States | 2015-04-16 |
| Jeffrey Bouvier | Flanders, NJ, United States | 2015-04-16 |
| Larry Karipidis | Succasunna, NJ, United States | 2015-04-16 |
| phil riff | Hopatcong, NJ, United States | 2015-04-16 |
| Fern Roome | flanders, Jersey | 2015-04-16 |

| Name | Location | Date |
|---|---|---|
| D Yules | Ledgewood, NJ, United States | 2015-04-16 |
| BRYAN DEL VECCHIO | Ledgewood, NJ, United States | 2015-04-16 |
| Mike Hefferon | Flanders, NJ, United States | 2015-04-16 |
| Terry Pence | Flanders, NJ, United States | 2015-04-16 |
| Jessica Parrotta | Dover, NJ, United States | 2015-04-16 |
| Janice Steigler | Ledgewood, NJ, United States | 2015-04-16 |
| Arleen Swart | Keyport, NJ, United States | 2015-04-16 |
| Katrina Bolchune | Succasunna, NJ, United States | 2015-04-16 |
| Sean Prendergast | Succasunna, NJ, United States | 2015-04-16 |
| Willie List | Roxbury Township, NJ, United States | 2015-04-16 |
| Carmen Torres arias | Ledgewood, NJ, United States | 2015-04-16 |
| Jennifer Roushinko | Succasunna, NJ, United States | 2015-04-16 |
| Susie DeRiancho | Oak Ridge, NJ, United States | 2015-04-16 |
| Bill Morrocco | Hicksville, NY, United States | 2015-04-16 |
| Casey Ury | Landing, NJ, United States | 2015-04-16 |
| Julie LaFranco | Ledgewood, NJ, United States | 2015-04-16 |
| Deanna Caines | Ashland, KY, United States | 2015-04-16 |
| Brenda Hornsby | Catlettsburg, KY, United States | 2015-04-16 |
| Joyce peslak | Ledgewood, NJ, United States | 2015-04-16 |
| Kathy messina | Succasunna, NJ, United States | 2015-04-16 |
| Duans Corvalan | Succasunna, NJ, United States | 2015-04-16 |
| Greg Martin | Livingston, NJ, United States | 2015-04-16 |
| Vince Cattano | Landing, NJ, United States | 2015-04-16 |
| timothy farkas | Succasunna, NJ, United States | 2015-04-16 |
| Justin Everett | Succasunna, NJ, United States | 2015-04-16 |
| Anthony Fiore | Ledgewood, NJ, United States | 2015-04-16 |
| Barbara Herman | Ledgewood, NJ, United States | 2015-04-16 |
| glenn sivertsen | ledgewood, NJ, United States | 2015-04-16 |
| Jeff Schutz | Ledgewood, NJ, United States | 2015-04-16 |
| Charlene Leary Leary | Mine Hill Township, NJ, United States | 2015-04-16 |
| Kimberly Cioletti | Succasunna, NJ, United States | 2015-04-16 |
| Michael menendez | Landing, NJ, United States | 2015-04-16 |

| Name | Location | Date |
|---|---|---|
| lisa millus | Succasunna, NJ, United States | 2015-04-16 |
| Megan Bradley | Roxbury Township, NJ, United States | 2015-04-16 |
| kim Yamashita | Landing, NJ, United States | 2015-04-16 |
| Patricia fox | New York, NY, United States | 2015-04-16 |
| Addimando Sherry | Flanders, NJ, United States | 2015-04-16 |
| Debra Jones | Long Valley, NJ, United States | 2015-04-16 |
| Jim Stoltz | Budd Lake, NJ, United States | 2015-04-16 |
| andy puluse | Landing, NJ, United States | 2015-04-16 |
| john melicharek | Landing, NJ, United States | 2015-04-16 |
| Liz Chaplin | Landing, NJ, United States | 2015-04-16 |
| Robyn Dean | Ledgewood, NJ, United States | 2015-04-16 |
| Zina Mougharbel | Succasunna, NJ, United States | 2015-04-16 |

# Broncos Ditching Synthetic Field At Mile High, Using Kentucky Bluegrass Grown In Colorado

February 11, 2015 3:07 PM
Share on email9
View Comments

An image of the work being done on Wednesday from Copter4 (credit: CBS)

**Related Tags:**
Charlotte Hounds, Denver Broncos, Denver Outlaws, Fort Morgan, Graff's Turf Farms, Kentucky Bluegrass, Millennium Sports Technologies, Sports Authority Field at Mile High, Sports Contracting Group, Zach Myhra



**DENVER (CBS4)** – The Denver Broncos have begun a major renovation of the field at Sports Authority Field at Mile High this offseason.

According to the Broncos, the organization has partnered with Sports Contracting Group and Millennium Sports Technologies to upgrade the playing surface.

The field was removed on Monday and the new playing surface is expected to be in place by early April.

"Sports Authority Field at Mile High is committed to providing state-of-the-art amenities to fans and teams utilizing the stadium," Director of Facilities for Stadium Management Company Zach Myhra said in a statement. "After completing extensive upgrades to the stadium in recent years, our focus now is providing the safest and best possible playing surface at Sports Authority Field at Mile High."

An image of the work being done on Wednesday from Copter4 (credit: CBS)

The new field will be made of 100 percent Kentucky bluegrass sod grown by Graff's Turf Farms in Fort Morgan. It's a switch from the synthetic blend surface that has been used at the stadium since it opened in 2001.

The Denver Outlaws will have the honor of being the first to play on the new field during theirhome opener against the Charlotte Hounds on May 3.

EPA United States Environmental Protection Agency

## Exposure Research

## The Use of Recycled Tire Materials on Playgrounds & Artificial Turf Fields


Link to the news release for this study

> Downloadable Document
>
> Download "A Scoping-Level Field Monitoring Study of Synthetic Turf Fields and Playgrounds" (pdf, 123pp, 7.2MB)

### Background

Ground rubber — also called "tire crumb" or "crumb rubber" — is recovered from scrap tires or from the tire retreading process. It is used in road construction and in a number of athletic and recreational applications, including ground cover under playground equipment, running track material, and as a soil additive on sports and playing fields.

Crumb rubber is often used in synthetic turf fields as "infill" between turf fibers to provide stability, uniformity and resiliency to synthetic turf fields. Synthetic turf was developed in the mid-1960s and has since gained widespread popularity around the country. Synthetic turf was originally used in stadiums and on athletic fields for college and professional sports teams, but now is also used in municipal parks, golf courses, playgrounds, cruise ships, and airports. There is also a growing residential market.

According to the Synthetic Turf Council, synthetic turf has been installed in approximately 4,500 U.S. fields, tracks and playgrounds.

### Public Concerns

Over the past several years, a number of public concerns have been raised over the use of tire crumb materials in turf fields and playgrounds. For example, parents in Colorado were concerned about children carrying home small particles of tire crumbs on their clothing. About this time, high levels of lead were detected on some synthetic turf fields in New Jersey.

### EPA Research

In response to these concerns, the EPA developed an agency workgroup that initiated a limited-scale scoping study to test a study protocol and monitoring methods for generating environmental data associated with the use of recycled tire material on synthetic turf fields and playgrounds.

As part of this evaluation, data were collected at a limited number of sites. The full study protocol was implemented at two synthetic turf fields and one playground. Additional samples were collected at four other synthetic turf fields and a second playground. Sampling sites were located in North Carolina, Georgia, Ohio, and Maryland.

2 Athletic Field 1 playground + 4 Athletic Fields + 1 playground TOTAL 6 Field 2 Playground

It is important to have accurate and reproducible methods for measuring environmental concentrations of the components of synthetic turf fields and playgrounds. The study protocols and the majority of the methods evaluated were found to be appropriate for characterizing concentrations of tire crumb components in the environment.

<Limited>

Given the very limited nature of this study (i.e., limited number of components monitored, samples sites, and samples taken at each site) and the wide diversity of tire crumb material, it is not possible to extend the results beyond the four study sites or to reach any more comprehensive conclusions without the consideration of additional data.

Both the Consumer Product Safety Commission and the Centers for Disease Control and Prevention recommend that young children wash their hands frequently after playing outside and always before they eat. The EPA also recommends these practices.

**Key Technical Findings from the EPA's Study**

The key study findings are summarized below. In general, the study protocol is expected to reliably yield data for assessing environmental concentrations of selected tire crumb constituents and understanding potential routes of exposure.

1. The study protocol and many of the methods were found to be reliable and could be implemented in the field. Several limitations are noted as follows.
   - Collecting integrated air samples provided a high burden in terms of time and equipment.
   - Semivolatile organic compounds (SVOCs) were not measured.
   - At any single site, there can be substantial variability in the tire crumb materials used and the concentrations of contaminants measured. More work is needed to determine where to collect samples and how many samples to collect to fully characterize a given site.
   - It was difficult to obtain access and permission to sample at playgrounds and recreational fields. More work is needed to increase public and private owner participation if these studies are to be implemented.

   Very Limited Studies
2. Methods used to measure air concentrations of particulate matter (PM) and metals were found to be reliable.
3. Methods used to measure volatile organic compounds (VOCs) in air were found to be reliable.
4. Methods used to measure extractable metals from turf field blades, tire crumb materials, and turf field wipe samples were found to be reliable. However, the aggressive acid extraction procedure likely will overestimate the concentration of metals that are readily available for human uptake. Because understanding human uptake or absorption is a key component in understanding risk, methods to determine bioavailable metal concentrations are still needed.

   Need More In-depth Long-Term Studies ←
5. Given the limited nature of the study (limited number of constituents monitored, sample sites, and samples taken at each site) and the wide diversity of tire crumb material, it is not possible, without additional data, to extend the results beyond the four study sites to reach more comprehensive conclusions.

Need more long-term studies

When considering future study designs and implementation, the research needs to carefully consider issues associated with identifying and gaining site access, and benefits of obtaining the data versus the resource burden, and the implementation of other methods for generating data to address specific research hypotheses. Future studies will need a carefully developed and implemented communications plan to promote the value of the research and gain access to the required facilities.

**Additional information on the use of recycled tire materials**

After a review of the literature, the EPA identified a number of compounds or materials that may be found in tires, although not all are contained in every tire:

- acetone
- aniline
- arsenic
- barium
- benzene
- benzothiazole
- cadmium
- chloroethane
- chromium
- cobalt
- copper
- halogenated flame retardants
- isoprene
- latex
- lead
- manganese
- mercury
- methyl ethyl ketone
- methyl isobutyl ketone
- naphthalene
- nickel
- nylon
- phenol
- pigments
- polycyclic aromatic hydrocarbons
- polyester
- rayon
- styrene - butadiene
- toluene
- trichloroethylene

**Look here for other feature stories**

**U.S. Department of Health and Human Services Secretary Sylvia M. Burwell** released the *13th Report on Carcinogens* on October 2, 2014. (Press Release) (*Federal Register* notice PDF HTML)

The Report on Carcinogens (RoC) is a congressionally mandated, science-based, public health document that the NTP prepared for the HHS Secretary.

The report identifies agents, substances, mixtures, and exposure circumstances that are *known or reasonably anticipated* to cause cancer in humans.
*Official Citation:* NTP (National Toxicology Program). 2014. *Report on Carcinogens, Thirteenth Edition.* Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service. http://ntp.niehs.nih.gov/pubhealth/roc/roc13/

**Substances Listed in the Thirteenth Report on Carcinogens -** Bold entries indicate new or changed listings in the Thirteenth Report on Carcinogens.

**Known To Be Human Carcinogens**
Aflatoxins
Alcoholic Beverage Consumption
4-Aminobiphenyl
Analgesic Mixtures Containing Phenacetin (see Phenacetin and Analgesic Mixtures Containing Phenacetin)
Aristolochic Acids
Arsenic and Inorganic Arsenic Compounds
Asbestos
Azathioprine
Benzene Benzidine (see Benzidine and Dyes Metabolized to Benzidine)
Beryllium and Beryllium Compounds
Bis(chloromethyl) Ether and Technical-Grade Chloromethyl Methyl Ether
1,3-Butadiene
1,4-Butanediol Dimethanesulfonate
Cadmium and Cadmium Compounds
Chlorambucil
1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea (see Nitrosourea Chemotherapeutic Agents)
Chromium Hexavalent Compounds
Coal Tars and Coal-Tar Pitches
Coke-Oven Emissions
Cyclophosphamide
Cyclosporin
A Diethylstilbestrol
Dyes Metabolized to Benzidine (Benzidine Dye Class) (see Benzidine and Dyes Metabolized to Benzidine)
Erionite Estrogens, Steroidal
Ethylene Oxide
Formaldehyde
Hepatitis B Virus
Hepatitis C Virus
Human Papillomaviruses: Some Genital-Mucosal Types
Melphalan
Methoxsalen with Ultraviolet A Therapy
Mineral Oils: Untreated and Mildly Treated
Mustard Gas
2-Naphthylamine
Neutrons (see Ionizing Radiation)
Nickel Compounds (see Nickel Compounds and Metallic Nickel)
Radon (see Ionizing Radiation)
Silica, Crystalline (Respirable Size)
Solar Radiation (see Ultraviolet Radiation Related Exposures)
Soots

Strong Inorganic Acid Mists Containing Sulfuric Acid
Sunlamps or Sunbeds, Exposure to (see Ultraviolet Radiation Related Exposures)
Tamoxifen
2,3,7,8-Tetrachlorodibenzo-p-dioxin
Thiotepa
Thorium Dioxide (see Ionizing Radiation)
Tobacco Smoke, Environmental (see Tobacco-Related Exposures)
Tobacco Smoking (see Tobacco-Related Exposures)
Tobacco, Smokeless (see Tobacco-Related Exposures)
**o-Toluidine**
Ultraviolet Radiation, Broad-Spectrum (see Ultraviolet Radiation Related Exposures)
Vinyl Chloride (see Vinyl Halides [selected])
Wood Dust
X-Radiation and Gamma Radiation (see Ionizing Radiation)

**Reasonably Anticipated To Be Human Carcinogens**
Acetaldehyde
2-Acetylaminofluorene
Acrylamide
Acrylonitrile
Adriamycin
2-Aminoanthraquinone
o-Aminoazotoluene
1-Amino-2,4-dibromoanthraquinone
2-Amino-3,4-dimethylimidazo[4,5-f]quinoline (see Heterocyclic Amines [Selected])
2-Amino-3,8-dimethylimidazo[4,5-f]quinoxaline (see Heterocyclic Amines [Selected])
1-Amino-2-methylanthraquinone
2-Amino-3-methylimidazo[4,5-f]quinoline (see Heterocyclic Amines [Selected])
2-Amino-1-methyl-6-phenylimidazo[4,5-b]pyridine (see Heterocyclic Amines [Selected])
Amitrole
o-Anisidine and Its Hydrochloride
Azacitidine
Basic Red 9 Monohydrochloride
Benz[a]anthracene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Benzo[b]fluoranthene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Benzo[j]fluoranthene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Benzo[k]fluoranthene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Benzo[a]pyrene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Benzotrichloride
2,2-Bis(bromomethyl)-1,3-propanediol (Technical Grade)
Bis(chloroethyl) Nitrosourea (see Nitrosourea Chemotherapeutic Agents)
Bromodichloromethane
**1-Bromopropane**
Butylated Hydroxyanisole
Captafol
Carbon Tetrachloride
Ceramic Fibers (Respirable Size)
Chloramphenicol
Chlorendic Acid
Chlorinated Paraffins (C12, 60% Chlorine)
Chloroform
1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea (see Nitrosourea Chemotherapeutic Agents)
3-Chloro-2-methylpropene

4-Chloro-o-phenylenediamine
Chloroprene
p-Chloro-o-toluidine and Its Hydrochloride
Chlorozotocin (see Nitrosourea Chemotherapeutic Agents)
Cisplatin
Cobalt
Cobalt–Tungsten Carbide: Powders and Hard Metals
p-Cresidine
**Cumene**
Cupferron
Dacarbazine
Danthron
2,4-Diaminoanisole Sulfate
2,4-Diaminotoluene
Diazoaminobenzene
Dibenz[a,h]acridine (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Dibenz[a,j]acridine (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Dibenz[a,h]anthracene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
7H-Dibenzo[c,g]carbazole (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Dibenzo[a,e]pyrene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Dibenzo[a,h]pyrene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Dibenzo[a,i]pyrene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Dibenzo[a,l]pyrene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
1,2-Dibromo-3-chloropropane
1,2-Dibromoethane
2,3-Dibromo-1-propanol
1,4-Dichlorobenzene
3,3′-Dichlorobenzidine and Its Dihydrochloride
Dichlorodiphenyltrichloroethane
1,2-Dichloroethane
Dichloromethane
1,3-Dichloropropene (Technical Grade)
Diepoxybutane
Diesel Exhaust Particulates
Di(2-ethylhexyl) Phthalate
Diethyl Sulfate
Diglycidyl Resorcinol Ether
3,3′-Dimethoxybenzidine (see 3,3′-Dimethoxybenzidine and Dyes Metabolized to 3,3′-Dimethoxybenzidine)
4-Dimethylaminoazobenzene
3,3′-Dimethylbenzidine (see 3,3′-Dimethylbenzidine and Dyes Metabolized to 3,3′-Dimethylbenzidine)
Dimethylcarbamoyl Chloride
1,1-Dimethylhydrazine
Dimethyl Sulfate
Dimethylvinyl Chloride
1,6-Dinitropyrene (see Nitroarenes [Selected])
1,8-Dinitropyrene (see Nitroarenes [Selected])
1,4-Dioxane
Disperse Blue 1
Dyes Metabolized to 3,3′-Dimethoxybenzidine (3,3′-Dimethoxybenzidine Dye Class) (see 3,3′-Dimethoxybenzidine and Dyes Metabolized to 3,3′-Dimethoxybenzidine)
Dyes Metabolized to 3,3′-Dimethylbenzidine (3,3′-Dimethylbenzidine Dye Class) (see 3,3′-Dimethylbenzidine and Dyes Metabolized to 3,3′-Dimethylbenzidine)
Epichlorohydrin
Ethylene Thiourea

Ethyl Methanesulfonate
Furan
Glass Wool Fibers (Inhalable), Certain
Glycidol
Hexachlorobenzene
Hexachloroethane
Hexamethylphosphoramide
Hydrazine and Hydrazine Sulfate
Hydrazobenzene
Indeno[1,2,3-cd]pyrene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
Iron Dextran Complex
Isoprene
Kepone
Lead and Lead Compounds
Lindane, Hexachlorocyclohexane (Technical Grade), and Other Hexachlorocyclohexane Isomers
2-Methylaziridine
5-Methylchrysene (see Polycyclic Aromatic Hydrocarbons: 15 Listings)
4,4′-Methylenebis(2-chloroaniline)
4,4′-Methylenebis(N,N-dimethyl)benzenamine
4,4′-Methylenedianiline and Its Dihydrochloride
Methyleugenol
Methyl Methanesulfonate
N-Methyl-N′-Nitro-N-Nitrosoguanidine (see N-Nitrosamines: 15 Listings)
Metronidazole
Michler's Ketone
Mirex
Naphthalene
Nickel, Metallic (see Nickel Compounds and Metallic Nickel)
Nitrilotriacetic Acid
o-Nitroanisole
Nitrobenzene
6-Nitrochrysene (see Nitroarenes [Selected])
Nitrofen
Nitrogen Mustard Hydrochloride
Nitromethane
2-Nitropropane
1-Nitropyrene (see Nitroarenes [Selected])
4-Nitropyrene (see Nitroarenes [Selected])
N-Nitrosodi-n-butylamine (see N-Nitrosamines: 15 Listings)
N-Nitrosodiethanolamine (see N-Nitrosamines: 15 Listings)
N-Nitrosodiethylamine (see N-Nitrosamines: 15 Listings)
N-Nitrosodimethylamine (see N-Nitrosamines: 15 Listings)
N-Nitrosodi-n-propylamine (see N-Nitrosamines: 15 Listings)
N-Nitroso-N-ethylurea (see N-Nitrosamines: 15 Listings)
4-(N-Nitrosomethylamino)-1-(3-pyridyl)-1-butanone (see N-Nitrosamines: 15 Listings)
N-Nitroso-N-methylurea (see N-Nitrosamines: 15 Listings)
N-Nitrosomethylvinylamine (see N-Nitrosamines: 15 Listings)
N-Nitrosomorpholine (see N-Nitrosamines: 15 Listings)
N-Nitrosonornicotine (see N-Nitrosamines: 15 Listings)
N-Nitrosopiperidine (see N-Nitrosamines: 15 Listings)

N-Nitrosopyrrolidine (see N-Nitrosamines: 15 Listings)
N-Nitrososarcosine (see N-Nitrosamines: 15 Listings)
o-Nitrotoluene
Norethisterone
Ochratoxin A
4,4′-Oxydianiline
Oxymetholone
**Pentachlorophenol and By-products of Its Synthesis**
Phenacetin (see Phenacetin and Analgesic Mixtures Containing Phenacetin)
Phenazopyridine Hydrochloride
Phenolphthalein
Phenoxybenzamine Hydrochloride
Phenytoin and Phenytoin Sodium
Polybrominated Biphenyls
Polychlorinated Biphenyls
Procarbazine and Its Hydrochloride
Progesterone
1,3-Propane Sultone
β-Propiolactone
Propylene Oxide
Propylthiouracil
Reserpine
Riddelliine
Safrole
Selenium Sulfide
Streptozotocin (see Nitrosourea Chemotherapeutic Agents)
Styrene Styrene-7,8-oxide
Sulfallate
Tetrachloroethylene
Tetrafluoroethylene
Tetranitromethane
Thioacetamide
4,4′-Thiodianiline
Thiourea
Toluene Diisocyanates
Toxaphene
Trichloroethylene
2,4,6-Trichlorophenol
1,2,3-Trichloropropane
Tris(2,3-dibromopropyl) Phosphate
Ultraviolet Radiation A (see Ultraviolet Radiation Related Exposures)
Ultraviolet Radiation B (see Ultraviolet Radiation Related Exposures)
Ultraviolet Radiation C (see Ultraviolet Radiation Related Exposures)
Urethane
Vinyl Bromide (see Vinyl Halides [Selected])
4-Vinyl-1-cyclohexene Diepoxide
Vinyl Fluoride (see Vinyl Halides [Selected])

This document can be made available
In alternate formats upon request

State of Minnesota

# House of Representatives

EIGHTY-NINTH SESSION

## H.F. No. 1601

03/09/2015 Authored by Clark, McNamara and Kahn
This bill was read for the first time and referred to the Committee on Health and Human Services Reform

as introduced - 89th Legislature (2015 - 2016) Posted on 03/10/2015

A bill for an act

relating to health; limiting the use of synthetic turf on certain athletic fields; requiring the commissioner of health to study the impacts of the use of crumb rubber; requiring reports; appropriating money; proposing coding for new law in Minnesota Statutes, chapter 145.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF MINNESOTA:

Section 1. **[145.946] HEALTH ASSESSMENT OF SYNTHETIC TURF.**

Subdivision **1. Definitions**. For purposes of this section, the following terms have the meanings given.

(a) "Crumb rubber" means ground rubber derived from waste tires, which contain one or more of the following: acetone, arsenic, cadmium, chromium, lead, vanadium, or zinc.

(b) "Synthetic turf" means any materials or compositions that include crumb rubber used in the place of grass to surface parks, outdoor athletic playing fields, indoor athletic facilities, or other venues.

Subd. **2. Use of synthetic turf**. No person may install synthetic turf on an athletic playing field within the boundaries of a public or private school or a public park until the Department of Health, in consultation with the Pollution Control Agency, has prepared a site-specific impact report on the health and environmental effects of the use or installation of synthetic turf on that athletic playing field.

Subd. **3. Health study; report**. The commissioner of health must study the health impacts related to the use of crumb rubber within synthetic turf and review all available data relating to the potential health risks and health effects of synthetic turf, with particular attention to the crumb rubber content of the synthetic turf. In conducting this study, the commissioner must examine the health and environmental impact of various pathways of exposure including, but not limited to, small-fill particle inhalation, volatility, leaching into groundwater, dermal absorption, and the persistence in the environment of the original and degraded by-products of crumb rubber. By June 30, 2016, the commissioner of health shall report the findings of the study to the chairs and ranking minority members of the legislative committees with jurisdiction over health and environment policy.

Sec. 2. **APPROPRIATION.**

$....... is appropriated in fiscal year 2016 from the general fund to the commissioner of health to prepare impact reports and study the use of crumb rubber within synthetic turf.

BioMed Central The Open Access Publisher | BMC Sports Science, Medicine & Rehabilitation
this article | search | submit a manuscript | register

BMC Sports Sci Med Rehabil. 2014; 6: 11.

Published online 2014 Mar 1. doi: 10.1186/2052-1847-6-11

PMCID: PMC4108054

# The perceptions of professional soccer players on the risk of injury from competition and training on natural grass and 3rd generation artificial turf

Constantine CN Poulos,[✉1] John Gallucci, Jr,[2,3] William H Gage,[1] Joseph Baker,[1] Sebastian Buitrago,[1] and Alison K Macpherson[1]

Author information ► Article notes ► Copyright and License information ►



## Abstract

Go to:

## Background

Participation in soccer poses an inherent risk of injury, that can arise from the interplay of many different factors. The incidence of injury due to soccer participation has been shown to range from 12 to 35.5 injuries/1000 hours of games and 1.5 to 7.6 injuries/1000 of practice for different leagues across the world, and varying levels of competition – mostly adult male professional players (e.g., lower tier professional division, top-tier professional division, international level competition) [1]. It is imperative to understand the risk factors leading to injury in soccer in order to initiate measures to reduce their occurrence and associated burden. Currently, two types of surfaces are sanctioned by FIFA and UEFA for soccer competition at the elite professional level: natural grass (NG) surfaces, and artificial turf surfaces (including both 3rd generation and 4th generation) otherwise referred to as "Football turf" (FT) [2]. The main reasons for the introduction of artificial turf were to lessen the impact of environmental conditions on surfaces, to decrease the high operating costs associated with NG, and to increase field usability [3-5].

Studies analyzing the injury risk associated with elite soccer competition and training on FT and NG have found comparable rates of injury on both surfaces [6-10]. In a recent study of elite male professional players the incidence of acute injuries were reported to be 3.5 v 3.5/1000 training hours, and 22.4 v 21.7/1000 match hours for FT and NG respectively [7]. Similar incidences were further reported in an earlier study of elite male professional players (2.42 v 2.49/1000 training hours and 19.60 v 21.48/1000 match hours for FT and NG respectively) [6]. Notably missing in this body of literature are studies exploring professional soccer players' subjective experiences about competition and training on FT and NG. No study has focused on understanding professional soccer players' opinions about the influence of surface type on injury.

Movement patterns, ball skills, and the impressions of Swedish elite male and female soccer players were analyzed during competitive games on 2nd and 3rd generation artificial turf and NG by Andersson et al. [11]. No differences were observed in the movement or technical patterns of the players between the two surfaces, yet roughly two thirds of the male sample reported that games were more physically demanding on artificial turf compared to natural grass [11]. However, Nedelec and colleagues found that a sample of 13 professional players had no negative impressions of artificial turf during recovery (data were collected 10 minutes, 24 hours, and 48 hours after the test) following a 90-minute soccer-specific aerobic field test performed on NG and artificial turf [12]. Players did although report moderately higher soreness in the quadriceps immediately after the test, in the gluteals 24 hours after the test, and in the hamstrings 48 hours after the test in the artificial turf condition [12].

The aim of this study was to assess professional soccer players' perceptions regarding injuries, physical recovery, and the influence surface related factors such as field mechanical properties and maintenance can have on injury, and other complaints related to soccer participation on FT compared to NG. Doing so is important for assessing the completeness of the current surface-injury paradigm, and to put the findings of the current epidemiological literature into the context of professional players day-to-day experiences with these surfaces, thereby narrowing the gap between science and practice.

Go to:

## Methods

Major League Soccer is the highest level of professional soccer in North America. It is comprised of 16 teams from the United States and 3 teams from Canada, which compete from March to December. Along with regular season competition, teams compete concurrently in friendly matches, domestic tournaments, and in one major international tournament (CONCACAF Champions League). Of the 18 teams competing in the MLS during the 2011 season, 6 teams were invited to participate in the study based upon the availability and willingness of these teams to participate in the study directives. Access to the teams was facilitated by the Medical

Coordinator for the MLS, who provided contact information, and support throughout the study period. Fulltime professional players who were signed to a first team contract were asked to complete a paper questionnaire. All participating players had to be able to read and speak English, and voluntarily consent to participation in the study. Players were instructed to recall their experiences on FT rather than earlier generation turf surfaces, and a description of FT was provided in the survey. In accordance with the UEFA model for epidemiological studies a member of the medical team was selected as the primary contact person [13]. The Head and/or Assistant Athletic Therapist's/Trainer's were responsible for administering the surveys. The study was reviewed and approved under the research ethics protocols by the Human Participants Review Subcommittee at York University, Toronto, Canada.

We could not find a validated questionnaire and had therefore developed our own. A graphic artist was hired to design the visual components of the survey, such as the color scheme, text selection and graphical layout. An extensive literature review was conducted to identify: 1) Salient issues in the current research on NG and FT (e.g., more ankle injuries occur on artificial turf, and player impressions that it is harder, and more fatiguing to play on artificial turf as opposed to grass). 2) Outcome variables that have been used in soccer injury research (e.g., contact vs. non-contact injuries, acute vs. chronic injuries, exposure time, age, and anatomical region of injury). Further questions were drawn from the National Football League Players Association (NFLPA) *Playing Surfaces Opinion Survey*, administered to all active NFL players in 2004 and 2008 [14,15]. The final questionnaire was a consolidation of the information from these sources, and included 18 closed-ended attitudinal questions, 2 of which had an open-ended component asking players "why" they chose their respective response, and 1 open-ended attitude question. All technical terms used in this survey were defined following the recommendations of the *Consensus Statement on Injury Definitions and Data Collection Procedures in Studies of Soccer Injuries* published under the auspices of the FIFA Medical Assessment and Research Center [16]. The questionnaire was pilot-tested with the York University Varsity Men's Soccer Team and minor changes were made before it was administered to the study sample. A copy of the questionnaire administered to the players can be found in Additional file 1 A electronically online.

Some questions in each survey were missing answers. In these cases the completed data were used in the analysis, and the missing data were excluded. Descriptive statistics including means, standard deviations and frequencies, were calculated using SPSS version 20.0 (IBM Corp., Armonk, NY). Open-ended responses were analyzed and interpreted by the primary research team and a Certified Athletic Therapist who works in a soccer setting. Table 1includes the key phrases in the players' comments that were used to stratify responses into the surface mechanical groupings.

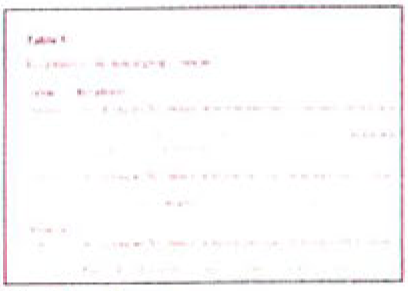


Table 1
Key phrases for mechanical group comments

Go to:

## Results

Out of a total of 18 teams in the league at the time of the study 6 teams completed the surveys (33%). Out of a total of 180 potential respondents across the six teams, 99 players (55%) completed the surveys. For the 13 questions analyzed 4% of the data were missing (49/1,396 potential responses). Table 2 provides data on the 99 players and the 6 teams.

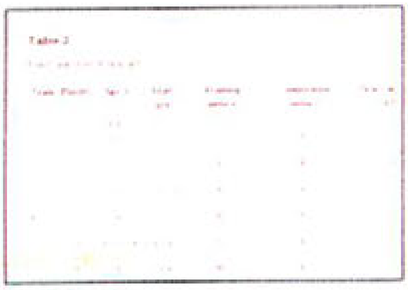


Table 2
Player and team demographics

Field Turf
Greater muscel soreness 97%
Greater Joint soreness 96%
More time To Recover 90%
most impacted Overuse Injuries During season 89%

### Physical experiences on football turf and natural grass

Most of the players responded that playing and practicing on FT resulted in greater muscle and joint soreness (97%, 96/99 and 96%, 95/98; 1 missing response respectively). Further, the majority of players (90%, 89/99) also felt that it took more time to recover after a game on FT when compared to NG. These findings were also reflected in the following terms, that players used to describe FT; *"Greater Stress of Joints/Body"*, *"Greater Muscle Tightness/Soreness"*, *"Breaks down body"*, *"Shock to Muscles/Joints"*. When asked which surface most impacted overuse injuries over the entire course of a season only 2 players (2%, 2/98; 1 missing response) felt that NG would lead to more chronic injuries, 9 players (9%, 9/98; 1 missing response) were unsure or had no opinion, and the remaining 87 players (89%, 87/98; 1 missing response) chose FT. There was a difference between how players perceived contact and non-contact injuries. Seventy percent of the players (68/98; 1 missing response) agreed that the risk of sustaining a contact injury was the same regardless of the surface the training session or match was being conducted on. Conversely, eighty percent (78/98; 1 missing response) of the players felt the risk of sustaining a non-contact injury was elevated when training and competing on FT. Overall, 94% of the players (92/98; 1 missing response) chose FT as the surface most likely to increase the risk of sustaining an injury.

80% risk of Sustaining Non Contact Injury was elevated on Field Turf

## Analysis of player comments

94% Field Turf Increase risk of Sustaining Injury

The two open-ended questions asked the players' "why" they chose their respective response to the following closed-ended items: a) "On which surface does it take you more time to recover after a game?" b) "Overall on which surface do you feel the risk of sustaining an injury is higher?" For question (a) there were 17 missing responses (82/99), and for question (b) there were 26 missing responses (73/99). Three surface related risk factors (i.e., surface stiffness, surface friction, and metabolic cost) were identified by analyzing the key phrases in the players' responses (Table 3).

Table 3
Frequency and distribution of mechanical comments for open ended questions

## List of original player comments

The original player comments below provide further insight into the viewpoint of FT for this group of players.

"All my 3 biggest injuries have happened on turf matches, hence why I believe natural grass is still much safer"

"Feet stick when wet, and the ball moves too fast and your joints are put under more stress because there is no give in turf surface"

"Personally coming off back-to-back ACL tears in my left Knee (both happened on turf) I feel mentally scared to play on turf. Even prior to the ACLs I was hesitant to play full out"

"Football Turf doesn't give like grass. If a foot gets caught in, it is more dangerous because the turf can't dig up to release the foot".

"It's just proven in my experience of playing that more injuries occur on turf. To avoid this the quality of the turf has to be very high"

"I have always played a little cautious on turf for fear of having a cleat stick in the turf"

"The first time I played on the new type of field turf, I broke my 5th metatarsal in a non-contact plant"

"Temperature on hot days zaps and dehydrates the body", "Hot, wet weather is difficult to play in"

"Turf can feel like running on sand", "Requires more physical effort"

### Surface type, quality, and weather as a risk factor for injury

Players agreed that both the type and quality of a playing surface could impact the risk of sustaining an injury (92/99, 93% and 93/98; 1 missing response, 95% respectively). Thirty seven percent of the players (37/99) felt surface quality had the greatest influence on the risk of injury on FT, 36% (36/99) felt the risk of injury was greater on NG, and 21% (21/99) thought that surface quality was no more important in affecting the risk of injury on one surface over the other. The remainder of the players were either unsure or did not have an opinion (5%, 5/99). Sixty eight percent (67/99) of players agreed that climatic conditions can affect the risk of injury on both surfaces. From this group of respondents 48% (32/67) felt that weather affected the risk of injury more on FT, 33% (22/27) felt the risk was the same on both surfaces, 15% (10/67) felt the risk was greater on NG, and 4% (3/67) were not sure. According to the players who reported weather as having an affect on FT 72% (23/32) reported that wet weather had the most significant affect, 19% (6/32) reported hot weather, and 9% (3/32) reported cold weather.

### Age, training surface, and surface history

Three descriptive variables were selected to analyze the players responses across the items: Age (Stratified into three groups: 18 – 22, 23 – 27, and 28+), Training Surface (Team 1 who trained on Football Turf was compared to Teams 2 – 6 who trained on grass), and Surface History (Those players who had a surface exposure of 50% or greater on Football Turf over the course of their careers were compared to those who had less than 50% exposure). A Chi Square test was performed and no significant differences were found between the three descriptive variables and the question responses.

Go to:

## Discussion

Our findings indicate that a selected group of professional players, representing a sample of professional soccer players in North America believe that there is an increased risk of injury, specifically non-contact injury, as a result of training and competing on FT compared to NG. Previous studies comparing the incidence of injury on FT and NG, found no differences in the risk of injury from training and competition on both surfaces [6-10,17,18]; however 94% of the players in this study felt that the risk of injury was greater on FT. Similarly, players strongly believed that they experienced greater muscle and joint soreness and longer recovery times after competition and training on FT. Three surface mechanical properties (i.e., surface stiffness, surface friction, and metabolic cost) were identified by the players as important factors in surface related injury. Furthermore players' reported that the magnitudes of the three surface variables were greater on FT, and that these differences were the primary reason why they perceived injury rates, muscle and joint soreness and recovery times to be higher on FT. Along with these three factors players further believed that surface quality and climatic conditions could influence the risk of injury on FT and NG.

A pre-established bias towards synthetic surfaces could possibly explain the divergence of players' perceptions. Player comments (see the 'List of original player comments' section) suggest that past personal injury experiences on FT can mar players' attitudes toward the surface, and even affect the way they play on FT in the future. Players could have solidified their perceptions of FT based on previous negative experiences on earlier generation turfs that were shown to increase the risk of injury [19]. However, it is unlikely that such experiences and opinions can fully explain why the majority of the players reported greater risk of injury on FT. Moreover players reported that surface type did not influence contact injuries. In an injury audit of 12 European Championships from 2006 to 2008 it was found that traumatic injuries due to player contact represented 54% of all injuries overall, and were more frequent among match injuries (63%) [20]. In order to understand how surface type might affect these injuries future comparative studies should report the occurrence, and mechanisms of both non-contact and contact injuries.

In the NFLPA Surface Opinion Survey conducted in 2004 and 2008 it was found that 96% and 91% of all NFL players reported feeling more soreness and fatigue on artificial in-filled surfaces as opposed to grass [14,15]. These results are similar to those found for the group of players in this study and it would be interesting to see if these findings extend to the entire MLS; and further, to other professional soccer leagues in North America and internationally. The findings of this study suggest that the full effects of training and competing on FT have not been captured in the current literature. This might be related to the definition of injury (i.e., using the time-loss definition, which according to the consensus statement on injury only records an event as an injury if a player cannot take full part in future training or match play). This method is not sensitive enough to capture self-reported problems, such as players experiencing soreness, as they would still participate in sessions or games. This notion is supported by Walden et al., who in a study of injuries in Swedish Elite Football suggested that subjective somatic complaints without objective signs of injury might not be captured by certain injury definitions [21]. It is possible that these effects (i.e., greater muscle and joint soreness after games and training) could also explain why players perceive the risk of injury to be higher on FT. Future epidemiological studies using a time-loss definition should prospectively track players perceptions, specifically levels of muscle and joint soreness and recovery times, concurrently with injury incidence for players training and competing on both surfaces. Doing so will provide another level of comparison between NG and FT, and could potentially uncover novel information on the dynamics between soreness, recovery, and injury for professional players over a period of competition and training regardless of, or in light of surface type.

Surprisingly players identified without any prompt, the surface mechanical properties reported in the literature as risk factors modifying the risk of injury on both surfaces [10]. Greater surface stiffness seems to be the primary reason why players in this study reported the risk of injury to be higher on FT, as it was reported with the greatest frequency. It is speculated that the stiffness properties of a surface influence the frequency of injury and that harder surfaces can increase the impact forces on the body, which in turn might have an influence on some chronic overuse injuries [5]. Similar results have been reported in a study by Martinez et al., in which players reported that artificial turf had worse shock absorbency properties than NG [22]. Similarly, 57% of all NFL players in 2008 believed that new artificial infilled surfaces should be made softer, and 92% reported that they could distinguish the difference between a softer or firmer artificial surface [15]. The player comments also seem to support the postulation that high frictional forces between the foot and playing surface results in foot fixation and possibly injury [23]. Evidence of higher physiological activation on FT found in the literature can also put the players comments into context [24]. Similar findings were also reported by Andersson et al. who found that male elite players reported games on artificial turf as more physically demanding compared to natural grass [11]. Fatigue has been associated with an increase of injury in soccer players [10], and therefore the reported perception of higher physiological activation on FT in this study, and others, could be a contributing mechanism to injury risk. Based on these findings more research needs to be undertaken to understand the player-surface relationship and how it possibly influences the risk of injury. In particular future studies should focus attention on how surface stiffness and injury risk are related on FT and NG, as it seems that independent groups of professional players (NFL American football players, soccer players) have the opinion that FT is "too hard".

Although it is widely accepted that without proper maintenance the performance and physical characteristics of FT decline, it is unknown if a decline in surface quality can affect the risk of injury. The fact that players in this study reported surface quality as being important in affecting the risk of injury for both NG and FT suggests that there could be a link between these two variables. It follows that proper maintenance of FT and NG is important to players, and that perhaps the relationship between the risk of non-contact injury and the quality of FT should be explored in future studies.

Climate and weather conditions can have a significant influence on the playing conditions of NG, and this has been shown to impact sport related injury [25]. Considering this, it is perplexing that players in this study believed weather to have a greater influence in affecting injury on FT. Although FT retains a significant amount of heat in hot weather, wet weather was reported in the greatest frequency for affecting injury on FT. A possible explanation for this finding is that wet weather accelerates the movement of the ball, thereby the speed of play, more so on FT than NG forcing players to work harder and imposing increased strain on the body to compete in such an environment. This postulation is supported by the opinions of the expert group of players and coaches interviewed in a study by Martinez et al., who found ball roll to be more rapid on artificial surfaces [22]. Further evidence into how speed of play could affect the risk of injury on FT can be found in the original player comments section.

It has been suggested that familiarization with FT is important to consider when measuring players impressions of artificial and natural grounds [12]. In a study by Nedelec et al. the absence of negative perceptions of FT by a group of young male professional soccer players was explained to be in part due, to the familiarization of FT for this group of players [12]. In contrast, in the present study it was found that players who had a history of playing on FT and players who currently trained on FT expressed preferences for NG, and had negative impressions of FT. The divergence of our findings and those of Nedelec et al. could be due to the age of the players employed in each study (average age 17.7 v 24.5 years for the study by Nedelec et al. and the current study respectively). Although we did not observe any significant differences in players' opinions across the 3 age cohorts, it may be possible that a difference exists in how younger and older professional players perceive FT and NG. Future studies should aim to elucidate how familiarization to FT and age may impact players perceptions of FT.

Practitioners working with male professional soccer players could use the findings of this study to help them manage their players after exposure to FT and to make appropriate decisions for future sessions knowing that players may possibly have longer recovery times and experience greater soreness. This could be especially true when dealing with players who have a history of muscular-tendon injury, past injuries to weight bearing joints, degenerative changes in weight bearing joints, or a history of recurring injury, although this conjecture is unsubstantiated and would need to be explored. Lastly another practical application could be in making appropriate decisions surrounding surface type exposure for various activities when returning a player back from injury in different steps of the rehabilitation process.

There are a number of limitations of this study, which should be noted. The sample size was small and therefore the results may not be representative of the opinions of all MLS players and the much broader, and more diverse, international professional male soccer population as a whole. Furthermore participants were not selected randomly, which could also affect the generalizability of the findings. Recall of information could have been inaccurate due to the study design, which was cross-sectional and retrospective. Players' responses could have been biased due to previous negative experiences on artificial surfaces, in addition to the cultural stigma surrounding artificial surfaces in soccer. Lastly, this study looked at professional male soccer players and therefore the results may not be characteristic of the opinions of sub-elite or amateur male players and elite, sub-elite or amateur female players. In a study by Zanetti it was found that Italian male amateur soccer players preferred playing on 3rd generation artificial turf rather than natural grounds [26], and Andersson et al. found elite female players reported a neutral position towards artificial grounds. Further research needs to be conducted on these populations [11].

Go to:

## Conclusion

This study explored the perceptions of injury, physical recovery, as well as the effect of surface related variables on injury as a result of soccer participation on NG and FT for 99 professional soccer players competing in Major League Soccer during the 2011 season. Overall it was found that players perceived FT as the surface most likely to lead to injury, more specifically non-contact injury, was associated with longer recovery times after games and training, as well as greater muscle and joint soreness.

Go to:

## Competing interests

The authors declare that they have no competing interests.

Go to:

## Authors' contributions

CCNP designed the study, developed the questionnaire, lead the data collection process, analyzed the data, and drafted the manuscript. JG Jr. provided access to the participating teams, aided in the data collection process, and aided in the editing of the manuscript. WHG provided insight into the questionnaire and study design, and aided in the drafting of the manuscript. JB aided in the drafting of the manuscript. SB aided in the questionnaire design, data analysis, and aided in the editing of the manuscript. AKM oversaw the study, providing insight into the study and questionnaire design, aiding in the data analysis, and drafting of the manuscript. All authors read and approved the final manuscript.

Go to:

## Pre-publication history

The pre-publication history for this paper can be accessed here:

http://www.biomedcentral.com/2052-1847/6/11/prepub

Go to:

## Supplementary Material

**Additional file 1:**

Players' Surface Opinion Survey on Natural Grass and Artificial Turf: AFocus on Injury.

Click here for file(65K, pdf)

Go to:

## Acknowledgements

The authors would like to thank all team staff, particularly the Athletic Therapists and Trainers for their commitment and energy towards this project. We would also

Environmental & Analytical Toxicology

Marsili et al., J Environ Anal Toxicol 2014, 5:2
http://dx.doi.org/10.4172/2161-0525.1000265

Research Article | Open Access

# Release of Polycyclic Aromatic Hydrocarbons and Heavy Metals from Rubber Crumb in Synthetic Turf Fields: Preliminary Hazard Assessment for Athletes

**Letizia Marsili[1]*, Daniele Coppola[1], Nicola Bianchi[1], Silvia Maltese[1], Massimo Bianchi[2] and Maria Cristina Fossi[1]**

[1]*Department of Physical Sciences, Earth and Environment, Siena University, Via Mattioli 4, 53100 Siena, Italy*
[2]*Department of Political Science and International, Siena University, Via Mattioli 10, 53100 Siena, Italy*

## Abstract

Synthetic turf, made with an infill of rubber crumb from used tyres or virgin rubber, is now common in many sporting facilities. It is known that it contains compounds such as polycyclic aromatic hydrocarbons (PAHs) and heavy metals. We evaluated in nine samples of rubber crumb the total content of some heavy metals (Zn, Cd, Pb, Cu, Cr, Ni, Fe) normally found in tyres by microwave mineralization and the levels of the 14 US EPA priority PAHs by Soxhlet extraction and HPLC analysis. The results showed high levels of PAHs and zinc in all rubber crumb samples compared to rubber granulate limits set by Italian National Amateur League (LND).

Following the precautionary principle, a risk assessment at 25°C was done, using the Average Daily Dose (ADD) assumed by athletes, expressed in terms of mass of contaminant per unit of body weight per day (mg/kg day), and the Lifetime Average Daily Dose (LADD) and then evaluating the Hazard Index (HI) and the Cumulative Excess Cancer Risk (∑ECR). In the different rubber granulates samples the HI ranges from a minimum of $8.94 \times 10^{-7}$ to a maximum of $1.16 \times 10^{-6}$, while the ∑ECR ranges from a minimum of $4.91 \times 10^{-9}$ to a maximum of $1.10 \times 10^{-8}$.

Finally, the aim of this study was to estimate the "hazard" for athletes inhaling PAHs released at the high temperatures this synthetic turf may reach. Then a sequence of proofs was carried out at 60°C, a temperature that this rubber crumb can easily reach in sporting installations, to see whether PAH release occurs. The toxicity equivalent (TEQ) of evaporates from rubber crumb is not negligible and represents a major contribution to the total daily intake of PAHs by different routes.

**Keywords:** Synthetic turf; PAHs; Rubber crumb; Heavy metals; Hazard assessment

**Abbreviations:** ADD: Average Daily Dose; AT: Averaging Time; B[a]A: Benzo(a)antracene; B[a]P: Benzo(a)pyrene; B[b]F:Benzo(b) fluoranthene; B[ghi]Per: Benzo(g,h,i)perylene; $BaP_{eq}$ Benzo(a)pyrene equivalents; CDC: Centers for Disease Control and Prevention; $C_A$: Concentration in Air; $C_F$: Concentration in Field; Chry: Chrysene; DIN: Deutsches Institut für Normung / German Institute for Standardization; ECR: Excess Cancer Risk; ΣECR: Cumulative Excess Cancer Risk; ED: Exposure Duration; EF: Exposure Frequency; $EF_{de}$ : Daily Exposure Frequency; EPA: Environmental Protection Agency; Fl: Fluorene; Flt: Fluoranthene; HI: Hazard Index; HQ: Hazard Quotient; IA: Interested Area; IR: Inhalation Rate; LADD: Lifetime Average Daily Dose; PAH: Polycyclic Aromatic Hydrocarbons; PEF: Particulate Emission Factor; Pyr: Pyrene; $R_fD$: Reference Dose; SBRr: Styrene:Butadiene Recycled rubber; SF: Slope Factor; TEF: Toxic Equivalency Factors; TEQ: Toxic Equivalent Quantity.

## Introduction

World population increase is accompanied by increasing consumption of resources. This makes recycling of materials extremely important to reduce waste. However, recycling itself is not enough, because it is necessary to understand if recycled materials have adverse effects on humans and environment, such as the case of used tyres, loaded of potentially toxic substances and recycled in synthetic turf. Today, synthetic turf is common in many sporting facilities. Created in the 1950s by the humanitarian Ford Foundation of New York and Chemstrand Corporation, it gained huge success in 1966 when used in the Astrodome stadium, Houston, Texas [1]. In the '70s and '80s, it was applied in many sports grounds in America and Canada, and was introduced into Europe in the mid-1980s. Softer new types of synthetic turf containing polyethylene were developed and introduced all over the world in the late 1990s [2]. Synthetic turfs differ in relation to their method of production and infill technique. Normally, the layer of infill consists of rubber crumb, which in a typical application reaches a thickness of 3 cm, and is spread on a thin layer of sand [3]. The most common source of rubber crumb is recycled tyres (recycled styrene-butadiene rubber - SBRr); the diameter of the crumb can vary between 0.5 and 3 mm [4]. Hazardous substances in crumb rubber infill are primarily, volatile components (nitrosamines, xylenes), benzothiazoles, secondary amines, heavy metals (especially zinc) and polycyclic aromatic hydrocarbons (PAHs) [5]. In particular, the presence of zinc (Zn) is due to zinc oxide that is used as a vulcanization aid in the rubber production process and PAHs come from high-aromatic oil that is used as an additive in the production of tyres. In 2005, the Italian Ministry for the Environment allowed SBR crumb for synthetic grass courts in Italy [6], but there are still no European Union guidelines defining measures to protect the environment and human health in relation to SBRr in synthetic turf. The only standard to which manufacturers refer in producing SBRr crumb was published in 2002 by the German Institute for Standardization (DIN) establishing limits for certain heavy metals in soil, but with no reference to PAHs [7]. This standard was also chosen by the Italian National Amateur League (LND) in its "Regulations for the construction of latest generation artificial turf football fields", which defines soccer field parameters necessary for approval and use. Besides purely technical qualities, it

***Corresponding author:** Letizia Marsili, Department of Physical Sciences, Earth and Environment, Siena University, Via Mattioli 4, 53100 Siena, Italy, Tel: +39 0577 232917; Fax: +39 0577 232930; E-mail: marsili@unisi.it

**Received** November 22, 2014; **Accepted** January 20, 2015; **Published** January 25, 2015

**Citation:** Marsili L, Coppola D, Bianchi N, Maltese S, Bianchi M , Fossi MC (2015) Release of Polycyclic Aromatic Hydrocarbons and Heavy Metals from Rubber Crumb in Synthetic Turf Fields: Preliminary Hazard Assessment for Athletes. J Environ Anal Toxicol 5: 265. doi:10.4172/2161-0525.1000265

**Citation:** Marsili L, Coppola D, Bianchi N, Maltese S, Bianchi M (2015) Release of Polycyclic Aromatic Hydrocarbons and Heavy Metals from Rubber Crumb in Synthetic Turf Fields: Preliminary Hazard Assessment for Athletes. J Environ Anal Toxicol 5: 265. doi:10.4172/2161-0525.1000265



also includes concentration limits for certain substances, including heavy metals and some high molecular weight PAHs (limits reflect those provided by Legislative Decree 152/2006 [8,9]. Sport grounds fitted with synthetic turf filled with crumb of recycled tyres may release dangerous particles in air, contaminate soil and groundwater with soluble contaminants leached by rain, and pose health hazards for residents and users due to inhalation of volatile substances [10]. Some coats for rubber granulates can effectively reduce emissions in the environment of these contaminants but they are not systematically used [11].

Though designed for sporting facilities, it is not uncommon to find synthetic grass in recreational parks and children's playgrounds. Synthetic turf may reach high temperatures: for example, on a day with an air temperature of 26°C in the early afternoon, synthetic surfaces may reach 60°C, making it difficult to play on them [2]. The U.S. Center for Disease Control and Prevention (CDC) has not yet assessed the risks associated with exposure to dust released by rubber crumb from playing fields. As a precautionary measure, it issued general recommendations for users to minimize any potential risk, such as wash aggressively hand and body after playing, do not eat and drink on the field and do not use clothes and shoes after the activity for normal life [12]. Some studies have focused on levels of heavy metals, such as Zn, or PAHs in tyre rubber, both in granulates and in leachate [3,13-15] evaluating also the ecotoxicological effects in different organisms and humans[14,16-19]. In response to concern about human exposure through direct contact or inhalation, the principal aims of this study were: 1) to quantify the PAHs and heavy metals contained in rubber crumb from recycled tyres, produced before 2010 [20], used in synthetic turf, to determine whether PAHs are released and at what concentrations, becoming bioavailable to synthetic turf users at high temperatures; 2) to estimate respiratory uptake by athletes training on these grounds.

## Materials and Methods

### Sample collection

Samples of nine different synthetic turfs from football fields in Tuscany and Lazio (Italy) were analyzed. Samples 1 to 5 were new and had not yet been spread on playing fields yet; samples 6 to 9 were obtained from fields that had been laid down for 1 to 8 years. The crumb of sample 5 was virgin rubber and not recycled tyres (Table 1). In the laboratory, the samples were kept at room temperature, in black bags, away from sunlight.

### Heavy metals analysis

The samples were mineralized in a microwave oven (EPA Method 3052 modified in the Lab. (Bianchi, p.c.)). About 0.3 g of rubber crumb sample was placed in Teflon containers, spiked with 8 mL nitric acid ($HNO_3$) and 2 mL hydrogen peroxide ($H_2O_2$), then transferred to a microwave oven. The solutions thus obtained were cooled to a final volume of 50 mL and concentrations of lead (Pb), copper (Cu), nickel (Ni), zinc (Zn), chromium (Cr), cadmium (Cd) and iron (Fe) were evaluated. A blank was included in each series to check the purity of reagents and two tests of reference materials (ERM-EC680k and NIST-SRM2710) with concentrations certified by the Community Bureau of Reference were performed to check analytical accuracy. Cr, Cu, Ni, Pb and Cd concentrations were determined with PerkinElmer AAnalyst700 high-performance atomic absorption spectrometers with graphite furnace. Zn and Fe concentrations were determined with an Analytik Jena ContrAA700 acetylene flame atomic absorption spectrophotometer. All metal concentrations were expressed as the mean of three replicates in µg/g on a dry weight basis.

### PAH analysis

**PAH extraction in rubber crumb:** PAHs were extracted according to Griest and Caton [21,22] and Holoubek et al [22]. with some modifications [23]. About 1.0 g of rubber crumb was extracted with a mixture of KOH 2M/methanol (1:4) in a Soxhlet apparatus for 4 h at 75°C. The mixture was extracted by shaking in separator funnels with 200 mL of cyclohexane. Liquid/liquid separation was performed to bring the PAH fraction into the supernatant. The liquid recovered was concentrated in a Rotavapor system, resuspended with 10 mL acetone/hexane (1:1) and purified in a chromatographic column packed with 3 cm of Florisil, about 60–100 US mesh, previously set at 120°C for 2 h. Elution was carried out with 90 mL acetone/hexane (1:1). The organic fraction was concentrated and suspended in 0.5 mL acetonitrile for HPLC analysis.

**PAH Extraction in evaporates of rubber crumb:** Since synthetic fields can reach 60°C when the air temperature is about 25°C, a method to evaluate release of PAHs at this temperature was used. Small flasks (25 mL) were filled with a quantity of rubber crumb up to 3 cm high, in order to simulate their thickness in a synthetic field. Then, the following steps were applied: 1) a closed trap packed with a bottom layer of cotton/fiberglass and a 3 cm layer of Florisil, previously activated at 120°C for 2 h, was placed on every flask; 2) the flask/trap system was kept at 60°C for about 5 h (assumed to be the average period at 25°C in a day) to capture the evaporates of rubber crumb; 3) liquid chromatography was then immediately performed using the trap as a column by pouring in 10 mL acetone/hexane (1:1) and then a further 90 mL of the same mixture; 4) the extract thus obtained was concentrated in a Rotavapor system and resuspended in 0.5 mL acetonitrile for HPLC analysis. This procedure (steps 1-4) was repeated three times to obtain three consecutive readings for each sample, thus determining whether or not the release of PAHs was continuous. The efficiency of the traps was validated with two different evaporation tests: first evaporation of the standard EPA 610 in acetonitrile (1/100) and, second evaporation, with the same amount of EPA 610 (1/100) mixed with a rubber crumb sample 3 cm high. HPLC analysis showed that the efficiency of the traps was about the 90%. In fact, in the first case, summing the amount of PAHs found in the evaporated to those found in the sample left in the flask, the value was almost like to the original amount of the standard EPA 610. In the other case of the standard mixed with the rubber crumb, there was a little matrix effect because the amount of PAHs found in the evaporated was lower (5-10%) than those found in the evaporated of the standard alone.

**PAH analysis:** PAHs were analyzed by an HPLC/fluorescence system. PAHs were separated using a reversed-phase column (Supelcosil LC-18, 25 cm × 4.6 mm i.d., 0.5 µm particle size, pore size 120Å) with an acetonitrile/water gradient from 60% to 100% acetonitrile for 20 min, then isocratically for 10 min. The flow rate was 1.5 mL/min. The mobile-phase was degassed with a helium stream. An external standard consisting of 16 PAHs from Supelco (EPA 610) was used. Fourteen PAHs were analyzed and the results expressed in ng/g. Recoveries were 80–98%. The detection limit, calculated at a signal-to-noise ratio of three, was 0.1 ng/g for all PAHs. Assay reproducibility was determined by five replicate analyses of a single sample: the coefficient of variation was 1-3%, depending on the compound. Blanks contained undetectable amounts of PAHs.

**Citation:** Marsili L, Coppola D, Bianchi N, Maltese S, Bianchi M (2015) Release of Polycyclic Aromatic Hydrocarbons and Heavy Metals from Rubber Crumb in Synthetic Turf Fields: Preliminary Hazard Assessment for Athletes. J Environ Anal Toxicol 5: 265. doi:10.4172/2161-0525.1000265



| Sample | Sample 1 | Sample 2 | Sample 3 | Sample 4 | Sample 5 | Sample 6 | Sample 7 | Sample 8 | Sample 9 |
|---|---|---|---|---|---|---|---|---|---|
| Years since installation | 0 | 0 | 0 | 0 | 0 | 8 | 2 | 6 | 1 |

**Table 1:** Years of installation in sporting infrastructure of the rubber crumb samples analysed.

## Results and Discussion

### Heavy metal concentrations in rubber crumb

Table 2 shows the concentrations of heavy metals (cadmium, lead, chromium, nickel, copper, zinc and iron; mg/kg) in rubber crumb samples and the maximum admissible concentration set by the Italian National Amateur League [9]. These limits are identical to those of Dlgs. 152/2006 [8] for public parks and private and residential land.

Lead, chromium, nickel and copper were well below the limits in all samples. Three samples exceeded the limit for cadmium, two being new (samples 4 and 5) and the third already installed (sample 6). In the case of zinc, all samples recorded high concentrations: sample 1 showed the lowest concentration of zinc, exceeding the limit by a factor of more than 20; the worst case was sample 4, exceeding the limit by a factor of nearly 90. Concentrations were quite similar to those of the study of Bocca et al. [13], except for cadmium that was always below the limit in the cited study. Concentrations of iron were quite similar to each other, except for sample 2 that showed a particularly high peak.

Zinc values are in line with other studies concerned with it: Verschoor [3] not only assessed the quantity of zinc in the rubber infill, but also the amount released, showing that the aging of rubber has a high impact on the release of zinc, which the author estimated as an annual average of 50 mg/kg of rubber. The concentration of Zn found in leachate was 1.3 mg/L, which is above the limit imposed by the Dutch Soil Quality law [24,25].

*

ZINC IN Digestive Fluids Exceeded DEC

Another study evaluated the bioavailability of certain metals and PAHs in human digestive fluids, assuming ingestion of crumb from synthetic fields [26]. Their results showed that Zn in particular exceeded the limits of the Department of Environmental Conservation (DEC) of New York State [27] for soil (2200 ppm), while the lead content in rubber crumb never exceeded these limits, but was very bioavailable in synthetic gastric fluid, thus representing a potential risk to athletes.

NY DEC

### PAH levels in rubber crumb

It proved possible to identify and quantify the PAHs in all samples. All were priority PAHs according to USEPA [28] and some are known to be powerful carcinogens (Table 3) [29-32]. The total PAHs in tables and graphs are the sum of individual PAHs, while the carcinogenic PAHs are only those which are carcinogenic according to at least three classifications. Although benzo(a)pyrene (B[a]P) only accounted for 10-20% of the carcinogenic compounds, it is used by the European Commission Regulation 1881/2006 as an indicator of contamination by the 16 priority PAHs [33].

Table 4 shows the levels of single PAHs (ng/g) detected in samples 1 to 9. Samples 1 to 5 were obtained before they were spread on playing surfaces, whereas the samples 6 to 9 were collected directly from the fields and had been in place for 1 to 8 years. The two last rows of Table 4 show total PAH levels, obtained by summing all the PAHs quantified, and carcinogenic PAH levels, obtained by summing carcinogenic PAHs of Table 3.

Figure 1 compares levels of total PAHs and carcinogenic PAHs in rubber crumb from the various football fields. Very high levels of total PAHs were found in samples 2, 9 and 1. Lower levels were found in samples 3, 6, 7 and 8, indicating a difference between new samples and those already installed in soccer fields. Indeed, the load of PAHs was appreciably lower in samples 6, 7 and 8 (installed 3 to 8 years ago) than in the other samples. This shows that once installed, these fields lose part of their toxic load in the time. This fact is important for assessing toxicological hazard to athletes, therefore they are chronically exposed to these compounds.

Comparing the relative percentages of all PAHs on total PAHs of the different samples (Figure 2A-C), we noted that the highest PAHs in all samples, except sample 5, were benzo(b)fluoranthene (B[b]F) (samples 1, 2, 6 and 9) or pyrene (Pyr) (samples 3, 4, 7 and 8) but always followed by B[b]F. The fingerprint of sample 5 (natural rubber crumb, not recycled tyres) showed a high concentration of fluorene (Fl), followed by Pyr, fluoranthene (Flt) and B[b]F, unlike the other footprints. Although absolute levels of PAHs were high in this sample (Table 4), the three most abundant PAHs (Fl, Pyr and Flt) are not regarded as particularly hazardous or carcinogenic to humans and therefore this type of natural rubber crumb can be considered less toxic.

Table 5 shows the levels of those PAHs (mg/kg) of which the maximum admissible concentration is established [8], detected in the rubber crumb samples analyzed for this study. The Decree reported threshold values of concentration for some PAHs in soils and even if the comparison with the present data was not direct it could give some indications. All samples exceeded the limit for B[b]F and benzo(g,h,i) perylene (B[ghi]Per); in the case of B[b]F, sample 2 exceeded the limit by a factor of about 30, and samples 1 and 9 by a factor of about 20. No crumb exceeded the limit for chrysene (Chry). 3*

### PAH levels in evaporates of rubber crumb

Table 6 shows the levels of benzo(a)anthracene (B[a]A), Chry, B[a]P and B[ghi]Per, among the most toxic high molecular weight PAHs detected in evaporates of nine rubber crumbs. We have taken only these PAHs because, when the evaporation test was repeated three times to obtain three consecutive readings for each sample, were the only PAHs which standard deviation (S.D.) was below the mean value in all nine samples. Among all samples, turf fields 9 and 1 released particularly high levels of all considered compounds. Evaporation tests showed that the releasing of four PAHs into the air by rubber crumb did not decrease with the time, suggesting chronic contamination in areas fitted with synthetic turf filled with rubber crumb.

It was also evaluated the mean times for total release of these four PAHs from the samples (Table 7). In theory, considering for each compound the total amount present in the rubber crumb samples and the amount found in the evaporated samples, we can estimate that for the new turf fields are necessary from a minimum of 811 times (sample 3) to a maximum of 4423 times (sample 2) to exhaust emissions of these compounds when the turf temperature reaches 60°C, then when the atmospheric temperature is 25°C. Regarding the used samples, in the same conditions of temperature, are required from a minimum of 346 times (sample 7) to a maximum of 655 times (sample 6). Assuming solar radiation keeps atmospheric temperature at 25°C for at least 5 h/day (heating experimental time in the Lab.) for 5 months of the year, there are 150 suitable days per year. Ignoring other sources of elimination, such as rainwater or washing that cause leaching and cooler days when the crumb still becomes warm, it would hypothetically take a minimum

**Citation: Marsili L, Coppola D, Bianchi N, Maltese S, Bianchi M (2015) Release of Polycyclic Aromatic Hydrocarbons and Heavy Metals from Rubber Crumb in Synthetic Turf Fields: Preliminary Hazard Assessment for Athletes. J Environ Anal Toxicol 5: 265. doi:10.4172/2161-0525.1000265**



| | Cd (mg/kg) | Pb (mg/kg) | Cr (mg/kg) | Ni (mg(kg) | Cu (mg/kg) | Zn (mg/kg) | Fe (mg/kg) |
|---|---|---|---|---|---|---|---|
| **Sample 1** | 1.81 | 27.86 | 7.92 | 26.12 | 46.42 | **3474.00** | 489.60 |
| **Sample 2** | 1.77 | 17.51 | 17.52 | 9.86 | 39.96 | **3732.00** | 7256.00 |
| **Sample 3** | 0.47 | 13.97 | 4.12 | 4.11 | 5.59 | **8314.00** | 129.12 |
| **Sample 4** | **2.05** | 33.58 | 3.34 | 5.27 | 84.49 | **13292.00** | 657.40 |
| **Sample 5** | **2.68** | 11.23 | 2.84 | 8.95 | 9.50 | **8462.00** | 355.40 |
| **Sample 6** | **2.38** | 22.84 | 2.95 | 5.43 | 27.47 | **4868.00** | 1577.40 |
| **Sample 7** | 0.47 | 10.76 | 3.58 | 5.14 | 5.49 | **4168.00** | 543.00 |
| **Sample 8** | 1.51 | 29.44 | 1.91 | 3.90 | 14.43 | **6008.00** | 262.20 |
| **Sample 9** | 1.53 | 38.99 | 5.37 | 5.75 | 65.11 | **4194.00** | 346.80 |
| **Limit (LND, 2011)** | **2.00** | **100.00** | **150.00** | **120.00** | **120.00** | **150.00** | **N.D.** |

**Table 2:** Levels (mg/kg) of cadmium, lead, chromium, nickel, copper, zinc and iron in samples of rubber crumb. The triple horizontal line separates new crumb (samples 1-5) and crumb sampled from sporting installations (samples 6-9). Values in bold exceeded the limits set by the Italian National Amateur League reported in the last row.

| Compound | Abbreviation | Structure (# of rings) | Formula | Molecular weight (g/mol) | Solubility (mg/L) | Melting point (°C) | Boiling point (°C) | Vapor tension (Pa) at 25°C | Coefficient octanol/$H_2O$ (log $K_{ow}$) | Carcinogenicity IARC (2002) | Carcinogenicity NTP (2000) | Carcinogenicity IPCS (1998) | Carcinogenicity NRCC (1983) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Naphthalene (S) | Naph | 2 | $C_{10}H_8$ | 128.17 | 31 | 81 | 217.9 | 10.4 | 3.40 | 2B | | (?) | 0 |
| Acenaphthene (S) | Ace | 3 | $C_{12}H_{10}$ | 154.21 | 3.8 | 95 | 279 | $2.9x10^{-1}$ | 3.92 | 3 | | (?) | 0 |
| Fluorene (S) | Fl | 3 | $C_{13}H_{10}$ | 166.22 | 1.9 | 115-116 | 295 | $8.0x10^{-2}$ | 4.18 | 3 | | - | 0 |
| Phenanthrene (S) | Phen | 3 | $C_{14}H_{10}$ | 178.23 | 1.1 | 100.5 | 340 | $1.6x10^{-2}$ | 4.60 | 3 | | (?) | 0 |
| Anthracene (S) | Ant | 3 | $C_{14}H_{10}$ | 178.23 | 0.045 | 216.4 | 342 | $8.0x10^{-4}$ | 4.50 | 3 | | - | 0 |
| Fluoranthene (C) | Flt | 4 | $C_{16}H_{10}$ | 202.26 | 0.26 | 108.8 | 375 | $1.2x10^{-3}$ | 5.22 | 3 | | + | 0 |
| Pyrene (C) | Pyr | 4 | $C_{16}H_{10}$ | 202.26 | 0.132 | 150.4 | 393 | $6.0x10^{-4}$ | 5.18 | 3 | | (?) | 0 |
| Benzo(a)anthracene (C) | B(a)A | 4 | $C_{18}H_{12}$ | 228.29 | 0.011 | 160.7 | 400 | $2.8x10^{-5}$ | 5.61 | 2B | Yes | + | + |
| Chrysene (C) | Chry | 4 | $C_{18}H_{12}$ | 228.29 | 0.0015 | 253.8 | 448 | $8.4x10^{-5}$ (20°C) | 5.91 | 2B | Yes | + | ± |
| Benzo(b)fluoranthene (C) | B(b)F | 5 | $C_{20}H_{12}$ | 252.32 | 0.0015 | 168.3 | 481 | $6.7x10^{-5}$ (20°C) | 6.12 | 2B | Yes | + | ++ |
| Benzo(k)fluoranthene (C) | B(k)F | 5 | $C_{20}H_{12}$ | 252.32 | 0.0008 | 215.7 | 480 | $1.3x10^{-8}$ (20°C) | 6.84 | 2B | Yes | + | 0 |
| Benzo(a)pyrene (C) | B(a)P | 5 | $C_{20}H_{12}$ | 252.32 | 0.0038 | 178.1 | 496 | $7.3x10^{-7}$ | 6.50 | [redacted] | | | |
| Dibenzo(a,h)anthracene (C) | D(ah)A | 6 | $C_{22}H_{14}$ | 278.35 | 0.0005 | 266.6 | 524 | $6.3x10^{-8}$ (20°C) | 6.60 | 2A | Yes | + | ++ |
| Benzo(g,h,i)perylene (C) | B(ghi)Per | 6 | $C_{22}H_{12}$ | 276.34 | 0.00026 | 278.3 | 545 | $1.4x10^{-8}$ | 7.10 | 3 | | (?) | 0 |
| Indeno(1,2,3cd)pyrene (C) | I(1,2,3-cd)P | 6 | $C_{22}H_{12}$ | 276.34 | 0.062 | 163.6 | 536 | $1.3x10^{-8}$ (20°C) | 6.58 | 2B | Yes | + | + |
| | | | | | | | | | | 1 demonstrated carcinogenic<br>2A probable carcinogenicity<br>2B possible carcinogenicity<br>3 carcinogenicity not demonstrated | | + positive<br>- negative<br>? uncertain<br>( ) insufficient evidence | 0 not carcinogenic<br>± uncertain carcinogenicity<br>+ carcinogenic |

**Table 3:** PAH compounds detected in rubber crumb samples. Abbreviations: S – petrogenic; C – pyrogenic. Grey shades indicate carcinogenicity, determined in at least three published studies, and degree of carcinogenicity.

| | Sample 1 (ng/g) | Sample 2 (ng/g) | Sample 3 (ng/g) | Sample 4 (ng/g) | Sample 5 (ng/g) | Sample 6 (ng/g) | Sample 7 (ng/g) | Sample 8 (ng/g) | Sample 9 (ng/g) |
|---|---|---|---|---|---|---|---|---|---|
| Naphthalene | 774.28 | 2039.61 | 360.19 | 804.53 | 424.87 | 248.14 | 407.59 | 223.32 | 1136.00 |
| Acenaphthene | 7297.50 | 10148.88 | 352.12 | 4200.53 | 416.15 | 405.31 | 1309.41 | 508.71 | 6321.31 |
| Fluorene | 10367.21 | 11025.47 | 426.81 | 1347.92 | 4944.42 | 1152.60 | 528.52 | 1665.02 | 7145.12 |
| Phenanthrene | 708.74 | 1160.10 | 146.90 | 1560.01 | 149.00 | 247.79 | 76.03 | 37.92 | 1013.08 |
| Anthracene | 80.30 | 138.12 | 38.25 | 282.62 | 44.56 | 76.39 | 7.64 | 34.59 | 182.28 |
| Fluoranthene | 2939.37 | 3740.04 | 872.96 | 1979.53 | 2243.22 | 710.43 | 893.99 | 817.50 | 3244.74 |
| Pyrene | 5670.11 | 6729.04 | 3983.32 | 5974.83 | 3600.41 | 1643.56 | 2144.43 | 1909.15 | 10280.99 |
| Benzo(a)anthracene | 1166.03 | 1612.58 | 92.28 | 440.21 | 287.10 | 115.46 | 41.37 | 5.38 | 389.40 |
| Chrysene | 2898.05 | 3422.21 | 923.00 | 1396.91 | 700.38 | 243.57 | 921.07 | 622.18 | 916.56 |
| Benzo(b)fluoranthene | 11103.33 | 15715.42 | 1149.65 | 4569.85 | 1583.07 | 1899.14 | 1248.07 | 1440.33 | 10185.76 |
| Benzo(k)fluoranthene | 679.05 | 1203.44 | 68.25 | 604.87 | 353.09 | 128.77 | 224.24 | 611.64 | 3615.68 |
| Benzo(a)pyrene | 256.10 | 464.58 | 119.81 | 229.96 | 165.92 | 265.10 | 60.28 | 51.72 | 662.56 |
| Dibenz(a,h)anthracene | 484.36 | 382.12 | 192.90 | 72.75 | 426.97 | 344.52 | 109.13 | 134.76 | 573.26 |
| Benzo(g,h,i)perylene | 902.69 | 449.76 | 395.63 | 418.68 | 585.24 | 543.82 | 239.69 | 344.92 | 475.49 |
| **Total PAHs** | **48307.32** | **68211.37** | **9122.08** | **23783.19** | **16884.40** | **8020.60** | **8311.46** | **8407.13** | **48142.49** |
| **Carcinogenic PAHs** | **18586.92** | **22780.35** | **2546.89** | **7214.88** | **3478.82** | **2894.58** | **2604.18** | **2868.02** | **18345.42** |

**Table 4:** Levels of PAHs (ng/g) detected in nine samples of rubber crumb. The triple vertical line separates new crumb (1-5) from crumb sampled directly from sporting facilities (6-9).

Citation: Marsili L, Coppola D, Bianchi N, Maltese S, Bianchi M (2015) Release of Polycyclic Aromatic Hydrocarbons and Heavy Metals from Rubber Crumb in Synthetic Turf Fields: Preliminary Hazard Assessment for Athletes. J Environ Anal Toxicol 5: 265. doi:10.4172/2161-0525.1000265



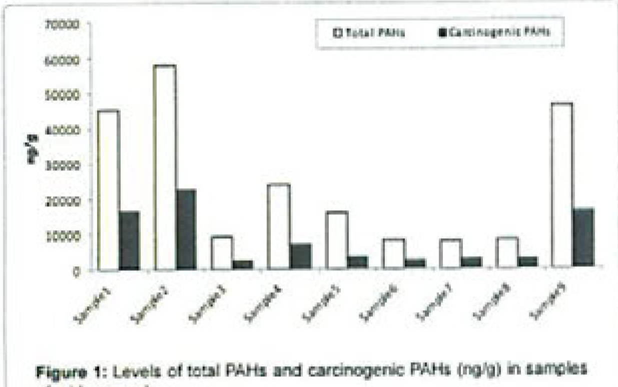



Figure 1: Levels of total PAHs and carcinogenic PAHs (ng/g) in samples of rubber crumb.

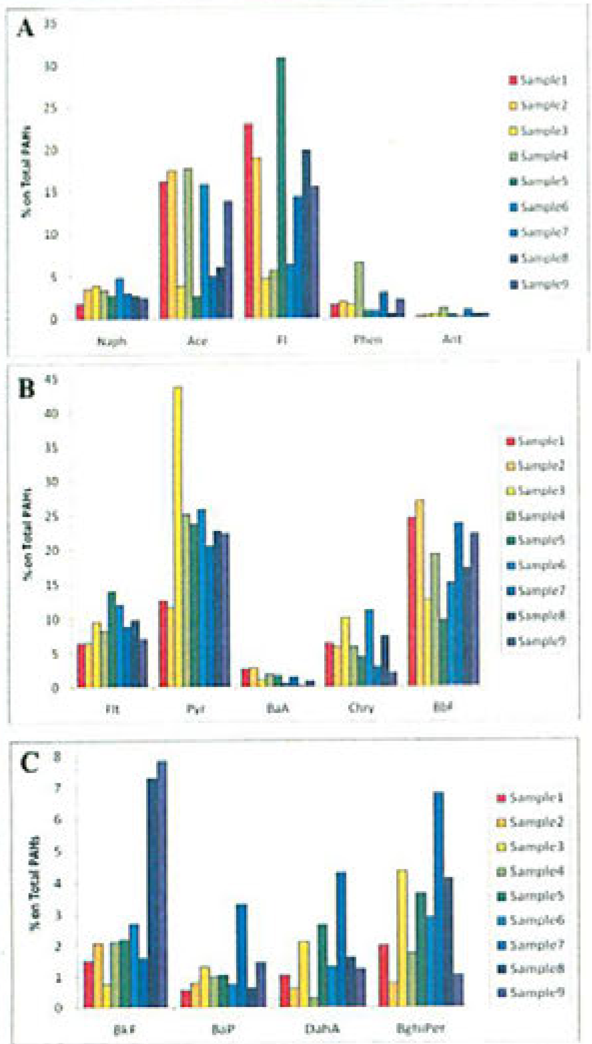



Figure 2: A-B-C Relative percentages of all PAH fingerprints on total PAHs of the different samples.

of 2 years (sample 7) to a maximum of about 29 years (sample 2) to reach theoretical zero concentration of PAHs.

## Risk assessment for PAH inhalation from synthetic fields

The approach to assess human health risks through the inhalation route in the synthetic turf fields, plans to consider field surface as soil surface [24]. Then, if field surface does not reach a temperature of 25°C, the contaminant release in air can be associated to wind erosion and volatilization and the inhalation risk must consider also the contaminated dust resuspension. This site-specific inhalation risk evaluation that we have conducted on the rubber granulates of the nine synthetic fields, follows the recommendations of the Dlgs. 152/06 [8] and the indication of the technical procedure issued by APAT [34]. This evaluation procedure is applied separately on each pollutant and, at the end, all individual risk values obtained are summed. In order to proceed to this estimation, it is important to know the particulate emission factor (PEF) of outdoor matter of the survey site. We considered PEF equal to PM10×10⁶ kg/mg, where PM10 are the levels of total inhalable dusts (mg/m³) potentially containing PAHs, assuming that all the particles present in the air as PM10 result from the volatilization of particles from the field, and not as an input from the wide variety of anthropogenic and crustal sources. Then, the following results are overestimated and they must be considered as extreme worst case screening. The precautionary principle is applied taking into account the highest average concentration of PM10 recorded in 2010 in Tuscany (since 8 turfs of 9 came from Tuscany) which is PM10 = 0.0517 mg/m³. Considering a punctiform source of contamination, it is possible to evaluate the contaminant concentration in air ($C_A$) given by $C_A$ = contaminant concentration in field ($C_F$) (mg/kg) × PEF. In this way it is possible to calculate the Average Daily Dose (ADD), assumed by the athletes, expressed in terms of mass of contaminant per unit of body weight per day (mg/kg day). The ADD is calculated to evaluate toxic effects taking into consideration the $C_A$ values, the inhalation rate (IR) of an athlete (3.6 m³/h), the daily exposure frequency ($EF_{de}$) (2 h/d), the exposure frequency (EF) in a year (208 d/year), the exposure duration (ED) (20 years), the body weight (BW) (70 kg) and the averaging time (AT) (20 years x 365 d/year):

$$ADD = (C_A \times IR \times EF_{de} \times EF \times ED) / (BW \times AT)$$

Furthermore, the Lifetime Average Daily Dose (LADD), used for the evaluation of carcinogenic effects, is calculated simply with the same parameters of ADD, except the Averaging Time (AT) that for carcinogenic effects considers 70 years (70 years x 365 d/year).

Starting from ADD and LADD values, in the last step it is possible to calculate a Hazard Quotient (HQ) as an indicator of risks associated with health effects other than cancer, and Excess Cancer Risk (ECR) as the incremental probability of an exposed person developing cancer over

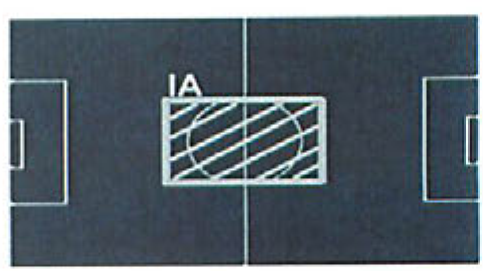



Figure 3: The interested Area (IA) of size 18 x 32 m (576 m²) in the central position of a regular soccer field.

**Citation:** Marsili L, Coppola D, Bianchi N, Maltese S, Bianchi M (2015) Release of Polycyclic Aromatic Hydrocarbons and Heavy Metals from Rubber Crumb in Synthetic Turf Fields: Preliminary Hazard Assessment for Athletes. J Environ Anal Toxicol 5: 265. doi:10.4172/2161-0525.1000265



| | Pyr (mg/kg) | B(a)A (mg/kg) | Chry (mg/kg) | B[b]F (mg/kg) | B(k)F (mg/kg) | B(a)P (mg/kg) | D(ah)A (mg/kg) | B(ghi)Per (mg/kg) |
|---|---|---|---|---|---|---|---|---|
| **Sample 1** | **5.67** | **1.17** | 2.90 | **11.10** | **0.68** | **0.26** | **0.46** | **0.90** |
| **Sample 2** | **6.73** | **1.61** | 3.42 | **15.72** | **1.20** | **0.46** | **0.36** | **0.45** |
| **Sample 3** | 3.98 | 0.09 | 0.92 | **1.15** | 0.07 | **0.12** | **0.19** | **0.40** |
| **Sample 4** | **5.97** | 0.44 | 1.40 | **4.57** | 0.50 | **0.23** | 0.07 | **0.42** |
| **Sample 5** | 3.80 | 0.27 | 0.70 | **1.56** | 0.35 | **0.17** | **0.43** | **0.59** |
| **Sample 6** | 1.64 | 0.12 | 0.24 | **1.90** | 0.13 | **0.27** | **0.34** | **0.54** |
| **Sample 7** | 2.14 | 0.04 | 0.92 | **1.25** | 0.22 | 0.06 | **0.11** | **0.24** |
| **Sample 8** | 1.91 | 0.01 | 0.62 | **1.44** | **0.61** | 0.05 | **0.13** | **0.34** |
| **Sample 9** | **10.28** | 0.39 | 0.92 | **10.19** | **3.62** | **0.66** | **0.57** | **0.48** |
| **Limit (Dlgs 152/2006)** | **5.00** | **0.50** | **5.00** | **0.50** | **0.50** | **0.10** | **0.10** | **0.10** |

**Table 5:** Levels of PAHs (mg/kg) with maximum admissible concentration known detected in samples and the limits set by the Legislative Decree 152/2006. The triple horizontal line separates new crumb (samples 1-5) from crumb sampled from sporting installations (samples 6-9). Values in bold exceeded the limit.

| | Benzo(a)anthracene (ng/g) | | Chrysene (ng/g) | | Benzo(a)pyrene (ng/g) | | Benzo(g,h,i)perylene (ng/g) | |
|---|---|---|---|---|---|---|---|---|
| | *Mean* | *S.D.* | *Mean* | *S.D.* | *Mean* | *S.D.* | *Mean* | *S.D.* |
| **Sample 1** | 0.43 | 0.14 | 5.82 | 3.18 | 0.48 | 0.32 | 0.58 | 0.30 |
| **Sample 2** | 0.16 | 0.07 | 1.46 | 0.07 | 0.15 | 0.10 | 0.43 | 0.17 |
| **Sample 3** | 0.14 | 0.06 | 1.43 | 0.42 | 0.12 | 0.02 | 0.42 | 0.19 |
| **Sample 4** | 0.15 | 0.10 | 1.30 | 0.57 | 0.11 | 0.07 | 0.50 | 0.23 |
| **Sample 5** | 0.27 | 0.18 | 1.06 | 0.09 | 0.21 | 0.06 | 0.62 | 0.50 |
| **Sample 6** | 0.16 | 0.05 | 1.73 | 1.33 | 0.28 | 0.19 | 0.68 | 0.36 |
| **Sample 7** | 0.18 | 0.07 | 2.26 | 1.42 | 0.26 | 0.11 | 0.64 | 0.28 |
| **Sample 8** | 0.28 | 0.06 | 1.32 | 0.29 | 0.19 | 0.02 | 0.49 | 0.09 |
| **Sample 9** | 0.49 | 0.66 | 2.53 | 1.08 | 0.89 | 0.70 | 1.28 | 0.07 |

**Table 6:** Levels (ng/g) of benzo(a)anthracene, chrysene, benzo(a)pyrene and benzo(g,h,i)perylene in evaporates of rubber crumb samples at 60°C.

| | Mean Time (days at atmospheric T=25°C) | SD |
|---|---|---|
| **Sample 1** | 1325 | 1047 |
| **Sample 2** | 4423 | 3990 |
| **Sample 3** | 811 | 185 |
| **Sample 4** | 1734 | 967 |
| **Sample 5** | 846 | 150 |
| **Sample 6** | 655 | 396 |
| **Sample 7** | 346 | 136 |
| **Sample 8** | 410 | 229 |
| **Sample 9** | 568 | 234 |

**Table 7:** Estimated mean time (days) and standard deviation (SD) for total release of B[a]A, Chry, B[a]P and B[ghi]Per (sum of the four PAHs) from rubber crumb samples. The triple horizontal line divides new crumb (samples 1-5) from crumb sampled from sporting installations (samples 6-9).

Precautionary Principle

a lifetime using for each pollutant the inhalation pathway toxicological parameters that are Reference Dose ($R_fD$) for HQ calculation (HQ = ADD/$R_fD$) and Slope Factor (SF) for ECR calculation (ECR = LADD × SF) (Table 8A-B). The values of these parameters are included in the ISS/ISPESL 2009 database [35] (Table 8A-B). HQs for all PAHs are summed to provide an overall Hazard Index (HI). When HI ≤ 1 there are no concern for potential adverse systemic health effects in the exposed individuals. Summing the individual ECR for all PAHs, it provides the Cumulative Excess Cancer Risk (ΣECR), that is acceptable if < $10^{-6}$ [36]. In the different rubber granulates samples was found a HI range that varies between a minimum of $8.94 \times 10^{-7}$ in sample 4 and a maximum of $1.16 \times 10^{-6}$ in sample 1 (Table 8A). The ΣECR range goes from a minimum of $4.91 \times 10^{-9}$ for sample 6 to a maximum of $1.10 \times 10^{-8}$ for sample 1 again (Table 8B). All values were considered as acceptable. Menichini et al. [37] found an excess lifetime cancer risk of $1 \times 10^{-6}$ for an athlete with an intense 30-years activity; then despite the different parameters considered for the athlete in this study, the results are very similar.

Heat on Turf Field

In reality, when the ambient temperature is 25°C and direct sunlight exposure is present on field, rubber granulates reach a mean temperature of 60°C, where a chronic release of PAHs occur, as seen in section 3.3. According to the high evaporation which occurs in this condition and knowing that these fields are used anyway with such temperatures, despite it should be decreased by watering, we calculate an estimate of risk for outdoor fields at 60°C. Applying again the precautionary principle estimating the maximum risk, we consider only the central area of the field of size 18 × 32 m (576 $m^2$), from now indicated as Interested Area (IA) (Figure 3), where the exchange of air at 2 m is irrelevant because it comes from surrounding perimeter and then it has the same toxicological characteristics. The air temperature at 2 m above the field is considered to have the same temperature as the granulates, according to the principle of the vertical temperature gradient. First, we calculated the quantity of crumb in a soccer field, averaging the specific weights (γ), which were similar, of the various samples analyzed (mean 0.518 g/mL). Considering IA paved with synthetic turf 3 cm thick, the quantity of crumb of specific weight 0.518 g/mL is 8951 kg. To estimate risk to human health from exposure to PAHs, we expressed the toxicity of the various PAHs with respect to B[a]P, in other words as Benzo(a)Pyrene Equivalent ($BaP_{eq}$). We calculated the Toxic Equivalent Quantity (TEQ) by multiplying the individual PAH levels in evaporates by their Toxic Equivalency Factor

**Citation:** Marsili L, Coppola D, Bianchi N, Maltese S, Bianchi M (2015) Release of Polycyclic Aromatic Hydrocarbons and Heavy Metals from Rubber Crumb in Synthetic Turf Fields: Preliminary Hazard Assessment for Athletes. J Environ Anal Toxicol 5: 265. doi:10.4172/2161-0525.1000265



| A | RfD | Sample 1 | Sample 2 | Sample 3 | Sample 4 | Sample 5 | Sample 6 | Sample 7 | Sample 8 | Sample 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | HQ | HQ | HQ | HQ | HQ | HQ | HQ | HQ | HQ |
| Pyr | $3.00x10^{-02}$ | $5.73x10^{-07}$ | $6.80x10^{-07}$ | $4.02x10^{-07}$ | $6.04x10^{-07}$ | $3.84x10^{-07}$ | $1.66x10^{-07}$ | $2.17x10^{-07}$ | $1.93x10^{-07}$ | $1.04x10^{-06}$ |
| B(a)A | $2.85x10^{-01}$ | $1.24x10^{-08}$ | $1.71x10^{-08}$ | $9.81x10^{-10}$ | $4.68x10^{-09}$ | $2.84x10^{-09}$ | $1.23x10^{-09}$ | $4.40x10^{-10}$ | $5.72x10^{-11}$ | $4.14x10^{-09}$ |
| Chry | $3.00x10^{-02}$ | $2.90x10^{-07}$ | $3.46x10^{-07}$ | $9.32x10^{-08}$ | $1.41x10^{-07}$ | $7.07x10^{-08}$ | $2.46x10^{-08}$ | $9.30x10^{-08}$ | $6.28x10^{-08}$ | $9.26x10^{-08}$ |
| B[b]F | $2.85x10^{-01}$ | $1.18x10^{-07}$ | $1.67x10^{-07}$ | $1.22x10^{-08}$ | $4.86x10^{-08}$ | $1.66x10^{-08}$ | $2.02x10^{-08}$ | $1.33x10^{-09}$ | $1.53x10^{-08}$ | $1.08x10^{-07}$ |
| B(k)F | $2.85x10^{-02}$ | $7.22x10^{-08}$ | $1.28x10^{-07}$ | $7.26x10^{-09}$ | $5.37x10^{-08}$ | $3.75x10^{-08}$ | $1.35x10^{-08}$ | $2.38x10^{-08}$ | $6.50x10^{-08}$ | $3.84x10^{-07}$ |
| B(a)P | $3.14x10^{-00}$ | $2.48x10^{-10}$ | $4.49x10^{-10}$ | $1.16x10^{-10}$ | $2.22x10^{-10}$ | $1.60x10^{-10}$ | $2.56x10^{-10}$ | $5.83x10^{-11}$ | $5.00x10^{-11}$ | $6.40x10^{-10}$ |
| B(ghi)Per | $3.00x10^{-02}$ | $9.12x10^{-08}$ | $4.54x10^{-08}$ | $4.00x10^{-08}$ | $4.23x10^{-08}$ | $5.91x10^{-08}$ | $5.49x10^{-08}$ | $2.42x10^{-08}$ | $3.48x10^{-08}$ | $4.80x10^{-08}$ |
| HI | | **$1.16x10^{-06}$** | **$1.38x10^{-06}$** | **$5.56x10^{-07}$** | **$8.94x10^{-07}$** | **$5.71x10^{-07}$** | **$2.81x10^{-07}$** | **$3.71x10^{-07}$** | **$3.71x10^{-07}$** | **$1.68x10^{-06}$** |
| **B** | **SF** | **Sample 1** | **Sample 2** | **Sample 3** | **Sample 4** | **Sample 5** | **Sample 6** | **Sample 7** | **Sample 8** | **Sample 9** |
| | | ECR | ECR | ECR | ECR | ECR | ECR | ECR | ECR | ECR |
| B(a)A | $6.00x10^{-01}$ | $6.06x10^{-10}$ | $8.38x10^{-10}$ | $4.79x10^{-11}$ | $2.29x10^{-10}$ | $1.39x10^{-10}$ | $6.00x10^{-11}$ | $2.15x10^{-11}$ | $2.80x10^{-12}$ | $2.02x10^{-10}$ |
| Chry | $6.10x10^{-03}$ | $1.53x10^{-11}$ | $1.81x10^{-11}$ | $4.87x10^{-12}$ | $7.38x10^{-12}$ | $3.70x10^{-12}$ | $1.29x10^{-12}$ | $4.86x10^{-12}$ | $3.29x10^{-12}$ | $4.84x10^{-12}$ |
| B[b]F | $6.00x10^{-01}$ | $5.77x10^{-09}$ | $8.16x10^{-09}$ | $5.97x10^{-10}$ | $2.37x10^{-09}$ | $8.12x10^{-10}$ | $9.87x10^{-10}$ | $6.48x10^{-10}$ | $7.48x10^{-10}$ | $5.29x10^{-09}$ |
| B(k)F | $3.10x10^{-02}$ | $1.82x10^{-11}$ | $3.23x10^{-11}$ | $1.83x10^{-12}$ | $1.36x10^{-11}$ | $9.48x10^{-12}$ | $3.40x10^{-12}$ | $6.02x10^{-12}$ | $1.64x10^{-11}$ | $9.71x10^{-11}$ |
| B(a)P | $7.32x10^{+00}$ | $1.62x10^{-09}$ | $2.94x10^{-09}$ | $7.59x10^{-10}$ | $1.46x10^{-09}$ | $1.05x10^{-09}$ | $1.68x10^{-09}$ | $3.82x10^{-10}$ | $3.28x10^{-10}$ | $4.20x10^{-09}$ |
| D(ah)A | $7.30x10^{+00}$ | $2.93x10^{-09}$ | $2.29x10^{-09}$ | $1.22x10^{-09}$ | $4.60x10^{-10}$ | $2.70x10^{-09}$ | $2.18x10^{-09}$ | $6.90x10^{-10}$ | $8.52x10^{-10}$ | $3.62x10^{-09}$ |
| ∑ECR | | **$1.10x10^{-08}$** | **$1.43x10^{-08}$** | **$2.63x10^{-09}$** | **$4.54x10^{-09}$** | **$4.71x10^{-09}$** | **$4.91x10^{-09}$** | **$1.75x10^{-09}$** | **$1.95x10^{-09}$** | **$1.34x10^{-08}$** |

**Table 8.** Hazard Quotient (HQ) and Excess Cancer Risk (ECR) values calculated using the Reference Dose ($R_fD$) for HQ calculation (HQ = ADD/$R_fD$) (Table 8A) and Slope Factor (SF) for ECR calculation (ECR = LADD x SF) (Table 8B). The values of the $R_fD$ and SF are included in the ISS/ISPESL 2009 database (ISS/ISPESL, 2009). HQs for all PAHs are summed to provide an overall Hazard Index (HI). When HI ≤ 1 there are no concern for potential adverse systemic health effects in the exposed individuals. Summing the individual ECR for all PAHs, it provides the Cumulative Excess Cancer Risk (∑ECR), that is acceptable if < $10^{-6}$ (USEPA, 2009) [39].

| | Sample 1 | Sample 2 | Sample 3 | Sample 4 | Sample 5 | Sample 6 | Sample 7 | Sample 8 | Sample 9 |
|---|---|---|---|---|---|---|---|---|---|
| **TEQ (ng/g)** | 0.59 | 0.19 | 0.15 | 0.14 | 0.25 | 0.30 | 0.32 | 0.24 | 0.98 |

**Table 9.** Toxicity Equivalent (TEQ) in benzo(a)pyrene equivalents ($BaP_{eq}$) in evaporate of crumb samples.

(TEF). This data was only calculated for PAHs that showed limited variability in the three replicates of evaporates, as mentioned above. Thus, the TEQ is based on Chry (TEF=0.01), B[a]A (TEF=0.1), B[a]P (TEF=1) and B[ghi]Per (TEF=0.01) [38-40] making it underestimated, as many other compounds with known TEF were found in the evaporates. The TEQ for each sample (Table 9) was calculated using the following formula:

$$TEQ\ (ng/g) = B[a]A \times 0.10 + Chry \times 0.01 + B[a]P \times 1.00 + B[ghi]Per \times 0.01$$

IA use 8951 kg of rubber crumb and we estimated the TEQ in µg referred to the crumb evaporates of the different fields at an average air temperature of 25°C (Table 10A). Estimating evaporation up to a height of 2 m, we have a volume of 1152 $m^3$ (576 $m^2$ × 2m). Table 10B shows the results in µg/$m^3$ obtained dividing the TEQ of evaporates of the rubber crumb samples (µg) by the estimated volume of air ($m^3$) above the field. Knowing that an athlete inhalation rate is around 3.6 $m^3$ per hour [41], the TEQ inspired by him in a standard two-hour workout was calculated on the basis of that assumption. In 2 h of training, the daily intake of $BaP_{eq}$ of an athlete is showed in Table 10C. If a player trains for 2 h a day, three times a week, five times for professionals, plus the match, his estimated intake of PAHs as TEQ ranged from 31.2 µg/week (sample 4) to 219.2 µg/week (sample 9), for an average weekly exposure of 8 h (Table 10D). Dividing this by 7 days we obtain 4.46 - 31.3 µg/day of $BaP_{eq}$ inhaled as daily mean dose, not considering other PAH inputs for the athletes (Table 10E). For a 70 kg athlete, we obtain an intake of 0.06 - 0.45 µg/kg bw of $BaP_{eq}$ per day (Table 10F). Since the release of PAHs is continuous and constant throughout the life of the field (Table 6), a chronic exposure of 0.06 to 0.44 µg/kg bw per day $BaP_{eq}$ for a 70 kg athlete should not be underestimated. In fact recent studies have shown that 0.57 – 5.00 ng/kg bw per day is a *virtually safe dose* of B[a]P in food, which implies a risk of $1x10^{-6}$ (one person in a million will develop cancer after chronic exposure). Considering that, generally, carcinogenic PAHs are about 10-fold higher than the B[a]P alone, the carcinogenicity increases and a *virtually safe dose* of B[a]P, as an indicator of carcinogenic PAHs in food, would be in the range 0.06 - 0.50 ng/kg bw per day [42], theoretically 1000 times lower than the range of 0.06 to 0.45 µg/kg bw per day found in this study.

## Conclusions

Rubber crumb derived from recycled tyres, like the tyres themselves, should be considered non-hazardous special waste. The literature and the present study show that crumb contains PAHs and heavy metals. Fine dust may become airborne and leachate may filter into the soil. The magnitude of human exposure depends on chemicals of concern concentration in field, exposure parameters describing human physiology (e.g. dermal contact, body weight) and population-specific parameters describing exposure behaviour (exposure frequency, duration). Randomly ingested crumb may release these compounds in the digestive tract. Most of all, evaporation at high temperatures may expose users of sports grounds, who are often children between 5 and 13 years of age, in a very sensitive phase of growth, to many of these toxic compounds.

The results of the present study demonstrate that PAHs are continuously released from rubber crumb through evaporation. Athletes frequenting grounds with synthetic turf are therefore exposed to chronic toxicity from PAHs. The main conclusion we can draw from this preliminary study, which will be validated by further field and laboratory research, is that although synthetic turf offers various advantages over natural grass, the quantity of toxic substances it releases when heated does not make it safe for public health. When we extrapolated the data obtained in laboratory, the toxicity equivalent (TEQ) of the different compounds evaporating from the crumb was far from negligible and would contribute substantially to an athlete's total daily PAH intake. In fact, all rubber crumb samples of this study exceeded the Dlgs. 152/2006 [8] for B[b]F, B[ghi]Per and Zn, but all

**Citation:** Marsili L, Coppola D, Bianchi N, Maltese S, Bianchi M (2015) Release of Polycyclic Aromatic Hydrocarbons and Heavy Metals from Rubber Crumb in Synthetic Turf Fields: Preliminary Hazard Assessment for Athletes. J Environ Anal Toxicol 5: 265. doi:10.4172/2161-0525.1000265



PAHs, except Chry, were over the threshold in almost one synthetic field. It must be underlined that this preliminary hazard assessment overestimates the PAH contribution of the field because the input from the wide variety of anthropogenic and crustal sources were not considered and then, this theoretical approach must be considered as an extreme worst case screening.

**Acknowledgments**

We thank Prof. Eros Bacci for expert guidance in support of this research.

**References**

1. Kolitzus HJ (2007) Artificial turf surfaces for soccer. What owners of soccer pitches should know about artificial turf. IST Switzerland, United States Sports Surfacing Laboratory USSL 1-29.
2. Claudio L (2008) Synthetic turf: health debate takes root. Environ Health Perspect 116: A116-122.
3. Verschoor AJ (2007) Leaching of zinc from rubber infill on artificial turf (football pitches). National Institute for Public Health and the Environment, The Netherlands. RIVM Report 601774001. 1-55.
4. Beausoleil M, Price K, Muller C (2008) Chemicals in outdoor artificial turf: a health risk for users. BISE 19:1-11.
5. van Rooij JG, Jongeneelen FJ (2010) Hydroxypyrene in urine of football players after playing on artificial sports field with tire crumb infill. Int Arch Occup Environ Health 83: 105-110.
6. Ministerial Circular (2005) Ministero dell'Ambiente e della Tutela del Territorio. Indicazioni relative ai materiali riciclati e beni e manufatti ottenuti con materiale riciclato, proveniente da articoli in gomma, ai sensi del decreto ministeriale 8 maggio 2003, n. 203. Italian Official Journal 173.
7. DIN 18035-7 (2002) Sports grounds part 7: synthetic turf areas. Determination of environmental compatibility. Deutsches Institut für Normung eV, Berlin, Germany.
8. Dlgs (2006) 152/2006 of 3/04/2006. Rules in environmental field. Italian Official Journal 88.
9. LND (2013) I campi di calcio in erba artificiale – Regolamento per la realizzazione di un campo da calcio in erba artificiale di ultima generazione. Rome Italy 1-45.
10. Swedish Chemicals Inspectorate. Synthetic turf from a chemical perspective — a status report. Sweden: Sundbyberg 2006.
11. Gomes J, Mota H, Bordado J, Cadete M, Sarmento G, et al. (2010) Toxicological assessment of coated versus uncoated rubber granulates obtained from used tires for use in sport facilities. J Air Waste Manag Assoc 60: 741-746.
12. CDC (2008) Potential exposure to lead in artificial turf: public health issues, actions, and recommendations.
13. Bocca B, Forte G, Petrucci F, Costantini S, Izzo P (2009) Metals contained and leached from rubber granulates used in synthetic turf areas. Sci Total Environ 407: 2183-2190.
14. Cheng H, Hu Y, Reinhard M (2014) Environmental and health impacts of artificial turf: a review. Environ Sci Technol 48: 2114-2129.
15. Li X, Berger W, Musante C, Mattina MI (2010) Characterization of substances released from crumb rubber material used on artificial turf fields. Chemosphere 80: 279-285.
16. Birkholz DA, Belton KL, Guidotti TL (2003) Toxicological evaluation for the hazard assessment of tire crumb for use in public playgrounds. J Air Waste Manag Assoc 53: 903-907.
17. Ginsberg G, Toal B, Simcox N, Bracker A, Golembiewski B, et al. (2011) Human health risk assessment of synthetic turf fields based upon investigation of five fields in Connecticut. J Toxicol Environ Health A 74:1150-1174.
18. Ginsberg G, Toal B, Kurland T (2011) Benzothiazole toxicity assessment in support of synthetic turf field human health risk assessment. J Toxicol Environ Health A 74: 1175-1183.
19. Simcox N, Bracker A, Ginsberg G, Toal B, Golembiewski B, et al. (2011) Synthetic turf field investigation in Connecticut. J Toxicol Environ Health A 74:1133-1149.
20. European Community (2005) Directive 2005/69/EC of the European Parliament and of the Council. Amending for the 27th time Council Directive 76/769/EEC on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations (polycyclic aromatic hydrocarbons in extender oils and tyres). Official Journal of the European Union L323.
21. Griest WH, Caton JE (1983) Extraction of polycyclic aromatic hydrocarbons for quantitative analysis. Handbook of Polycyclic Aromatic Hydrocarbons. (Ed) Bjørseth A 95-148.
22. Holoubek I, Paasivirta J, Maatela P, Lahtipera M, Holoubkova I, et al. (1990) Comparison of extraction methods for polycyclic aromatic hydrocarbons determination in sediments. Toxicol Environ Chem 25:137-154.
23. Marsili L, Fossi MC, Casini S, Savelli C, Jimenez B, et al. (1997) Fingerprint of polycyclic aromatic hydrocarbons in two populations of southern sea lions (Otaria flavescens). Chemosphere 34: 759-770.
24. Berardi S, Bemporad E, Gherardi M, Mariani M (2010) Intrusione di vapori da suolo contaminato: un approccio alternativo per la valutazione del rischio. Ambiente e sicurezza 2:71.
25. Boekhold AE (2008) Ecological risk assessment in legislation on contaminated soil in The Netherlands. Sci Total Environ 406: 518-522.
26. Zhang JJ, Han IK, Zhang L, Crain W (2008) Hazardous chemicals in synthetic turf materials and their bioaccessibility in digestive fluids. J Expo Sci Environ Epidemiol 18: 600-607.
27. DEC (2006) 6 NYCRR part 375 - Environmental Remediation Program.
28. USEPA (1984) Health effects assessment for polycyclic aromatic hydrocarbons (PAH). Cincinnati, OH: U.S. Environmental Protection Agency, Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office. First Draft. ECAO-CIN-H013.
29. IARC Working Group on the Evaluation of Carcinogenic Risks to Humans (2010) Some non-heterocyclic polycyclic aromatic hydrocarbons and some related exposures. IARC Monogr Eval Carcinog Risks Hum 92: 1-853.
30. IPCS (1998) Environmental Health Criteria 202: selected non-heterocyclic polycyclic aromatic hydrocarbons. International Programme on Chemical Safety, World Health Organization, Geneva, Switzerland.
31. NRCC (1983) Polycyclic aromatic hydrocarbons in the aquatic environment: formation, sources, fate and effects on aquatic biota. NRCC Report. 18981: 1-209.
32. NTP (2005) Report on Carcinogens. (11th edtn) Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program.
33. European Community (2006) Regulation (EC) No 1881/2006. Setting maximum levels for certain contaminants in foodstuffs. Official Journal of the European Union L364.
34. APAT - Italian Environmental Protection Agency and Technical Services (2008) Criteri metodologici per l'applicazione dell'analisi assoluta di rischio ai siti contaminati. 1-156.
35. ISS/ISPESL (2009) ISPRA/ISPESL database "Chemical/physical and toxicological properties of pollutants".
36. USEPA (2009) Risk assessment guidance for superfund volume I human health evaluation manual.
37. Menichini E, Abate V, Attias L, De Luca S, di Domenico A, et al. (2011) Artificial-turf playing fields: Contents of metals, PAHs, PCBs, PCDDs and PCDFs, inhalation exposure to PAHs and related preliminary risk assessment. Sci Total Environ 409: 4950-4957.
38. Nisbet IC, LaGoy PK (1992) Toxic equivalency factors (TEFs) for polycyclic aromatic hydrocarbons (PAHs). Regul Toxicol Pharmacol 16: 290-300.
39. USEPA (1993) Provisional guidance for quantitative risk assessment of Polycyclic Aromatic Hydrocarbons, US Environmental Protection Agency, Research Triangle Park, NC, EPA-600/R-93/089.
40. Larsen JC, Larsen PB (1998) Chemical carcinogens, in: Hester, R.E., Harrison, R.M. (Eds.), Air pollution and health. Royal Society of Chemistry, Cambridge, UK 33-56.
41. USEPA (1997) Exposure factors handbook. National Center for Environmental Assessment. Office of Research and Development 1216.
42. Kulhnek A, Trapp S, Sismilich M, Jank J, Zimovj M (2005) Crop-specific human exposure assessment for polycyclic aromatic hydrocarbons in Czech soils. Sci Total Environ 339: 71-80.

**Overview of the risks of synthetic turf fields**
**by David R. Brown Sc.D., Public Health Toxicologist**
April 4, 2015

If one looks at the number of studies on synthetic turf fields that have attempted to estimate the risk to young students' and athletes' from the exposures to chemicals contained in the fields, you will see the problem.

The **findings of each of the studies** are based on a startling **limited number (2 to 12) actual samples of crumb rubber** (each weighing a no more than few ounces), **on small number of fields** most without with any testing of the crumb rubber (4 to 6 fields at most). There is **no study that is comprehensive systematic assessment of the risk**. *

Instead, a **natural experiment** is being conducted **in which thousands of children** are being exposed on playing fields to rubber, **1**) *known to contain carcinogens* and **2**) documented to produce cancer in the workers in the tire manufacturing plants. *

The **results** of this human health experiment *is to determine* ***whether there is enough exposure to carcinogens in the synthetic turf fields to cause cancer in the children who play on these fields.***

Now that there is **strong indication that cancer** has appeared in one segment of the student groups that have played on synthetic turf, (soccer goalies in particular as well as others) the experiment is allowed to continue with health departments standing by until they can obtain positively statistical confirmation of the cancer hazard. *

* **Crumb rubber infill** contains a *large number of chemicals known to be toxic to humans*. These include *chemicals* ***associated with cancer, asthma,*** *and other adverse health effects*. There is **no "safe"** threshold level for exposure to carcinogens.

The only **way to eliminate cancer risk** from these chemicals is to eliminate exposure. No existing study disputes the inherent hazard of these chemicals; the studies simply draw varying conclusions regarding the total amount that these chemicals pose to children who are likely to be exposed when they play on the artificial turf fields. *

The bottom line is that **nobody knows exactly** what *the mix of chemicals is in any given field containing crumb rubber made from recycled tires*. Tires themselves are manufactured with a wide variety of chemicals. Fields may contain tires from a variety of sources, and there is no source of information to identify exactly what chemicals, and in what quantity, are present in any given field. No entity providing the crumb rubber * provides any quality control, identification of source, or analytical analysis of the contents of the rubber used.

* **Children are more susceptible** than adults to a variety of **environmental hazards**, for several reasons. Children's organ systems are developing rapidly. ***A toxic exposure during a critical window of development can have life-long consequences.*** * Children's detoxification mechanisms are also immature, so an exposure that might not have an important effect on an adult could have an important effect on a child. In addition, children have many years in which to develop disease.

**Cancer**, in particular, is **a disease with long latency**: disease can develop many years after exposure. For this and other reasons, it is particularly important to *avoid carcinogenic exposures during childhood.*

There has been **no comprehensive assessment of the data on cancer among athletes exposed to crumb rubber from artificial turf exposures.** However, the evidence collected to date indicates a basis for concern and an urgent need for closer scrutiny. **Most notable** is that **the ratio of lymphomas and leukemia is the reverse** of that expected in the general population for that age group. Such *a reverse in the* ***pattern of cancers present** is considered **a signal that an active chemical carcinogen is present**.*

Given the high stakes, it is prudent to take action to protect children from this known hazard rather than wait for definitive evidence of harm.

– Precautionary Principle –

Thank you for your attention,

David R Brown Sc.D. Public Health Toxicologist and Director of Public Health Toxicology for Environment and Human Health, Inc.; Past Chief of Environmental Epidemiology and Occupational Health at Connecticut's Department of Health; Past Deputy Director of The Public Health Practice Group of ATSDR at the National Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia.

--

Nancy Alderman, President
Environment and Human Health, Inc.
1191 Ridge Road
North Haven, CT 06473
(phone) 203-248-6582
(Fax) 203-288-7571
http://www.ehhi.org
http://ehhijournal.org

# NY Elected Officials Introduce Bipartisan Bill to Protect Children from Toxic Chemicals

*Child Safe Products Act Would Require New York to Report, and Ultimately Ban, Toxic Chemicals in Children's Products*

ALBANY, NY— Today, Sen. Phil Boyle (R-Bay Shore) and **Assemblyman Steve Englebright (D-East Setauket)** announced the introduction of a bill that would empower New York State to identify and phase out dangerous chemicals in products marketed to kids in New York.

If enacted, the bill [S.4102/A.5612], commonly known as the **Child Safe Products Act**, would ***first establish a list of high-concern chemicals, based on authoritative scientific evidence that the chemicals cause major health problems.*** Next, it ***would establish a list of priority chemicals used in children's products for disclosure.*** Children's ***product makers would be required after a year to report their use of priority chemicals in their merchandise, and then phase out their use three years later.***

Unless the bill is passed, thousands of toxic children's products will remain on the shelves, tainted by chemicals like arsenic, mercury, cadmium, formaldehyde and cobalt.

The **toxic chemicals in children's products have been linked to a host of serious medical problems including cancer, learning and developmental disabilities, reproductive problems, and asthma.** Until the bill is enacted, New York children remain at risk.

**Senator Phil Boyle, (R-Bay Shore)**, lead sponsor of S. 4102, said, "Protecting children from toxic chemicals is just common sense. Despite market advancements and announcements by major retailers, voluntary measures just don't get us there. It's up to us, as elected officials, to take action to protect our own residents. I thank my colleague Assemblyman Englebright for introducing the Child Safe Products Act, and I am committed to seeing it enacted in 2015."

"Children are not just small adults and their developing systems are more sensitive to and are at an increased risk of chemical exposure," said **Assembly Environmental Conservation Committee Chair Steve Englebright (D-East Setauket)**. "Currently, New York prohibits the use of dangerous chemicals on a chemical-by-chemical basis. The President's Cancer Panel reported that nearly 80,000 chemicals are used in the country today, many of which are unstudied and largely unregulated. We need to act now to protect our children's health and the environment from unnecessary toxic chemicals found in products designed for them."

The reintroduction of the bill has generated significant support from the public, including the JustGreen Partnership, a coalition of pediatricians, environmental groups, environmental justice leaders, learning disability advocates, parent organizations, healthy schools advocates, sustainable companies and other members of the community.

"Each year, diseases of environmental origin in New York's children cost an estimated $4.35 billion. These include learning and developmental disabilities, cancer, and asthma. Such diseases are preventable, by protecting children from the chemicals that cause them," said **Dr. Philip Landrigan, MD, MSc., pediatrician and epidemiologist at Mt. Sinai School of Medicine.** "The Child Safe Products Act is an important part of this prevention process."

"We must protect our children from exposure to dangerous chemicals in products meant for them. Many of these chemicals cause a reduction in a child's brain function and behavior and can alter later reproduction," said **Dr. David O. Carpenter, director of the Institute for Health & Environment at SUNY Albany**.

"Our brothers and sisters across the country are facing alarming rates of cancers, and we need the federal government and our decision-makers at the state level to take notice and help us come up with solutions," said **Mike McManus, president, New York State Professional Fire Fighters Association**. "Chemicals should be proven safe before ending up in our homes and building materials, to protect the health of Fire Fighters and families," McManus added.

"The New York State Breast Cancer Network urges the passage of the Child Safe Products Act. Several national researchers have found that exposure to tiny amounts of estrogen-mimicking chemicals during particular 'windows of susceptibility', such as the pre-natal, neo-natal and pre-adolescent periods, will place female babies and girls under 12-years old at risk for breast cancer in their adult lives." said **Andi Gladstone, Executive Director of the New York State Breast Cancer Network.**

"We commend the actions of our elected officials, on the local, state and county level who have already done what is necessary to protect the health and safety of our children now and for future generations," said **Francesca Sommer,Executive Director of the Learning Disabilities Association of New York State**. "We urge those who have not yet done so, to join us!"

"As moms, we may differ in our approaches to parenting, our career choices, or our politics, but we can all agree that toxic chemicals do not belong in our children's toys and products," said **Mitzi Rose, Moms for a Non-Toxic NY, Rochester chapter.**

"Independent business owners need the clarity that good regulations can provide," said **Laura Ornstein, Coordinator of the New York State Sustainable Business Council**. "Better regulatory oversight of chemicals will level the playing field by improving transparency, limiting liability, and reducing exposures."

"Pregnant women, infants and children are especially vulnerable to the health impacts of toxic chemical exposure", states **Trisha Sheehan, Moms Clean Air Force Regional Field Manager**. "The Child Safe Products Act is a step in the right direction to protect the families of New York from toxic chemicals. Moms should be able to trust that the products we use in our homes will not harm our children. We want strong policies that will limit our families' exposures to toxic chemicals."

"Toxic chemicals have absolutely no place in the homes and schools of our children," said **John Replogle, CEO of Seventh Generation,** the nation's leading brand of non-toxic and renewable bio-based household, baby and personal care solutions. "Our mission is to nurture the health of future generations, and with the introduction, and hopefully the passing of CSPA, we can see our mission through on behalf of New York's children."

"Time is of the essence in getting this common sense legislation passed into law," stated **Senate EnCon Committee Vice-Chair Tony Avella**. ""Our children's safety is of the utmost importance and it is our responsibility, as Legislators, to safeguard children's toys across the state. That is why I immediately signed onto the Child Safe Products Act as a co-sponsor. I urge my colleagues in the State Senate to vote in favor of this vital bill."

"We need a more comprehensive approach regulating chemicals used in the manufacture of children's toys in New York. It's our responsibility to ensure that our kids' playthings do not pose serious health risks. The effects of these chemicals in small doses can be extremely dangerous to young developing children. Let's pass the Child Safe Products Act this year," said **Felix W. Ortiz, Assistant Speaker in the NYS Assembly**.
"New York's parents deserve to know what is safe for their families, but right now they're flying blind, said **Kathy Curtis, Executive Director of Clean and Healthy New York and co-leader of the JustGreen Partnership**. "Meanwhile, it's legal and common practice to add toxic chemicals to infant's and children's products. To make the dream of safe products for all children a reality, the Legislature must pass this initiative and deliver it to the Governor," Curtis added.

"Environmental Advocates of New York applauds Senator Boyle and Assemblyman Englebright for introducing the 'Child-safe Products Act'," said **Saima Anjam, Environmental Health Director.** "With the Legislature and the Governor in agreement on the need to protect our children from toxic chemicals, there is no excuse for this common sense legislation to not become law in 2015."

***"Toxic chemicals do not belong in our air or our water, and they certainly do not belong in the products children use every day***," said **Caitlin Pixley, Conservation Association of the Sierra Club Atlantic Chapter.** "New Yorkers deserve a toxic-free future and we look to the Legislature for leadership on this issue, through passage of the Child Safe Products Act."

"In the communities that we work in, families do not have the time or the finances to bypass all of the toxic products on store shelves," said **Cecil Corbin-Mark, Deputy Director of WE ACT For Environmental Justice and Co-Leader of the JustGreen Partnership**. "With this bill, parents from Harlem to the west side of Buffalo can rest assured that the State of New York is on the job helping to protect their children from dangerous chemicals."

"The alarming findings of recent reports in Albany, Westchester, and Long Island have confirmed that action is needed to protect the health of New York's families," said Marcia Bystryn, President of the New York League of Conservation Voters. ***"Toxic chemicals have no place in children's toys, and they should not be on store shelves for sale.*** Parents deserve the right to know what dangers are lurking in the products they bring home so they can make informed decisions about their families' health."

In addition to the state legislative campaign, counties across New York are also taking action and introducing local legislation called the Toxic-Free Toys Act. Today and tomorrow, Westchester and Suffolk counties will hold public hearings on the issue. In 2015, 28 states are expected to advance policies to protect the public from toxic chemicals. **Eleven other states are considering policies** similar to New York's Child Safe Products Act.

**Learn more about state actions at: http://www.saferstates.org/news/2015map/**

TUESDAY, NOVEMBER 8, 2011

NJSA 2C:2-2 Culpability

# NJSA 2C:2-2 Culpability

2C:2-2. **Culpability**
***General requirements*** of culpability

a. **Minimum** requirements of culpability. Except as provided in subsection c.(3) of this section, a person is not guilty of an offense unless he acted purposely, knowingly, recklessly or negligently, as the law may require, with respect to each material element of the offense.

b. **Kinds** of culpability defined.

(1) **Purposely**. A person acts purposely with respect to the nature of his conduct or a result thereof if it is his conscious object to engage in conduct of that nature or to cause such a result. A person acts purposely with respect to attendant circumstances if he is aware of the existence of such circumstances or he believes or hopes that they exist. "With purpose," "designed," "with design" or equivalent terms have the same meaning.

(2) **Knowingly**. A person acts knowingly with respect to the nature of his conduct or the attendant circumstances if he is aware that his conduct is of that nature, or that such circumstances exist, or he is aware of a high probability of their existence. A person acts knowingly with respect to a result of his conduct if he is aware that it is practically certain that his conduct will cause such a result. "Knowing," "with knowledge" or equivalent terms have the same meaning.

(3) **Recklessly**. A person acts recklessly with respect to a material element of an offense when he consciously disregards a substantial and unjustifiable risk that the material element exists or will result from his conduct. The risk must be of such a nature and degree that, considering the nature and purpose of the actor's conduct and the circumstances known to him, its disregard involves a gross deviation from the standard of conduct that a reasonable person would observe in the actor's situation. "Recklessness," "with recklessness" or equivalent terms have the same meaning.

(4) **Negligently**. A person acts negligently with respect to a material element of an offense when he should be aware of a substantial and unjustifiable risk that the material element exists or will result from his conduct. The risk must be of such a nature and degree that the actor's failure to perceive it, considering the nature and purpose of his conduct and the circumstances known to him, involves a gross deviation from the standard of care that a reasonable person would observe in the actor's situation. "Negligently" or "negligence" when used in this code, shall refer to the standard set forth in this section and not to the standards applied in civil cases.

c. **Construction** of statutes with respect to culpability requirements.

(1) **Prescribed** culpability requirement applies to all material elements. When the law defining an offense prescribes the kind of culpability that is sufficient for the commission of an offense, without distinguishing among the material elements thereof, such provision shall apply to all the

material elements of the offense, unless a contrary purpose plainly appears.

(2) **Substitutes** for kinds of culpability. When the law provides that a particular kind of culpability suffices to establish an element of an offense such element is also established if a person acts with higher kind of culpability.

(3) **Construction** of statutes **not stating** culpability requirement. Although no culpable mental state is expressly designated in a statute defining an offense, a culpable mental state may nevertheless be required for the commission of such offense, or with respect to some or all of the material elements thereof, if the proscribed conduct necessarily involves such culpable mental state. A statute defining a crime, unless clearly indicating a legislative intent to impose strict liability, should be construed as defining a crime with the culpability defined in paragraph b.(2) of this section. This provision applies to offenses defined both within and outside of this code.

d. **Culpability** as **to illegality of conduct**. Neither knowledge nor recklessness nor negligence as to whether conduct constitutes an offense or as to the existence, meaning or application of the law determining the elements of an offense is an element of such offense, unless the definition of the offense or the code so provides.

e. **Culpability as determinant** of grade of offense. When the grade or degree of an offense depends on whether the offense is committed purposely, knowingly, recklessly or criminally negligently, its grade or degree shall be the lowest for which the determinative kind of culpability is established with respect to any material element of the offense.

L.1978, c. 95, s. 2C:2-2, eff. Sept. 1, 1979. Amended by L.1981, c. 290, s. 4, eff. Sept. 24, 1981.

2C:2-3. **Causal relationship between conduct and result**; divergence between result designed, contemplated or risked and actual result

a. **Conduct** is the cause of a result when:

(1) It is an **antecedent but for which the result in question would not have occurred**; and

(2) The **relationship between the conduct and result** satisfies any additional causal requirements imposed by the code or by the law defining the offense.

b. When the **offense requires that the defendant purposely or knowingly cause a particular result,** the actual result must be within the design or contemplation, as the case may be, of the actor, or, if not, the actual result must involve the same kind of injury or harm as that designed or contemplated and not be too remote, accidental in its occurrence, or dependent on another's volitional act to have a just bearing on the actor's liability or on the gravity of his offense.

c. When the **offense requires that the defendant recklessly or criminally negligently cause a particular result,** the actual result must be within the risk of which the actor is aware or, in the case of criminal negligence, of which he should be aware, or, if not, the actual result must involve the same kind of injury or harm as the probable result and must not be too remote, accidental in its occurrence, or dependent on another's volitional act to have a just bearing on the actor's liability or on the gravity of his offense.

d. A defendant shall **not be relieved of responsibility** for causing a result if the only difference between what actually occurred and what was designed, contemplated or risked is that a different person or property was injured or affected or that a less serious or less extensive injury or harm occurred.

e. When **causing a particular result is a material element of an offense for which absolute liability is imposed by law,** the element is not established unless the actual result is a probable consequence of the actor's conduct.

Draft
Page 3 Revision
Exemption #6

State of New Jersey
Highlands Water Protection and Planning Council
100 North Road (Route 513)
Chester, New Jersey 07930-2322 (908) 879-6737
(908) 879-4205 (fax)
www.highlands.state.nj.us

# Highlands Water Protection and Planning Act

Municipalities MUST Adhere to Highland's Enhanced standard's BAT Not Schools!

## Exemptions and Waivers

The Highlands Act creates seventeen exemptions that allow property owners to develop their properties without applying the enhanced environmental standards adopted by the New Jersey Department of Environmental Protection in the Preservation Area. In addition, the rules adopted by DEP include provisions for four waivers that allow some degree of deviation from the enhanced environmental standards.

**Exemptions**

1. **Construction of a single family dwelling for own use or family use:** The construction of a single family dwelling, for an individual's own use or the use of an immediate family member, on a lot owned by the individual on the date of enactment of this act or on a lot for which the individual has on or before May 17, 2004 entered into a binding contract of sale to purchase that lot;

2. **Construction of a single family dwelling on existing lot:** The construction of a single family dwelling on a lot in existence on the date of enactment of this act, provided that the construction does not result in the ultimate disturbance of one acre or more of land or a cumulative increase in impervious surface by one-quarter acre or more;

3. **Developments with prior Municipal and DEP Approvals:** A major Highlands development that received on or before March 29, 2004:

(a) one of the following approvals pursuant to the "Municipal Land Use Law," P.L.1975, c. 291

(C.40:55D-1 et seq.):

(i) preliminary or final site plan approval;

(ii) final municipal building or construction permit;

(iii) minor subdivision approval where no subsequent site plan approval is required;

(iv) final subdivision approval where no subsequent site plan approval is required; or

(v) preliminary subdivision approval where no subsequent site plan approval is required; and

(b) at least one of the following permits from the Department of Environmental Protection, if applicable to the proposed major Highlands development:

(i) a permit or certification pursuant to the "Water Supply Management Act," P.L.1981, c. 262 (C.58:1A-1 et seq.);

(ii) a water extension permit or other approval or authorization pursuant to the "Safe Drinking Water Act," P.L.1977, c. 224 (C.58:12A-1 et seq.);

(iii) a certification or other approval or authorization issued pursuant to the "The Realty

New Jersey is an Equal Opportunity Employer

Improvement Sewerage and Facilities Act (1954)," P.L.1954, c. 199 (C.58:11-23 et seq.); or

(iv) a treatment works approval pursuant to the "Water Pollution Control Act," P.L.1977, c. 74 (C.58:10A-1 et seq.); or

(c) one of the following permits from the Department of Environmental Protection, if applicable to the proposed major Highlands development, and if the proposed major Highlands development does not require one of the permits listed in sub-subparagraphs (i) through (iv) of subparagraph (b) of this paragraph:

(i) a permit or other approval or authorization issued pursuant to the "Freshwater Wetlands Protection Act," P.L.1987, c. 156 (C.13:9B-1 et seq.); or

(ii) a permit or other approval or authorization issued pursuant to the "Flood Hazard Area Control Act," P.L.1962, c. 19 (C.58:16A-50 et seq.).

The exemption provided in this paragraph shall apply only to the land area and the scope of the major Highlands development addressed by the qualifying approvals pursuant to subparagraphs (a) and (b), or (c) if applicable, of this paragraph, shall expire if any of those qualifying approvals expire, and shall expire if construction beyond site preparation does not commence within three years after the date of enactment of this act;

4. **Reconstruction of buildings or structures within 125% of the footprint:** The reconstruction of any building or structure for any reason within 125% of the footprint of the lawfully existing impervious surfaces on the site, provided that the reconstruction does not increase the lawfully existing impervious surface by one-quarter acre or more. This exemption shall not apply to the reconstruction of any agricultural or horticultural building or structure for a non-agricultural or non-horticultural use;

5. **Improvement to a single family dwelling:** Any improvement to a single family dwelling in existence on the date of enactment of this act, including but not limited to an addition, garage, shed, driveway, porch, deck, patio, swimming pool, or septic system;

6. **Places of worship, schools, or a hospitals:** Any improvement, for non-residential purposes, to a place of worship owned by a nonprofit entity, society or association, or association organized primarily for religious purposes, or a public or private school, or a hospital, in existence on the date of enactment of this act, including but not limited to new structures, an addition to an existing building or structure, a site improvement, or a sanitary facility; *No Exemption for installation of SYNTHETIC TURF containing any COMPONENT OF CRUMB RUBBER FILL which CRUMB RUBBER is the result of processing of waste tires, which contain numerous components, some which are known to be hazardous to people and the environment. The hazardous components include, arsenic, cadium, chromium, lead, vanadium, zinc, acetone, benzene, mercury, carbon black, 1,3 butadiene, phthalates, polycyclic aromatic hydrocarbons (PAHs),benzothiazole, butylated hydroxyanisole, n-hexadecane, 4-(t-octyl)phenol,* .

No EPA Studies on the Long-Term Effects of Tire-Crumb on the Environment-Health-Safety

Now

7. **Woodland and Forest management plans:** An activity conducted in accordance with an approved woodland management plan pursuant to section 3 of P.L.1964, c. 48 (C.54:4-23.3) or the normal harvesting of forest products in accordance with a forest management plan approved by the State Forester;

8. **Trails on public or private lands:** The construction or extension of trails with non- impervious surfaces on publicly owned lands or on privately owned lands where a conservation or recreational use easement has been established;

9. **Repair of transportation or infrastructure systems:** The routine maintenance and operations, rehabilitation, preservation, reconstruction, or repair of transportation or infrastructure systems by a State entity or local government unit, provided that the activity is consistent with the goals and purposes of this act and does not result in the construction of any new through-capacity travel lanes;

10. **Transportation safety projects:** The construction of transportation safety projects and bicycle and pedestrian facilities by a State entity or local government unit, provided that the activity does not result in the construction of any new through-capacity travel lanes.