Eight Good Reasons Why Artificial Turf Is One Bad Idea

The SynTurf.org's Brief
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1. Carbon Footprint

According to a news article in the *Santa Cruz Sentinel* (April 14, 2010), a report from the University of California at Berkeley concluded that significant greenhouse gases are released in … creation [of artificial turf fields]." Genevieve Bookwalter, "New study provides fuel for both sides of artificial turf fight," in Santa Cruz Sentinel, April 14, 2010, available at http://www.santacruzsentinel.com/localnews/ci_14879819 . The pdf version of this article is available via http://www.synturf.org/carbonfootprint.html (Item No. 03).

The report concluded that "[a]rtificial turf releases more greenhouse gases in its production, transportation and processing than the maintenance of natural turf ever would." The report also stated that "[n]atural grass requires fertilizer, which could contaminate water supplies, and regular mowing, the emissions of which contribute to greenhouse gases. It also requires watering, which could tax a limited supply." The report however made no mention of the existence of natural grass technologies that address each of the grass-is-bad arguments: organic and natural occurring fertilizers as opposed to chemicals; integrated pest management systems, grass that requires less water and shorter growing season, with deeper root systems and shorter blades.

As for the artificial turf itself: A well-groomed and maintained artificial turf field requires watering (to keep silica dust down, smooth the playing surface, cool down); it requires also antibacterial treatments, pesticides, fungicides, and herbicides. While the installation, mowing (grass)/grooming (artificial turf) and lighting and watering (irrigation) all require some greenhouse gas emissions, in terms of carbon footprint the report did say this: "Artificial turf releases more greenhouse gases in its the production, transportation and processing than the maintenance of natural turf ever would."

In 2006, Upper Canada College, a private elementary and secondary school in Toronto, Canada, decided to replace its natural grass playing field with a new state-of-the-art, artificial turf surface. A study conducted by the Athena Institute, Merrickville, Ontario, compared the estimated greenhouse gases (GHG) emitted during the life cycle of the synthetic turf system with a natural grass surface. The study looked also at the number of trees that have to be planted in order to achieve a 10-year carbon neutral synthetic turf installation. For a 9,000 square-meter facility, the research showed a total CO_2 emission of 55.6 tons. The Athena study estimated that 1861 trees needed to be planted in order to achieve a 10-year carbon neutral synthetic turf installation. *See* Jamie Meil and Lindita Bush, *Estimating the Required Global Warming Offsets to Achieve a Carbon Neutral*

Synthetic Field Turf System Installation, available at http://www.athenasmi.ca/projects/recentProjects.html or accessible via http://www.synturf.org/carbonfootprint.html (Item No. 01).

Unlike the environmentally unsustainable artificial turf, a natural grass field acts to reduce CO2. A 2008 research found that "[a]fter reviewing the direct carbon sequestration of grasses and their root systems, … managed lawns sequester, or store, significant amounts of carbon, capturing four times more carbon from the air than is produced by the engine of today's typical lawnmower." The study also found that "well-managed turfgrasses that are cut regularly and at the appropriate height, fed with nutrients left by grass clippings, watered in a responsible way, and not disturbed at the root zone actively pull pollutants from the air, creating a greater carbon benefit." *See* Ranajit Sahu, *Technical Assessment of the Ccarbon Sequestration Potential of Managed Turfgrass in the United States* (2008). Dr. Sahu holds a masters and doctoral degrees in mechanical engineering from California Institute of Technology at Loyola Marymount University (Los Angeles, California) he teaches courses in air pollution and environmental health risk assessment. The report can be accessed via http://www.synturf.org/carbonfootprint.html (Item No. 02).

2. Heat Effect

In August 2008, *Morning Edition* program on the National Public Radio in the United States broadcast a package on the heating of artificial turf fields and its relation to urban heat island effect. The piece featured Rick Doyle, the president of the Synthetic Turf Council, who stated "I don't think anyone in our industry would suggest it's a good idea to play on a surface that's that [160 degrees] hot." "Just as coaches have to reschedule games due to rain when they play on grass fields," he said, so too they need to reschedule or consider an alternative surface to play on when it's hot and sunny. Allison Aubrey, "High Temps On Turf Fields Spark Safety Concerns," on *NPR - Morning Edition*, 7 August 2008. Audio link: http://www.npr.org/templates/player/mediaPlayer.html?action=1&t=1&islist=false&id=93364750&m=93364728 ; Transcript link: http://www.npr.org/templates/story/story.php?storyId=93364750 ; also available via http://www.synturf.org/images/NPR-http___www.npr.org_templates_story_story.pdf .

The most compelling evidence of the heat effect of artificial turf fields is found in the satellite imagery of urban heat islands in Montreal, Toronto, and Vancouver, which includes a chapter on heat island effect of synthetic turf fields. The work is available via http://www.synturf.org/images/CamiloNewSynthetic_turf_Montreal.pdf courtesy of the author Camilo Perez Arrau of www.urbanheatislands.com .

3. Greater Risk Of Injury To Lower Extremities And Of Concussion Due To Biomechanical Causes

According to a 2009 research paper from Michigan State University, infill and fiber spacing in artificial turf fields are factors in lower extremity injuries. Mark R.Villwock,

Eric G. Meyer, John W. Powell, Amy J. Fouty, and Roger C. Haut, "Football playing Surface components may affect lower extremity injury risk," presented at the 2008 North American Conference on Biomechanics, August 5-9, Ann Arbor, MI (http://www.x-cdtech.com/nacob/Session5.html), published as "The effects of various infills, fibre structures, and shoe designs on generating rotational traction on an artificial surface," in *Journal Proceedings of the Institution of Mechanical Engineers, Part P: Journal of Sports Engineering and Technology*, Vol. 223, No. 1 (2009), pp. 11-19. The full text of the paper is available at http://journals.pepublishing.com/content/g51027g43j450472/ ; the abstract is available at http://www.x-cdtech.com/nacob/Abstracts/37.pdf or via http://www.synturf.org/images/LowerExtremityInjury.pdf .

The paper investigated the role of infill material and fiber structure on the rotational traction associated with American football shoes on infill-based artificial surfaces. A mobile testing apparatus with a compliant ankle was used to apply rotations and measure the torque produced at the football shoe–surface interface. Here are some excerpts from the study:

"Injuries to the lower extremity are among the most frequent injuries in all levels of sports and often account for more than 50% of reported injuries (Fernandez et al., 2007). While translational friction is necessary for high-level performance during any athletic contest, it is generally accepted that excessive rotational friction results in high forces being transmitted to vulnerable anatomic structures which may then precipitate ankle and knee injuries.

"In the current study a mobile testing apparatus was developed to measure the torque produced at the shoe/surface interface on sixteen surface systems. It was hypothesized that the size and structure of the infill would affect the rotational resistance of cleated shoes.

"Infill material, fibre structure, and shoe design were all found to significantly affect rotational traction. The cryogenically processed styrene–butadiene rubber (SBR) infill yielded significantly higher peak torques than the ambient ground SBR and extruded thermoplastic elastomer (TPE) infills. An artificial surface with a nylon root zone yielded significantly lower peak torques than similar fibre surfaces without a nylon root zone. The size of infill particles and the presence of a nylon root zone may influence the compactness of the infill layer. These features may act to alter the amount of cleat contact with the infill, thereby influencing rotational traction. The amount of cleat contact with the surface may also be determined by the shoe design.

"Peak torques were significantly affected by playing surface…. FieldTurf and the native soil natural grass system produced significantly different torques than all other surfaces. This was in agreement with the trend in a comparable study performed by Livesay et al (2006). In the … analyses, all three infills were found to be

"significantly different from one another. The highest torques were associated with the cryogenic SBR infill. This infill consisted of fine crumb rubber particles capable of

packing into a dense structure thought to increase a cleated shoe's resistance to rotation. The lowest torques were associated with the extruded infill, a larger rounded cylindrical particle made of TPE, incapable of packing as tight as the cryogenically processed infill. The open structure of the extruded infill layer was thought to reduce the frictional resistance.

"Generation of excessive torque at the shoesurface interface was a factor of both the infill particle size and fiber spacing. The peak torques measured in the current study exceed injury levels based on cadaveric studies (Hirsch and Lewis, 1965). However, muscle stiffness has been shown to protect the lower extremity at similar torques (Shoemaker, 1988). Future studies using a more biofidelic ankle may help establish relationships between shoe-surface interfaces and the potential for ankle injury.

"Additionally, epidemiological studies of shoe and surface injury rates will be important for validating the injury risk potential of various shoe-surface interfaces."

A 2014 statistical analysis found a faster aging curve among baseball players playing on artificial turf. According to the study of 655 baseball players who played at least three consecutive seasons on artificial turf fields between 1995 and 2014 on the basis of wOBA (weighted on-base average) "playing on turf a lot early in one's career can lead to a steeper aging 'curve.' This seems to fit the conventional wisdom associated with playing on turf." wOBA) is a catch-all offensive statistical methods; it measures a hitter's overall offensive value based on the relative values of each distinct offensive event. Chris Teeter, "Does playing on artificial turf affect how players' age?," on *BeyondtheBoxScore* (28 November 2014) at http://www.beyondtheboxscore.com/2014/11/28/7296843/artificial-turf-age-curve-blue-jays-rays-baseball-woba .

That more injuries occur on artificial turf fields is also a conclusion reached by Justine Shaginaw, an athletic trainer for the U.S. Soccer Federation and a member of the Aria 3b Orthopaedic Institute. According to a news report in *The Plainville Citizen* (Connecticut, 5 August 2014), Shaginaw believes that "[r] esearch has shown that as the coefficient of friction increases there is an increase in the rate of lower extremity injuries. This means that the more traction you get on the field or court, the higher the risk of injury. The common thought is that turf has more traction than grass and therefore we will see more injuries on turf." Adam Stuhlman, "Funds secured for artificial turf field at high school," in *The Plainville Citizen*, 5 August 2014, at http://www.plainvillecitizen.com/news/allnews/5218635-129/funds-secured-for-artificial-turf-field-at-high-school.html .

For soccer players artificial turf is an issue of occupational safety and health. For the last seven years SynTurf.org's Players' View page http://www.synturf.org/playersview.html has been cataloguing statements by sportsmen and sportswomen with safety and health concerns about playing on artificial turf fields—not on the mat-on-concrete variety of yore, but on the so-called "third generation" simulated plastic grass with synthetic dirt (infill) like crumb rubber. Surveys by Fédération International de Footballeurs Professional (FIFPro), the world's soccer players' union, has shown consistently that

soccer players prefer natural grass to artificial turf "Research: artificial turf versus natural grass" at http://www.fifpro.org/en/news/research-artificial-turf-versus-natural-grass (Published: 08 April 2013).

The Dutch and Danish soccer players too are on the record for having rejected artificial turf—see "Dutch and Danish soccer players reject artificial turf" at http://www.synturf.org/playersview.html (Item No. 45)—while according to a 2006 survey by the Swiss Association of Professional Footballers (SAFP) around 88% of the Super League professional soccer players in Switzerland did not like playing on artificial turf. Swiss Association of Professional Footballers (SAFP), "Swiss Super League pro footballers reject synthetic turf," at http://www.old.safp.ch/news/detail.php?lang=0&id=90 (August 2006).

In Canada—"[a] study done by researchers at York University in Toronto backs up the players' objections. They interviewed 99 professional players from six Major League Soccer teams during the 2011 season and found that 94 per cent felt it posed more risk of injury than natural grass. They overwhelming reported that the surface feels stiffer, creates more friction, and requires more physical exertion when one plays on it compared to natural grass. Among their responses were descriptive phrases like 'pounds on joints,' 'cleats don't slide,' 'body gets tired faster' and 'running in sand.' Rachel Brady, "FIFA, CSA threatened with lawsuit over turf concerns," in *The Globe and Mail*, 26 September 2014, at http://www.theglobeandmail.com/sports/soccer/lawyers-put-fifa-csa-on-notice-over-artificial-turf-lawsuit/article20805748/ .

A 2012 study from Stanford University found that between 2004 and 2009, NCAA football players experienced a greater number of ACL injuries in games compared with practices, in scrimmages compared with regular practices, and when playing on artificial turf surfaces. Jason L. Dragoo, et al., "Incidence and Risk Factors for Injuries to the Anterior Cruciate Ligament in National Collegiate Athletic Association Football," in *American Journal of Sports Medicine*, vol. 40, no. 5, pp. 990-995 (May 2012), published online before print on 5 April 2012. The data that the study analyzed came from the 2004-2005 through 2008-2009 National Collegiate Athletic Association Injury Surveillance System. http://ajs.sagepub.com/content/40/5/990.abstract .

The 2004 NFL Players Playing Surfaces Opinion Survey found that professional football players preferred grass over synthetic turf. 64.93 % of the respondents said that infill synthetic grass is more likely to contribute to injury. 73.87% of the respondents said that infill synthetic grass causes more soreness and fatigue. 67.11% of the respondents said that infill synthetic grass is more likely to shorten a player's career. 61.19% of the respondents said that infill synthetic grass is more likely to negatively affect the player's quality of life after football. The NFL players also ranked the NFL fields. All of the fields in top 19 fields were natural grass. The survey is available via http://www.synturf.org/images/2006_NFLPA_Players_Playing_Surface_Survey.pdf .

According to the 2008 NFL Players Playing Surfaces Opinion Survey 84.8% of the respondents said artificial infilled turf was more likely to contribute to injury; 91% of

respondents said infilled artificial turf was more likely to cause more soreness and fatigue; 92.6% of the respondents said infilled artificial turf was more likely to shorten career; and 61.6% of the respondents said infilled artificial turf was more likely to impact quality of life after playing days are over. The survey is available via http://www.synturf.org/images/2008_NFLPA_Surface_Survey.pdf .

The 2010 NFL Players Playing Surfaces Opinion Survey found that artificial turf was more likely to contribute to injury, soreness and fatigue, shortened career, and negatively impacting quality of life after football. 82.4% of respondents thought artificial turf was more likely to contribute to injury; 89.1% of respondents thought artificial turf caused more soreness and fatigue; 89.7% of respondents thought artificial turf was more likely to shorten one's career; and 64.4% of respondents thought artificial turf was more likely to negatively affect one's quality of life after football. The survey is available via http://www.synturf.org/images/NFLPA-2010-survey.pdf .

Finally, a 2013 report from the "American Academy of Neurology suggests that concussions are more prevalent on synthetic turfs, in part because improved traction lets athletes accelerate and collide at higher speeds." Jonathan Crowl (*Yahoo! Sports*), "Is Synthetic Turf Giving Athletes Cancer?" at http://www.thepostgame.com/blog/daily-take/201410/synthetic-turf-giving-athletes-cancer-soccer-crumb-rubber-goalie-fields (24 October 2014). The logic is straightforward: greater the acceleration brought about by the superb traction qualities of artificial turf fields the more forceful collision/impact between players, thereby increasing the risk of concussion. According to the Report of the Guideline Development Subcommittee of the AAN, which focused on the factors that increase/decrease concussion risk, "[i]n football, playing on artificial turf is possibly a risk factor for more severe concussions," citing Guskiewicz KM, Weaver NL, Padua DA, Garrett WE Jr.. "Epidemiology of concussion in collegiate and high school football players," in *American Journal of Sports Medicine* 2000: 28:643–650 http://www.ncbi.nlm.nih.gov/pubmed/11032218 . The AAN report stated that a higher rate of concussions was reported in a study of injuries sustained on artificial turf (22%) relative to those sustained on natural grass (9%). The AAN report is available via http://www.synturf.org/images/concussion_guidelines.pdf .

4. Greater Susceptibility To Staph/MRSA & Other Infections

It is an established fact that "some artificial turf fields can create 'rug burns' and may be a potential infestation area for staph." Fox Sports, "NFL teams working hard to stop staph," available at http://msn.foxsports.com/nfl/story/7149542 . The study of the relationship between Staph infection and athletes is nothing new. The following is a review of a few studies and their conclusions.

The CDC report (August 2003) summarized several reported clusters of skin and soft tissue infections associated with MRSA among participants in competitive sports in Colorado, Indiana, Pennsylvania, and Los Angeles County for the years 2000-2003. It identified possible risk factors for infection, for example, physical contact, skin damage, and sharing of equipment or clothing. "The findings underscore[d] 1) the potential for

MRSA infections among sports participants; 2) the need for health-care providers to be aware that skin and soft tissue infections occurring in these settings might be caused by MRSA; and 3) the importance of implementing prevention measures by players, coaches, parents, and school and team administrators." CDC, "Methicillin-resistant staphylococcus aureus infections among competitive sports participants--Colorado, Indiana, Pennsylvania, and Los Angeles County, 2000-2003," in *MMWR Morb Mortal Wkly Rep.,* 2003 August 22; 52(33): 793-795 (Centers for Disease Control and Prevention), available at http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=12931079&ordinalpos=5&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVDocSum.

The Begier Study (October 2004) identified turf burns and body shaving as facilitating Staph infections. It looked at 100 college football payers at a Connecticut college that had reported occurrence of Staph infections to the Connecticut public health department. Among the players, the study identified 10 case patients. It found that player position at cornerback and receiver showed the highest risk of infection, followed by players with abrasions gained from artificial turf burns, followed by infections due to cuts and scrapes associated with body shaving. The study concluded, "MRSA was likely spread predominantly during practice play, with skin breaks facilitating infection. Measures to minimize skin breaks among athletes should be considered, including prevention of turf burns and education regarding the risks of cosmetic body shaving." "Players who'd had turf burns were seven times more likely to get an MRSA infection," the study found. E.M. Begier, et al., Infectious Disease Division, Connecticut Department of Public Health, "A high-morbidity outbreak of methicillin-resistant Staphylococcus aureus among players on a college football team, facilitated by cosmetic body shaving and turf burns," in *Clinical Infectious Diseases*, 2004 November 15; 39(10): 1446-1453 (journal of Infectious Diseases Division, Connecticut Department of Public Health, Hartford), available at http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=15546080&ordinalpos=9&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVDocSum .

The definitive study about the connection of turf burn and Staph infection, however, remains the CDC-Rams Study (2005). In 2003 an outbreak of MRSA among the players on the St. Louis Rams football team prompted the team to ask the CDC to examine the outbreak. In an article published in New England Journal of Medicine in February 2005, the principal researcher of the CDC study, Sophia V. Kazakova, placed the blame for the spread of the infection on turf burns "or areas of skin rendered raw by a run-in with artificial turf as both the source and means of spreading the fast-spreading bacteria that invade the body via cuts in the skin." While the infections were likely to have spread on as well as off the field through rough play and shared towels, whirlpools, and weights, "[t]hese abrasions were usually left uncovered, and when combined with frequent skin-to-skin contact throughout the football season, probably constituted both the source and the vehicle for transmission," according to Kazakova. Kazakova found "the infections occurred at the site of a turf burn and rapidly progressed to large abscesses 5 to 7

centimeters in diameter that required surgery to drain." Kazakova also found "linemen were 10 times more likely to develop the infection than a heavily guarded quarterback or other backfielder; the heavier the linebacker, the greater the risk." S. V. Kazakova, et al., "A Clone of Methicillin-Resistant Staphylococcus aureus among Professional Football Players,*New England Journal of Medicine*, Feb. 3, 2005; vol 352, no. 5, pp 468-75.

The suppliers of antibacterial and antimicrobial products and sanitization systems look at an artificial turf field and see a cesspool of germs. This leads to an interesting body of literature that capitalizes on private pains and public consternation about Staph and other infections. The marketing literature of two such suppliers, TurfAide and AstroShield are discussed at http://www.synturf.org/industrynotes.html (Item No. 3: Disinfecting the fields).

Dr. Philip J. Landrigan is a professor of pediatrics and the chairman of preventive medicine at the Mount Sinai School of Medicine in New York. In a news story, Landrigan cautioned against the health risks that artificial turf surfaces pose to children. He stated, "several medical journals have reported that athletes who fall on synthetic turf are more likely to sustain skin burns that put them at risk of staph infections." Jeff Holz, "Parents Raising Concerns Over Synthetic Turf," The New York Times, October 28, 2007, available at http://www.nytimes.com/2007/10/28/nyregion/nyregionspecial2/28turfwe.html?_r=1&oref=slogin .

5. The Chemicals Of Concern In Crumb (Tire) Rubber: Carcinogens, Neuro-Toxicants, Other Toxins, Heavy Metals, Endocrine Disrupters, Irritants, Etc.

According to a 2007 study by the Connecticut Agricultural Experiment Station, tire crumbs used in synthetic turf athletic fields show significant amounts of four volatile organic compounds that are released into the air when the material is under conditions mimicking a hot summer day. The study says that crumb rubber, from ground-up tires, readily heats up under direct sunlight to temperatures 40 degrees or more hotter than the surrounding air temperatures, so subjecting it to testing in temperatures of up to 140 degrees is reasonable.

The four compounds identified in the study are benzothiazole, hexadecane, 4-(tert-Octyl)-phenol and butylated hyroxyanisole. According to information provided by Environment and Human Health benzothiazole is a skin and eye irritant that can be harmful if swallowed or inhaled. Hexadecane is a carcinogen, while 4-(tert-Octyl)-phenol can cause burns and is "very destructive of mucous membranes," according to the organization. The fourth chemical is an irritant, it said. The information is attributed to the Material Safety Data Sheet for each chemical. Volatile organic compounds are chemicals that release gases into the air that can have short- or long-term health effects, according to the Environmental Protection Agency. Judy Benson, "Study Finds Volatile Organics in Turf Fields," on *TheDay.Com*, August 18, 2007 http://www.theday.com/re.aspx?re=491e8ad8-406e-440d-8670-6f51901cc457 . The experiment station's study can be found at:

www.ct.gov/caes/lib/caes/documents/publications/fact_sheets/examinationofcrumbrubberac005.pdf .

Although many chemicals were found, the four compounds that were conclusively identified with confirmatory tests were benzothiazole; butylated hydroxyanisole; n-hexadecane; and 4-(toctyl) phenol. Approximately two dozen other chemicals were indicated at lower levels. The four chemicals found have the following reported actions:

• Benzothiazole: Skin and eye irritation, harmful if swallowed. There is no available data on cancer, mutagenic toxicity, teratogenic toxicity, or developmental toxicity.

• Butylated hydroxyanisole: Recognized carcinogen, suspected endocrine toxicant, gastrointestinal toxicant, immunotoxicant (adverse effects on the immune system), neurotoxicant (adverse effects on the nervous system), skin and sense-organ toxicant. There is no available data on cancer, mutagenic toxicity, teratogenic toxicity, or developmental toxicity.

• n-hexadecane: severe irritant based on human and animal studies. There is no available data on cancer, mutagenic toxicity, teratogenic toxicity, or developmental toxicity.

• 4-(t-octyl) phenol: corrosive and destructive to mucous membranes. There is no available data on cancer, mutagenic toxicity, teratogenic toxicity, or developmental toxicity.

Source: The Environment and Human health, Inc (North Haven, Connecticut), *Artificial Turf: Exposures to Ground Up Rubber Tires - Athletic Fields, Playgrounds, Garden Mulch* (2007) at http://www.ehhi.org/reports/turf/ .

For a list of chemicals and heavy metals found in tire crumb by the researchers at Rochestarians Against the Misuse of Pesticides (2007), *see Synthetic Turf Chemicals*, (October 2007), first reported on the website of the Institute of Health and the Environment of the State University of New York at Albany as an emerging environmental issue ("Possible Health Effects of Synthetic Turf" http://www.albany.edu/ihe/emerging.htm at http://www.albany.edu/ihe/SyntheticTurfChemicalsdar.htm) and reported also at http://www.nyenvirolaw.org/nyeljp-turf_files/SyntheticTurf%20RAMP%20Sciencecorps%20Site.htm . The document's new url is http://www.albany.edu/ihe/Synthetic_Turf_Chemicals.php (also available also on at http://www.synturf.org/images/RAMP-Synthetic_Turf_Chemicals.pdf).

In an undated document [1997 is the date of the most recent source cited in the document] on the US Environmental Protection Agency's website at http://infohouse.p2ric.org/ref/11/10504/html/intro/openfire.htm (home page at http://www.epa.gov/osw/conserve/materials/tires/fires.htm) (also available at http://www.synturf.org/images/openfire.pdf , EPA states that "[o]pen tire fire emissions include 'criteria' pollutants, such as particulate, carbon monoxide (CO), sulfur oxides

(SOx), nitrogen oxides (NOx), and volatile organic compounds (VOCs). They also include 'non-criteria' hazardous air pollutants, such as polynuclear aromatic hydrocarbons (PAHs), dioxins, furans, hydrogen chloride, benzene, polychlorinated biphenyls (PCBs); and metals, such as arsenic, cadmium, nickel, zinc, mercury, chromium and vanadium." With thanks to Environment and Human Health Inc. for bringing this document to our attention, here is the list of the substances identified by the EPA as carcinogens: Acenaphthene, Acenaphthylene, Arsenic, Benz(a)anthracene, Benzene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzylchloride, Butadiene, Carbon tetrachloride, Chloroform, Chromium, Chrysene, Coal tar pitch (volatile), 1,2-Dichloropropane, Dibenz(a,b)anthracene, Ethylene dichloride, Hexachloroethane, Lead, Methylene chloride, Nickel, Phenol, Styrene, 1,1,2-Trichloroethane, and Trichloroethylene. To the aforelisted alphabet soup of carcinogens one should add also ortho-Toluidine. *See* http://www.synturf.org/crumbrubber.html (Item No. 35, SynTurf.org's Note). *See* Centers for Disease Control and Prevention (CDC), "Tire and Rubber Company (2) (o-Toluidine Exposure," in *NIOSH* [National Institute for Occupational Safety and Health] *Publications and Products* at http://www.cdc.gov/niosh/pgms/worknotify/O-toluidine.html (1990) updated 13 July 2012 and further reviewed 3 February 2014).

According to the EPA "Data from a laboratory test program have also shown that open tire fire emissions contain 16 times more mutagenic compounds than from residential wood combustion in a fireplace, and 13,000 times more mutagenic compounds than coal-fired utility emissions with good combustion efficiency and add-on controls. The emissions from an open tire fire can pose significant short-term and long-term health hazards to nearby persons (e.g. firefighters, residents, etc.). These health effects include irritation of the skin, eyes, and mucous membranes, respiratory effects, central nervous system depression, and cancer."

6. Application Of The Precautionary Principle

When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context the proponent of an activity, rather than the public, should bear the burden of proof. The process of applying the precautionary principle must be open, informed and democratic and must include potentially affected parties. It must also involve an examination of the full range of alternatives, including no action.

A major 2014 European study has called for precautionary actions on the assessment of chemical mixtures even in cases where individual toxicants are present at seemingly harmless concentrations. The study is entitled "Mixtures of Chemical Pollutants at European Legislation Safety Concentrations: How Safe Are They?" and was published first in the journal of the Society of Toxicology Toxicological Sciences (*Toxicol Sci.*) on 23 June 2014. The abstract of the study is available at http://toxsci.oxfordjournals.org/content/early/2014/06/23/toxsci.kfu118.abstract?sid=f1b957ac-a4c8-4148-8e67-bd028614b06e and a shorter version at

http://toxsci.oxfordjournals.org/content/early/2014/06/23/toxsci.kfu118.short .

The authors of the study are Raquel Negrão Carvalho and eighteen other researches represented such institutions as the European Commission's DG Joint Research Centre, Institute for Environment and Sustainability; Norwegian University of Science & Technology; National Institute for Industrial Environment and Risks (France); Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA) in Italy; Technical University of Denmark (Department of Environmental Engineering); Institute of Life Sciences, The Hebrew University of Jerusalem, Israel; Masaryk University, Faculty of Science, RECETOX, Czech Republic; Analytical and Environmental Sciences Division, King's College London; Marine Biology Station Piran - National Institute of Biology, Slovenia; University of Natural Resources and Life Sciences, Vienna, Austria; Diabetes and Nutritional Sciences Division, King's College London; National Institute of Nutrition and Seafood Research, Bergen, Norway; Life Science Center, Örebro University, Sweden; Eawag, Swiss Federal Institute of Aquatic Science and Technology; Swiss Centre for Applied Ecotoxicology; Swiss Federal Institute of Aquatic Science and Technology; Swiss Federal Institute of Technology, Department of Environmental Systems Science; EPF Lausanne, School of Architecture, Civil and Environmental Engineering, Switzerland; Department of Environmental and Life Sciences, Università del Piemonte Orientale Vercelli Novara Alessandria, Alessandria, Italy.

According to the abstract of the study: "The risk posed by complex chemical mixtures in the environment to wildlife and humans is increasingly debated, but has been rarely tested under environmentally relevant scenarios. To address this issue, two mixtures of 14 or 19 substances of concern (pesticides, pharmaceuticals, heavy metals, polyaromatic hydrocarbons, a surfactant and a plasticizer), each present at its safety limit concentration imposed by the European legislation, were prepared and tested for their toxic effects."

"The effects of the mixtures were assessed in 35 bioassays, based on eleven organisms representing different trophic levels. A consortium of 16 laboratories was involved in performing the bioassays. The mixtures elicited quantifiable toxic effects on some of the test systems employed, including i) changes in marine microbial composition, ii) microalgae toxicity iii) immobilization in the crustacean Daphnia magna, iii) fish embryo toxicity, iv) impaired frog embryo development and v) increased expression on oxidative stress-linked reporter genes. Estrogenic activity close to regulatory safety limit concentrations was uncovered by receptor-binding assays. The results highlight the need of precautionary actions on the assessment of chemical mixtures even in cases where individual toxicants are present at seemingly harmless concentrations."

Many of the compounds studied are present in artificial turf systems as they are also part of the tire and plastic products used in them. Players are exposed to the dust from these compounds, and more. What needs to be addressed as well is long term chronic vs. immediate acute toxicity.

7. Problem With Pro-Turf Studies

David Brown, who is a public health toxicologist and Director of Public Health Toxicology for Environment and Human Health, Inc (www.ehhi.org) (EHHI) in North Haven, Connecticut, told *SoccerWire.com* (14 October 2014) that he "was not surprised when he read the recent NBC News report alleging links between artificial grass surfaces and cancer." Tim Froh, "Former CDC toxicologist unsurprised by alleged link between artificial turf, cancer," on *SoccerWire.com*, 14 October 2014, at http://www.soccerwire.com/news/a-level-of-risk-former-cdc-toxicologist-unsurprised-by-alleged-link-between-artificial-turf-cancer/ .

According to Brown, "[t]he primary weakness[ ] in the existing [pro-turf] literature is that they did not identify the compounds that were present. They reached several conclusions that I thought were not supported by the literature. They assumed that all the products are exactly the same. When actually, depending on what the rubber was designed for in its original form, it had differing amounts of various chemicals, particularly some carcinogenic chemicals that had been put into the crumb rubber. We know that about a third of the tires have high levels of oils that are called poly[cyclic] aromatic oils, that are in them." Brown also believes that while most researchers and industry experts acknowledge the presence of known carcinogens in rubber tire crumbs, no long-term studies have been conducted on these carcinogens and the effects of sustained and consistent exposure to them.

According to Brown, as reported by *SoccerWire*, most of the major studies have downplayed the possible pathways for human exposure to the carcinogens in rubber tire crumbs. "I thought there was a really strong dermal pathway, where [users] would get it on their hands, and then wipe or put their hands in their mouths," he said. "There's also a strong air pathway that's there." Users come into frequent contact with the tire crumbs, whether from dives, tackles or kicks. These crumbs can cover multiple surfaces, including skin, hair and shoes. Sustained exposure to crumb rubber could have serious long-term health consequences, NBC News' report suggested, and children may be at greatest risk. In a 2005 paper assessing susceptibility to cancer from early-life exposure to carcinogens, the Environmental Protection Agency found several reasons why children are more susceptible to certain kinds of cancers. These include more frequent cell division, certain cells' lack of key DNA repair enzymes, an immune system that's not fully developed, and hormonal systems that operate at different levels at different life stages.

"The nature of cancer – what happens physiologically – is that the cell nucleus is changed a bit when the carcinogen gets in there," Brown explained." But then it can repair itself if it doesn't divide." "If the cell is there and the nucleus is changed, the nucleus can repair itself, but it takes about three or four days for that to happen in an adult. It takes about four or five hours for it to happen in a child because they're growing so much faster." Brown supports a more cautious approach to the use of fields utilizing crumb rubber. There isn't enough content there to answer [the cancer question]," he said. "[Artificial-turf advocates] are deluding themselves."

When asked what advice he would give parents thinking of letting their children play on turf fields, Brown was adamant. “My basic advice is, don’t do it,” he replied. “I think they would have to understand that there is a level of risk that the child is incurring.”
In the absence of conclusive long-term studies on the known carcinogens found in some artificial turf fields, Brown believes it’s better to be safe than sorry. “If I had to make recommendations, I would never have a soccer goalie practice on the turf fields. Play on it, but not practice on it. The very young children, I’d get them off those fields,” Brown told *SoccerWire.com*.

The artificial turf industry cites some 16 studies that, as they say, conclude that artificial turf is safe to play on. In a recent communication to EHHI’s distribution list, Brown provided a list of questions to be asked as a “Response to synthetic turf studies and literature review summaries:” (1) Does the study have sufficient analytical power to detect exposures? (2) Is this study based on original analytical data or secondary source data? (3) the findings and conclusions supported by the factual information? In order to assess a health risk such as cancer, neurotoxicity, or respiratory actions it is necessary to know (1) Chemicals present in the product; (2) The mechanisms of transfer to humans; and (3) The amount that could enter the blood and bioaccumulate.

One example of an inadequate study that then results in misleading or inaccurate conclusions is the study by Environmental and Occupational Health Studies Institute in New Jersey, which is funded by the New Jersey Department of Environmental Protection, Recycling Program and Planning. They tested seven fields, each with sample sizes of less than a gram (200 mg). When the authors detected no VOCs, it was concluded that there is no potential exposure to a regulated VOC. “The sensitivity of the study,” Brown states “would be considered low at best but the Connecticut Experiment Station has clearly shown a series of VOCs using only water as a solvent.” According to Brown, “[t]he inhaled and ingested exposure levels [is] far beyond 1 gram. It is also well known that many of the chemicals of concern do not have regulatory standards. “The authors do note some limitations to their study in the body of the report,” he noted.

“General studies lack the sensitivity or the exposure durations to achieve these minimal goals,” according to Brown. “Thus one finds the language used in their summaries become, for example, ‘'no evidence was found etc.’. “The overwhelming facts are,” Brown wrote, “there has not been any investigation by the industry or government that completely determine the array of chemicals in or on a turf field.” “Nor can there be because the industry does not have quality control procedures,” he noted. “With 4,000 ground up rubber tires in each field—who knows where each tire has come from.”

According to Brown, “[n]o organization has assessed the health of players on these fields. That question is asked by nearly every community considering the fields. The typical answer is: ‘many reports have found nothing to be concerned about.’ But it is known that there are carcinogens and other toxic materials in the crumb rubber and possibly other infills, that children ingest the crumbs, track them into school rooms,

school bused, private cars and homes. Thus there are exposures across the country and no effort to determine what it means."

Brown has put forth an outline of the absolute minimum data that is needed to determine whether a synthetic turf field is safe or not. That would be: (1) Complete chemical analysis of content of the crumb rubber used in each field; (2) Quantification of all known carcinogenic chemicals, respiratory toxins and neurotoxins; (3) Identification of chemicals of unknown or untested toxicity; (4) Determination of residence times of each of the ingested chemicals in the body; (5) Determination of rates of dispersion from fields to school rooms, locker rooms and vehicles and residences; and (6) Maximum hourly exposure to participants on the fields. While no study has established direct link between playing in crumb rubber and cancer or other harm, Brown points out that it has been established that substantial human exposure occurs when playing on turf fields. Therefore there are exposures to carcinogens, neurotoxins and respiratory toxins. "Cancer risks are present," he notes "and cancer is a plausible outcome. The cancer cluster that has been observed in 38 children who have played extensively on synthetic turf fields is plausibly associated with their exposures from those fields." "Finally," he notes, "there is no attempt to follow-up on the health status of persons who have been exposed to the crumb rubber by any Federal, State or Private entity. There is no collection of either cancer or asthma data of those who have been exposed on those fields over a period of time."

On the question of increased concern about cancer patterns in synthetic turf fields, Brown believes that when one looks at the cancers that the soccer goalies who played on synthetic field are getting - most of the cancers are lymphomas. Lymphomas are cancers that are heavily influenced by environmental factors. The infill of synthetic turf fields is made up of ground up rubber tires that contain many carcinogenic compounds. Scientist understand today, that when a population that is exposed in a particular setting comes down with one type of cancer it is often caused by an exposure to a specific group of chemical carcinogens that are in that particular environment. The presence of a single type of tumor, or cancer, rather than the normal distribution of cancers expected in the overall population of that age group, is in itself an indication that the affected population is being exposed to the same chemical carcinogens.

The number of lymphomas in the population of athletes who played on synthetic turf collected by [soccer coach] Amy Griffin is much higher than would be normally expected. This suggests that the athletes who have come down with lymphomas and have played on synthetic turf for years, may have all been exposed to the same chemical carcinogens just like those found in rubber tire infill. Among the distribution of lymphomas in 15 to 19 year olds who are treated for cancer nationally, 13.5% for Hodgkin's lymphoma, 8.3% for non-Hodgkin's Lymphoma; and 1.1% for Burkitt's Lymphoma according to EPA's "America's Children and the Environment" http://www.epa.gov/ace/publications/ace_2003.pdf . The percentage of lymphomas in the population of athletes who played on synthetic turf collected by Amy Griffin [38 U.S. soccer players with blood cancers, including 34 goalkeepers] is much higher than this.

According to Nancy Alderman, President of EHHI, "[w]hile we have been focused on the health risks to children and athletes who play on synthetic turf fields," she says, "we just heard form a person who runs a company that maintains synthetic turf fields. He and his men are getting sick. This is what is happening to them: They are having respiratory problems and chest restrictions; when they blow their noses black mucous comes out; they are getting cuticle infections from touching the fields; they are getting headaches and watering eyes; the hotter the fields the worse the symptoms; the dryer the fields the worse the symptoms; and they are very worried." "These symptoms correspond to the chemicals that are found in rubber tires; this is another whole group of people being made sick by synthetic turf fields; this is extremely serious …. We must think about the continual exposures that students are NOW being subjected to. (1) First a toddler plays on a playground covered with rubber tire playground mulch. (2) Then that child—s till healthy—goes off to a grammar school where they might—or they might not—have a synthetic turf field filled with rubber tire crumb infill that the child plays on. (3) Then the child, now older, goes to high school where they very well might have a synthetic field that he or she will play on. (4) Then the student, goes to college, and if an athlete, will play on synthetic turf fields with rubber tire infill. These exposures are now for far longer periods of time than the college students who are now getting sick were exposed -- as they probably did not have playgrounds with rubber mulch in them -- and might not have had grammar schools with rubber tire infill. The point being—things can get a lot worse," says Alderman.

In view of the foregoing, EHHi — www.ehhi.org — has formulated talking points for those involved in discussing artificial turf installations, particularly when it comes to be relevant to children's health and well-being:

<u>When towns and schools think about whether they should install a synthetic turf field—what should they know and what should they ask?</u>

(1)What scientific evidence has already been established about children and toxins?

(a) Children, pregnant women and fetuses, have unique susceptibilities and vulnerabilities to chemical exposures.

(b) Children are quantitatively and qualitatively different from adults in their sensitivities. Examples of this are: the relationship of toxic exposures to children's small body weight, children are closer to the ground than adults and therefore often closer to toxic exposures, children often have more hand to mouth activity, and small children breathe faster than adults, thus taking in toxins at a faster rate.

(c) There is an association of chemical exposures to a variety of neuro-developmental disabilities and disorders, as well as other chronic diseases affecting children such as asthma and certain cancers.

(2) What questions should be asked before synthetic fields are installed in a school or a town?

(a) What chemicals will be in the complete product, including the synthetic grass-like blades and the infill?

(b) What chemicals will be used to maintain the fields—disinfectants, fire retardants, etc.?

(c) What other ingredients will be in—or used—to maintain the fields ?

(d) What is the probability that meaningful exposures to these chemicals will occur—and that they could cause adverse acute and chronic outcomes in user populations?

(e) Knowing that some vulnerable and susceptible populations will use the fields, and these include asthmatics, those sensitive to latex, pregnant women with their fetuses, infants, children, those with respiratory disease, those with allergies, those with neuro-disabilities and those with, or surviving, cancer—what will be their risks?

(f) What are the exposures that could take place not only on the field, but to those near the field, and what are the possibilities that toxins could be transferred into the environment beyond the field—such as run-off from water that has been washed off from the field. As well, many children who play on synthetic turf fields with ground up rubber inflll bring some of the infill home and cars on their shoes and their clothes.

(3) What is the level of uncertainty in the decision-making process when thinking about whether to install a synthetic turf field:

(a) Without knowing the exact chemical profile of the synthetic turf field and its maintenance requirements, determination of risk will be constrained—and uncertainty will prevail.

(b) Making a decision with such uncertainty—because of the possibility of hazardous risk to large number of sensitive populations—is tantamount to sanctioning an uncontrolled experiment on students and town residents using the synthetic turf fields.

(c) Before a complete decision can be made, more information is needed to reduce uncertainty and to minimize the possibility of unwarranted risk.

8. The Economics Of Acquisition, Maintenance & Replacement

The selling of an artificial turf system invariably is accompanied by assurances that over time the capital-intensive and expensive field installation will pay for itself mostly from savings occasioned by not spending money on maintenance of grass fields. In making the

point, the purveyors of artificial turf fields and their political allies inflate the cost of maintenance of grass fields and lowball the cost of maintaining an artificial turf surface.

The following *Frobes.com* article—also accessible via http://www.synturf.org/process.html (Item No. 68) -- accurately describes the myth of artificial turf's "lower" cost.

> Mike Ozanian (Sports Money), "How Taxpayers Get Fooled On The Cost Of An Artificial Turf Field" on *Forbes.com*, 28 September 2014, at http://www.forbes.com/sites/mikeozanian/2014/09/28/how-taxpayers-get-fooled-on-the-cost-of-an-artificial-turf-field/ — excerpts
>
> "So why are some municipalities still spending big bucks to install artificial turf fields? Main reason: taxpayers have been getting hoodwinked by bogus analysis into thinking artificial turf fields are cheaper than natural grass.
>
> "But the reality is that non-partisan studies have shown the exact opposite–natural grass fields are a bargain compared to artificial turf due to the huge costs taxpayers get stuck with to maintain and replace artificial fields after their warrantees expire. One of the artificial turf industry's selling points is that an artificial turf field will last eight-to-10 years, even though the usual warranty runs for only eight, and that the initial exorbitant cost of installation is recouped in no time from tens of thousands in savings from no longer maintaining a natural grass field. Another way proponents of artificial turf skew the math in their favor is by saying many more events will be held on the field once artificial turf is installed, thereby lowering "the cost per event" on the field relative to natural grass. But who knows if that math is based on reality …
>
> "Indeed, the Australian government did a comprehensive study dispelling the myth trumpeted by some politicians and artificial turf makers that artificial turf fields cost less than natural grass in the long term due to lower expenses for upkeep. But the politicians keep coming up with creative ways to fool the taxpayers into thinking they are going to save money in the long run with artificial turf.
>
> "For example, [the] … chart from a report done by Montgomery County [inset not reproduced here] looking at the cost of a natural grass field versus an artificial turf field. Notice that over 20 years the artificial field is 49% more expensive than the grass field (assuming the most expensive natural grass is used). Then, presto! Towards the bottom of the chart the number of hours the artificial turf field is used is doubled to twice the use of the natural grass field, thus based on "cost per hours of use" projections the artificial field is now cheaper. This type of math reminds me of the guy who went to a sale at a store determined to buy enough items on sale so that his he would "save" enough to pay for everything.

> "The fallacy in all this has to do with the concept of "saving" from maintenance of natural grass fields. Even if the budget shows an amount for the maintenance of a natural grass field, the chances are that the amount is not spent on the field. Tax revenue is fungible. Anyone who claims that there are "savings" needs to show how much in reality has been spent on the field in any given fiscal year going back ten years. What this also does not tell is that the savings, assuming there is any real savings, pays only for the initial installation; the savings do not pay for the replacement of the field in eight to 10 years, or perhaps longer."

Brad Fresenburg is a turf grass specialists at the University of Missouri extension in Coloubia, Missouri. According to him artificial turf is looking more and more like a bad idea. It costs $700,000 to $760,000 to install. Despite popular belief, artificial turf fields cost as much or more to maintain than natural grass fields. Several universities, including the University of Arkansas and the Michigan State University, found in 2009 that it is a myth that synthetic fields require less maintenance than natural turf grass fields. Without the need to replace artificial turf every 8 to 10 years, Michigan State University's certified sports turf managers said in 2009 the typical annual maintenance costs of artificial turf fields there ranged from $13,720 to $39,220. Artificial fields require additional infill, disinfectants and sprays to reduce odors and static cling, and removal of organic matter. You can't even eliminate irrigation from artificial fields because they need it to reduce the temperature of the field on warm, sunny days.

If you include the cost of replacing the field every 8 to 10 years, maintenance cost jumps to $65,000 to $110,000, depending on whether you have a basic or premium field. Just to dispose of the old, worn out field costs $130,000 plus transportation and landfill charges. A basic synthetic field costs roughly $600,000 initially and have an estimated $5,000 annual maintenance budget, Fresenburg's study found in 2012. A premium artificial turf installation was estimated to cost $1 million, plus $20,000 annually for maintenance. In contrast, natural grass, soil-based field like the ones we have now cost about $33,522 annually; although it can be maintained on a budget of $25,000. Ryan D. Wilson, "Grass not cheaper on the artificial side," 8 September 2014 at http://www.ccenterdispatch.com/opinion/article_f36e8394-379f-11e4-8d0f-0017a43b2370.html . *See also* http://cafnr.missouri.edu/research/turfgrass-costs.php .

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Dated: 30 January 2015