State of New Jersey
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF SCIENCE AND RESEARCH
428 East State Street
P.O. Box 420, Mail Code 428-01
Trenton, New Jersey 08625-0420
Tel. (609) 940-4080 • Fax (609) 292-7340
www.nj.gov/dep

PHILIP D. MURPHY
Governor

SHEILA Y. OLIVER
Lt. Governor

CATHERINE R. McCABE
Commissioner

TO: Martha Sullivan Sapp, Director
Green Acres Program

THROUGH: Gary A. Buchanan, Ph.D., Director GB
Division of Science and Research

FROM: Brian Pachkowski, Ph.D., Research Scientist 1 BP

DATE: 09/22/2020

SUBJECT: The Safety of Artificial Turf Fields

Executive Summary

This memorandum is written in response to a request from the Green Acres Program to the Division of Science and Research (DSR) regarding the safety of artificial turf fields. This memorandum specifically focuses on human exposure and human health aspects from chemical constituents of artificial turf fields.

Human health concerns with artificial turf fields typically focus on the crumb rubber infill, which is composed of recycled tires that can contain metals and organic compounds. Additionally, there is concern that chemicals can be adsorbed either by the tires prior to recycling during use on the road or by the installed crumb rubber from the air or dust. The dyes used to color the synthetic grass may also be a source of exposure to metals.

A number of research efforts in New Jersey and at the federal level have aimed to understand the human health risk to artificial turf fields[1]. By 2011, DSR research on artificial turf fields demonstrated the presence of substances (metals, organic compounds, polycyclic aromatic hydrocarbons) in artificial turf fields at such low concentrations that human exposure is minimal. These efforts suggest that artificial turf fields do not likely represent a risk to human health. Recently, the USEPA also stated that "while many chemicals are present in the recycled tire crumb rubber, exposure may be limited based on what is released into air or biological fluids." Studies by the National Toxicology Program (NTP) further revealed that oral ingestion of crumb rubber by mice resulted in no appreciable systemic exposure to the chemical constituents of this

[1] Appendix 1 provides a brief summary of research previously conducted by the state of New Jersey as well as more recent research by other federal, state, or academic entities.

material and typically no biologically significant changes in a number of traditional toxicological endpoints.

As risk is a function of hazard and exposure, artificial turf and crumb rubber does not appear to be a human health risk based on existing data. However, the available research to date does not definitively conclude whether exposure to artificial turf and crumb rubber is a risk to human health. Future research may ultimately provide a more definitive conclusion about the risk of artificial turf and crumb rubber to human health.

Appendix 1: Summary of artificial turf research

Previous research on artificial turf fields by the state of New Jersey

In 2008, the New Jersey Department of Health and Senior Services (NJDHSS, 2008a; 2008b; 2008c) reported on its investigation of artificial turf fields in the state. In part, this research found elevated levels of lead in 2 of 12 artificial turf fields sampled in New Jersey. The presence of lead was attributed to the nylon fibers used in these 2 fields[2].

By 2011, DSR had participated in 3 distinct research efforts on artificial turf fields (NJDEP, 2007; 2011a; 2011b; 2011c). This research has demonstrated the presence of substances (metals, organic compounds, polycyclic aromatic hydrocarbons) in artificial turf fields capable of being a hazard to human health. However, these studies have also demonstrated that these substances appear to occur at such low concentrations that human exposure is minimal (NJDEP, 2011a; 2011b; 2011c). Although based on information available in 2007, DSR had previously concluded that "there was no obvious toxicological concern raised that crumb rubber in its intended outdoor use on playgrounds and playing fields would cause adverse health effects in the normal population" (NJDEP, 2007). Together, these efforts by DSR and its collaborators suggest that artificial turf fields do not likely represent a risk to human health. Since 2011, DSR has not conducted any additional research on artificial turf fields, although the results from NJDEP (2011c) were published in the peer-reviewed journal article by Pavilonis et al. (2014).

Literature search

DSR requested that the Department's Environmental Research Library (ERL) conduct a literature search in September 2020 aimed at finding scientific studies focusing on human exposure and human health effects from artificial turf fields published on or after 2011. Over 50 peer-reviewed journal articles or other reports were identified. Of these, a 2019 report by the US Environmental Protection Agency (USEPA, 2019a; 2019b) contains a comprehensive review of the scientific literature regarding exposures and risks for tire crumb rubber used in synthetic turf fields and playgrounds. As this USEPA review contains many of the studies identified from the ERL literature search, the 2019 USEPA report will serve as the basis of the discussion below.

Recent research on artificial turf fields

In February 2016, the federal government launched a multi-agency research effort, known as the Federal Research Action Plan on Recycled Tire Crumb Used on Playing Fields and Playgrounds (FRAP[3]). Participating agencies include the USEPA, Centers for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry (CDC/ATSDR), and the Consumer Product Safety Commission (CPSC). The goal of this research is to characterize potential human exposures to the substances associated with recycled tire crumb rubber used on synthetic turf fields.

[2] Levels of lead in these 2 fields were 3,400 and 4,100 mg of lead per kg of turf fiber. As noted by the NJDHSS (2008a; 2008b; 2008c), there is no standard for lead in artificial turf. For comparative purposes, the NJDHSS reported that the NJDEP residential direct contact soil cleanup criteria for lead is 400 mg of lead per kg of soil.
[3] https://www.epa.gov/chemical-research/federal-research-recycled-tire-crumb-used-playing-fields

In July 2019, the USEPA released Part 1 of the research (in two volumes), which reports on research characterizing the composition of tire crumb rubber (USEPA, 2019a; 2019b). Part 2 of this research, which is to be released at a later date, will report on research characterizing potential human exposures to chemicals in tire crumb rubber. Part 2 is expected to include results from a biomonitoring study being conducted by CDC/ATSDR to investigate potential exposure to substances in tire crumb rubber[4].

The 2019 USEPA report (USEPA, 2019a; 2019b) presents the results for field sampling and laboratory measurements as well as literature-based research conducted by the FRAP agencies. Specifically, this research characterized the components of, and emissions from, recycled tire crumb rubber obtained from 40 synthetic turf fields and 9 tire recycling plants from across the US. Results from these analyses were comparable to those from previous scientific reports with regards to the qualitative and quantitative range of metals (e.g., arsenic, chromium, lead) and organic chemicals (e.g., semivolative and volatile organic compounds) detected[5], the low emissions of many organic chemicals from crumb rubber, and the low release of metals from crumb rubber into simulated biological fluids. Based on these data, the USEPA stated that "these findings support the premise that while many chemicals are present in the recycled tire crumb rubber, exposure may be limited based on what is released into air or biological fluids."

In addition to characterizing crumb rubber, the FRAP agencies conducted a state-of-the-science literature review and gap analysis (Appendix C of USEPA, 2019b). This review did not critically assess the strength and weaknesses of identified studies but rather provided the study authors' conclusions regarding their research. For the approximately 40 studies that were relevant to human health risks associated with the use of crumb rubber in artificial turf fields or other applications, the USEPA report stated that "many of the studies indicated that risks to human were minimal, others suggested that potential risks exist and should be further explored."

Although not fully reviewed in the 2019 USEPA report (2019a; 2019b), a series of studies by the National Toxicology Program (NTP) focused on characterizing the chemical and physical properties of crumb rubber and the potential for health effects[6]. One of these NTP studies is a first of the kind exposure in laboratory animals (specifically female mice) aimed at determining whether short-term (14-day) exposure to crumb rubber leads to systemic exposure[7] to crumb rubber constituents and resulting toxicity (NTP, 2019). This study found that oral exposure to crumb rubber resulted in no appreciable systemic exposure to the chemical constituents of this material and typically no biologically significant changes in a number of traditional toxicological endpoints (e.g., survival, food consumption, body and organ weights, histopathological lesions, hematological parameters, and bone marrow cytology).

---

[4] The biomonitoring study was scheduled to begin during the Spring of 2020. However, due to COVID-19, this study has been temporarily postponed. Additional details of the biomonitoring study can be found here: https://www.atsdr.cdc.gov/frap/biomonitoring_study.html

[5] Quantitative information for 21 metals, 49 semivolative organic compounds, and 31 volatile compounds can be found in the 2019 USEPA report (2019a; 2019b).

[6] In addition to the laboratory animal study reviewed here, an overview of the NTP research on synthetic turf and crumb rubber and the research reports for 3 other studies focused on either crumb rubber characterization, *in vitro* (cell-based) toxicity testing, or the feasibility of different exposure routes for animal testing can be found here: https://ntp.niehs.nih.gov/whatwestudy/topics/syntheticturf/index.html

[7] Systemic exposure refers to an exposure where a chemical constituent enters systemic circulation.

Conclusions

Available research demonstrates that artificial turf, particularly with crumb rubber, can contain a number of constituents (e.g., metals and organic chemicals) with known health hazards; however, human exposure to these constituents is likely minimal. As risk is a function of hazard and exposure, artificial turf and crumb rubber does not appear to be a human health risk based on extant data. Ultimately, the available research does not definitively conclude whether exposure to artificial turf and crumb rubber is a risk to human health.

Information is lacking for empirical measurements of crumb rubber constituents (e.g., metals, organic compounds) in humans using artificial turf, more specific toxicological endpoints (e.g., cancer, reproductive effects), and dose-response relationships between exposure to artificial turf and adverse health effects. However, research continues to be conducted by entities such as the FRAP agencies (USEPA 2019a; 2019b) and the California Office of Environmental Health Hazard Assessment[8]. This future research may ultimately provide more definitive conclusions about the risk of artificial turf and crumb rubber to human health.

References

NJDEP. 2007. New Jersey Department of Environmental Protection. Preliminary Assessment of the Toxicity from Exposure to Crumb Rubber: its use in Playgrounds and Artificial Turf Playing Fields. https://www.state.nj.us/dep/dsr/research/whitepaper%20-%20rubber.pdf

NJDEP. 2011a. New Jersey Department of Environmental Protection. An Evaluation of Potential Exposures to Lead and Other Metals as the Result of Aerosolized Particulate Matter from Artificial Turf Playing Fields. Final Report. Submitted by Stuart L. Shalat, Sc.D. https://www.nj.gov/dep/dsr/publications/artificial-turf-report.pdf

NJDEP. 2011b. New Jersey Department of Environmental Protection. An Evaluation of Potential Exposures to Lead and Other Metals as the Result of Aerosolized Particulate Matter from Artificial Turf Playing Fields. Research Project Summary. https://www.nj.gov/dep/dsr/publications/turf-pm.pdf

NJDEP. 2011c. New Jersey Department of Environmental Protection. Crumb Infill and Turf Characterization for Trace Elements and Organic Materials. Submitted by Dr. Paul J. Lioy and Dr. Clifford Weisel. https://www.nj.gov/dep/dsr/publications/turf-crumb-infill-study.pdf

NJDHSS. 2008a. New Jersey Department of Health and Senior Services. New Jersey Investigation of Artificial Turf and Human Health Concerns – April 2008. https://www.nj.gov/health/ceohs/documents/eohap/haz_sites/regional_state/art_turf/lead_in_turf_factsheet.pdf

NJDHSS. 2008b. New Jersey Department of Health and Senior Services. Update: New Jersey Investigation of Artificial Turf and Human Health Concerns – June 2008.

[8] Although not having published any research reports, information on the state of California's research on artificial turf can be found here: https://oehha.ca.gov/risk-assessment/synthetic-turf-studies

https://www.nj.gov/health/ceohs/documents/eohap/haz_sites/regional_state/art_turf/turf_update3_0608.pdf

NJDHSS. 2008c. New Jersey Department of Health and Senior Services. Update: New Jersey Investigation of Artificial Turf and Human Health Concerns – August 2008. https://www.nj.gov/health/ceohs/documents/eohap/haz_sites/regional_state/art_turf/turf_factsheet_update_aug08.pdf

NTP. 2019. National Toxicology Program. NTP Research Report on Synthetic Turf/Recycled Tire Crumb Rubber: 14-Day Exposure Characterization Studies of Crumb Rubber in Female Mice Housed on Mixed Bedding or Dosed Via Feed or Oral Gavage. Research Triangle Park, NC: National Toxicology Program. Research Report 14. https://ntp.niehs.nih.gov/publications/reports/rr/rr14/index.html

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

USEPA. 2019a. United States Environmental Protection Agency. Synthetic Turf Field Recycled Tire Crumb Rubber Research Under the Federal Research Action Plan Final Report: Part 1 - Tire Crumb Characterization. Volume 1. https://www.epa.gov/sites/production/files/2019-08/documents/synthetic_turf_field_recycled_tire_crumb_rubber_research_under_the_federal_research_action_plan_final_report_part_1_volume_1.pdf

USEPA. 2019b. United States Environmental Protection Agency. Synthetic Turf Field Recycled Tire Crumb Rubber Research Under the Federal Research Action Plan Final Report: Part 1 - Tire Crumb Characterization. Volume 2. https://www.epa.gov/sites/production/files/2019-08/documents/synthetic_turf_field_recycled_tire_crumb_rubber_research_under_the_federal_research_action_plan_final_report_part_1_volume_2.pdf