




 State of Connecticut


 Governor Dannel P. Malloy |

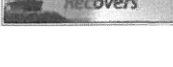
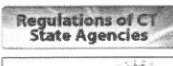

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Risk Assessment of Artificial Turf Fields

In response to public interest and concern, four state agencies, the University of Connecticut Health Center (UCHC), The Connecticut Agricultural Experiment Station (CAES), the Department of Public Health (DPH) and the Connecticut Department of Environmental Protection (DEP) completed a two-year comprehensive evaluation of the health and environmental impacts associated with artificial turf fields containing crumb rubber infill. The reports generated by each agency were peer reviewed by the Connecticut Academy of Science and Engineering (CASE) whose comments were incorporated into the final report.

The Final Report is a compilation of the separate state agency reports listed in the table below. The table includes links to each report component and identifies the main areas of study responsibility for each of these participating agencies.

Agency	Activity	Methods
UCHC	Human exposure field investigation Report	Measured air concentrations of approximately 200 chemicals at five fields during active play.
DPH	Human health risk assessment Report	Convert air concentrations measured by UCHC to the level of health risk to users of the fields from inhaling emitted chemicals.
CAES	Laboratory study Report	Measured offgassing and leaching of chemicals from crumb rubber and select alternative infill materials under defined laboratory conditions.
DEP	Environmental field investigation Summary/Report	Measured leaching of metals from fields during rain events.
CASE	Document review Report	Assembled nine member expert panel to review all aspects of the State of CT reports on artificial turf fields.

[July 30, 2010 Press Release on Result of State Artificial Turf Fields Study](#)

[January 2, 2009 Press Release on Study of Artificial Turf Fields](#)

Overall Executive Summary

Questions have been raised about possible exposures when playing sports on artificial turf fields cushioned with crumb rubber infill. Rubber is a complex mixture of various chemicals with some having toxic and carcinogenic properties. Exposure is possible, primarily via inhalation, given that chemicals emitted from rubber can end up in the breathing zone of players and these players have high ventilation rates. Rainwater may leach chemicals from the rubber into underlying groundwater or nearby streams.

Previous studies from Europe and the United States provide useful data but are limited particularly with respect to the variety of fields and scenarios evaluated. The current investigation involved air sampling at 1 indoor and 4 outdoor artificial turf fields under summer conditions in Connecticut. The main goal of that sampling was to document air concentrations of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), rubber-related chemicals (e.g. benzothiazole), and particulate matter less than 10 micron (PM10) at these fields under conditions of active use. These data were then used in a human health risk assessment that focused on children or adults using these fields. In companion studies, offgas studies were performed in two separate laboratories (Connecticut Agricultural Experiment Station; Wisconsin Occupational Health Laboratory) to evaluate the range of chemicals that could volatilize from crumb rubber from these fields at elevated temperature. Chemical migration in runoff from the outdoor fields was evaluated by collecting leachate in association with rain events. These reports were reviewed by the Connecticut Academy of Science and Engineering (CASE) and these comments were incorporated into the final report.

The laboratory studies showed offgassing of numerous compounds including polycyclic aromatic hydrocarbons (particularly naphthalenes), VOCs (e.g., benzene, hexane, methylene chloride, styrene, toluene), and rubber-related SVOCs (benzothiazole, tert-octylphenol, butylated hydroxytoluene). The primary constituent detected by both laboratories was benzothiazole. Pre-weathering the crumb rubber outdoors for ten weeks decreased the volatile emissions 20-80%.

The field investigation detected a variety of compounds that were present above the fields at concentrations greater than the range seen in background samples. Based upon the pattern of detection, it is considered likely that benzothiazole, acetone, toluene, methyl ethyl ketone, methyl isobutyl ketone, butylated hydroxytoluene, naphthalenes and several other PAHs were field-related, with other detected chemicals less certain to be field related. For example, benzene, methylene chloride, methyl chloride and acrolein were



detected only in personal monitoring samples and not in the stationary samplers placed just above the field. This suggests that sampling equipment or host exhaled breath may be a source of some of these VOCs. In general, detections were higher at the one indoor field compared to the outdoor fields, in some cases (e.g., benzothiazole), more than 10 times higher. Testing for volatile nitrosamines and PM10 failed to find detections above background while detections of lead in crumb rubber and grass blades were below well accepted criteria.

The risk assessment considered compounds detected above background as potentially field-related unless they were not detected on turf fields in the current or previous studies or in the offgas studies (e.g., acrolein). This led to a list of 27 chemicals of potential concern (COPCs) on both indoor and outdoor fields. These COPCs were entered into separate risk assessments for outdoor and indoor fields and for children and adults. Exposure concentrations were pro-rated for time spent away from the fields and inhalation rates were adjusted for play activity and for children's greater ventilation than adults. Toxicity values (cancer unit risks, RfCs, acute targets) were taken from national databases or derived by CT DPH. The risk assessment represents a screening analysis in which high end assumptions were used including the use of the maximum detect found at any field across all chemicals, assessing risks for benzene and methylene chloride even though they were only detected in the personal monitors and thus may not be coming from the fields, and the use of sunny low wind conditions to represent every day of playing. A screening level risk assessment is used to determine whether there is the potential for elevated risks under worst case assumptions. If risks are not elevated, no further analysis is needed.

Results indicate that in spite of worst case assumptions, cancer risks were only slightly above de minimis levels for all scenarios evaluated. This includes children playing indoors, the scenario with the highest exposure. These risks are well within typical risk levels in the community from ambient pollution sources and are below target risks associated with many air toxics regulatory programs. Further, the main cancer risk driver, benzene, was only above background in personal monitoring samples. Chronic non-cancer risks were not elevated above a Hazard Index of 1. The Hazard Index for acute risk was also not elevated above 1 but was close to 1 for children playing at the indoor field. The main contributor to this Hazard Index was benzothiazole, a rubber-related SVOC. This presents an uncertainty regarding the potential for benzothiazole and other volatile irritants to create a slight irritation response in sensitive individuals playing indoors.

Based upon these findings, outdoor and indoor artificial turf fields are not associated with elevated health risks from the inhalation of volatile or particle-bound chemicals. However, it would be prudent for building operators to provide adequate ventilation to prevent a buildup of rubber-related VOCs and SVOCs at indoor fields. New indoor fields should consider alternatives to crumb rubber infill as a cushioning agent.

A total of eight stormwater samples were collected from three synthetic turf fields and analyzed for total metals, hardness, pH, volatile organic compounds, semi-volatile organic compounds, pesticides/polychlorinated biphenyls (PCBs) and acute aquatic toxicity (48 hours for *Daphnia pulex* and 96 hours for *Pimephales promelas*). The sampling analysis detected various metals and semi-volatile compounds in the stormwater, with three samples exhibiting acute toxicity for both *Daphnia pulex* and *Pimephales promelas*. The only analyte in the stormwater detected in concentrations exceeding acute aquatic toxicity criteria for surface waters was zinc. Zinc exceedences of the acute criteria were detected in the same three stormwater samples that exhibited acute toxicity for both *Daphnia pulex* and *Pimephales promelas*. These results showed that there is a potential risk to surface waters and aquatic organisms associated with whole effluent and zinc toxicity of stormwater runoff from artificial turf fields.

The CASE review found 1) the cancer risks calculated by DPH may have been overestimates because of the inclusion of benzene detections that are likely not coming from the playing field but from the players themselves; 2) uncertainty with respect to the benzothiazole risk assessment since so little toxicology data are available for benzothiazole; and 3) the potential for allergic reactions to occur due to the presence of latex antigen in natural rubber. To address these comments, the risk assessment describes the issues and finds that they do not change the overall conclusions and are unlikely to present added risk. However, we cannot rule out the possibility for certain individuals to be sensitive to allergens present in crumb rubber; if allergic reactions occur, this should be reported to the family physician and the local health department. The CASE review agreed that zinc concentrations in the stormwater generated from artificial turf fields in the Study posed a potential environmental risk.

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