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August 6, 2019

Information Quality Guidelines Staff (Mail Code 2811R)
US EPA
1200 Pennsylvania Ave., NW
Washington, DC 20460

Re: Data Quality Complaint under the Information Quality Act for Part 1 of Synthetic Turf Tire Crumb Rubber Research Report.

To Whom It May Concern,

Public Employees for Environmental Responsibility (PEER) and the Ecology Center (Michigan) hereby submits this Request for Correction under the Information Quality Act (IQA) of 2000 [Section 515 of the Fiscal Year 2001 Treasury and General Government Appropriations Act, Pub. L. No. 106-554],[1] the Office of Management and Budget (OMB) Guidelines for Ensuring and Maximizing the Quality, Utility, and Integrity of Information disseminated by Federal Agencies (hereinafter "OMB Guidelines")[2], and the Environmental Protection Agency's (EPA) Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by the Environmental Protection Agency.[3]

We are submitting this letter to request corrections to *Synthetic Turf Field Recycled Tire Crumb Rubber Research Under the Federal Research Action Plan Final Report: Part 1 - Tire Crumb Characterization*, US Environmental Protection Agency, Centers for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry, 2019.

Summary of Our Data Quality Complaint

Part 1 of the Federal Research Action Plan (FRAP) is based on inaccurate, incomplete, and unreliable information regarding the potential risks to human health and the environment of exposure to recycled tire crumbs used in artificial turf, and issues conclusions that are not supported by the study. Part 1 of the FRAP violates the EPA Guidelines for Objectivity. It used an inaccurate lead testing methodology, failed to consider the actual and combined effects of the various chemical components of tire crumbs, tested for VOCs and SVOCs at inadequate temperatures, failed to consider the constituents of the carpet, and did not study the inhalation of fine particulate matter.

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The FRAP cautions against relying upon only the FRAP because of its limitations. The FRAP states that it cannot be used as a risk assessment. Despite this, the FRAP concludes, "While there are many chemicals associated with recycled tire crumb rubber, our laboratory experiments suggest that the amount of chemicals available for exposure through release into the air and simulated biological fluids is relatively low." This conclusion is not supported by the evidence and is outside the scope of its assessment.

Because the evidence in this report does not support its conclusion, PEER and the Ecology Center ask EPA to retract its conclusion and conduct further studies on the safety of artificial turf to ensure the objectivity, utility, and integrity of the information EPA disseminates to the public. We also ask EPA to rescind and correct online and print information regarding the safety of artificial turf in Part 1 of the FRAP on the basis that it contains inaccurate, incomplete, and unreliable information. Finally, we strongly urge the EPA to correct its methodology prior to releasing information to the public.

1. Background

Over the years, the public and scientists have raised concerns about the safety of reused ire crumb rubber used in synthetic turf fields and playgrounds throughout the United States. Numerous studies describe the chemical constituents of rubber crumb, and possible exposure and impacts, but they do not comprehensively evaluate all potential exposures in combination and individually through inhalation, absorption, and ingestion. Moreover, recent studies have raised additional concerns about inhalation of fine particulate matter. Because additional research is needed to help fill data gaps associated with potential risks from tire crumb rubber, EPA, the Centers for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry (CDC/ATSDR), and the US Consumer Product Safety Commission (CPSC) launched a multi-agency "Federal Research Action Plan on Recycled Tire Crumb Used on Playing Fields and Playgrounds" (FRAP). The goal of the FRAP was to examine chemical constituents of rubber crumb, and potential exposure to these chemicals from playing on synthetic turf fields and playgrounds. The FRAP was finalized in February 2016. Specifically, EPA and CDC/ATSDR developed a research protocol to 1) conduct a literature review and data gaps analysis; 2) characterize constituents of tire crumb rubber, and 3) perform human exposure characterization for synthetic turf field users. In addition, the CPSC is conducting additional research to assess potential risks to children associated with the use of recycled tire crumb rubber in playground surfaces.

Part 1 of the FRAP, the tire crumb rubber characterization, was released on July 25, 2019.[4] The report states that it was "prepared to communicate to the public the research objectives, methods, results and findings for the tire crumb rubber characterization research conducted as part of the Federal Action Research Plan,"[5] and repeatedly states that "[t]he study is not a risk assessment."[6] However, despite these disclaimers that the report was not intended to be a risk assessment, it concludes, "While there are many chemicals associated with recycled tire crumb rubber, our laboratory experiments suggest that the amount of chemicals available for exposure through release into the air and simulated biological fluids is relatively low." This conclusion gives a false impression that recycled tire crumb rubber is safe; indeed, some press immediately grabbed onto this conclusion, proclaiming, "[a] joint report from two US agencies has found that human exposure to chemicals in tyre crumb rubber 'appears to be limited.'"[7]

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EPA Information Quality Guidelines state that "Disseminated information should adhere to a basic standard of quality, including objectivity, utility, and integrity."[8] The FRAP was meant to fill important data and knowledge gaps, characterize constituents of recycled tire crumb, and identify ways in which people may be exposed to tire crumb based on their activities on the fields. There are already more than 12,000 artificial turf fields in the United States, and many towns and cities were awaiting the FRAP before deciding whether to install more fields. As such, the FRAP has a significant potential impact on further private and public decisions relating to the use of artificial turf and the management of scrap tires. Given the growing concerns about the safety of artificial turf, PEER and the Ecology Center seek to ensure that the EPA utilizes research based on sound science in fulfilling its regulatory functions.

Mounting evidence demonstrates that the use of tire crumbs in artificial turf presents unacceptable health and environmental risks, especially to vulnerable populations such as the children who regularly use these surfaces and whose developing bodies and brains are often sensitive to much lower levels of exposure than adults. As such, EPA must be particularly careful in its characterization of the limited research done so far.

2. Standing to Challenge the Objectivity of the FRAP

Any affected individual can challenge information disseminated by an agency by filing a demand for correction.[9] The EPA Guidelines propose a broad interpretation of "affected persons" and asks affected parties to describe how they are affected by the information in question.[10]

PEER is an affected individual in that its mission is to hold government agencies accountable for enforcing environmental laws, maintaining scientific integrity, and upholding professional ethics inside public agencies. PEER is a nonprofit organization chartered in the District of Columbia with members throughout the country who are affected by exposure to artificial turf. Among PEER's members are parents and children who are regularly exposed to these surfaces, as well as the recycled tire crumbs used as infill. Several members of PEER are scientists working in public agencies who have contacted PEER to express their concern that the human health and environmental risks involved in utilizing recycled tire crumbs in artificial turf have not been properly investigated. PEER and its members have a direct interest in the study being corrected. As such, PEER is an affected person according to the EPA Guidelines.

The Ecology Center, located in Anne Arbor and Detroit, Michigan, was founded in 1970 to develop innovative solutions for healthy people and a healthy planet. The Center educates consumers to help keep their families healthy and safe; pushes corporations to use clean energy, make safe products, and provide healthy food; provides people with innovative services that promote healthy people and a healthy planet; and, works with policymakers to establish laws that protect communities and the environment.

The FRAP Is Subject to EPA's Guidelines

EPA Guidelines cover information that EPA disseminates to the public. The Guidelines define information as "any communication or representation of knowledge such as facts or data, in any medium or form."[11] EPA Guidelines specify that EPA disseminate information to the public when "EPA prepares the information and distributes it to support or represent EPA's viewpoint,

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or to formulate or support a regulation, guidance, or other Agency decision or position."[12] The EPA Guidelines explain that "EPA intends to use notices to explain the status of information, so that users will be aware of whether the information is being distributed to support or represent EPA's viewpoint."[13]

Part 1 of the FRAP on tire crumbs is information subject to the EPA Guidelines. EPA released the FRAP on its website for the public in July 2019,[14] and is holding a webinar to disseminate the results on August 6, 2019. The FRAP has been distributed to the public in support of EPA's view that exposure to the multitude of toxic chemicals in tire crumb is "relatively low." As such, it is information disseminated to the public that is covered by the EPA Guidelines.

The FRAP Is "Influential" Scientific Information under EPA's Information Quality Guidelines

The FRAP is influential scientific information as defined by EPA guidelines. EPA considers information to be "influential" when the "dissemination of the information will have or does have a clear and substantial impact … on important public policies or private sector decisions."[15] EPA Guidelines list documents such as studies and guidance in support of "top Agency actions" as influential.[16] According to EPA, "top Agency actions usually have potentially great or widespread impacts on the private sector, the public or state, local or tribal governments" and "have the potential to result in major cross-Agency or cross-media policies."[17]

Currently, EPA plays a significant role in creating national policies on tire disposal, which involve multiple private and public sector stakeholders. In particular, the EPA encourages tire recycling through programs such as grant initiatives.[18] The EPA is also mandated to issue federal procurement standards, which apply to items purchased with federal funding.[19] The EPA has broad discretion to devise its procurement standards and it has chosen to include recycled tire rubber in its listing.[20] The EPA also coordinates a Scrap Tire Workgroup, which has aimed to divert 85% of scrap tires to beneficial uses, such as artificial turf.[21]

The FRAP is influential according to the EPA Guidelines because of its impact on public and private decisions concerning the use of recycled tire crumbs. Scrap tire management is an issue that affects the private sector, several federal agencies, as well as state, local, and tribal governments. The dissemination of the FRAP has a substantial impact on EPA's decision process as well as the decision process of various state, local, and tribal environmental protection, consumer protection, and health agencies. In addition, the FRAP will likely have a substantial impact on important private sector decisions by influencing the market for recycled tire crumbs.

Finally, the FRAP has been touted as the only comprehensive study that the EPA has conducted to investigate concerns about the characterization and safety of artificial turf containing recycled tire crumbs. As such, this FRAP is especially influential and should be subject to review due to its influence on public policy.

3. The FRAP Violates EPA's Information Quality Guidelines

A. The FRAP Violates EPA Guidelines for Objectivity

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i. The Lead Testing Is Inaccurate. The FRAP utilizes the scientifically flawed approach of compositing rubber crumb to test for lead and other metals. It is well known that rubber crumb is a particularly heterogeneous material. It is a waste product containing huge variability of compounds. This variability, also known as heterogeneity, has been noted by numerous researchers. Specifically, a 2009 EPA document stated that "At any single site, there can be substantial variability in the materials used and the concentrations of contaminants measured." In fact, these researchers measured "[u]p to a 36-fold difference was found between the analyses of seven pieces of tire crumb material from the same playground. These results suggest substantial heterogeneity in Pb [lead] bioaccessibility from tire crumb rubber samples."[22] In addition, a 2018 study tested identically labeled bags of tire crumb, and found that "the products are quite heterogeneous … This variety makes it difficult or impossible to assign fixed composition to a given labeled product. It also makes comparison across published studies problematical."[23]

The fact is that the lead content across any one field is highly variable. This high variability means that tests have to be done with numerous *individual* crumb samples taken from various places across the field. In Washington DC, tests done on individual pieces of rubber crumb showed that some pieces had non-detectable lead levels, while others had a lead level of 3,941 ppm.

In fact, the FRAP states, "[s]ubstantial variability in tire crumb rubber chemical concentrations has been reported."[24] It also states, "[w]ithin-field differences are important for understanding whether there might be different exposure potentials across a given field and how best to collect samples to provide representative results for a field."[25] Despite this, the FRAP did not appear to test individual pieces of crumb rubber. Specifically, samples were collected from multiple locations on a field and composited. A 250 ml container from each of seven locations on a field was collected, and then equal portions from each of the seven containers were composited. The methodology states, "Seven containers (one at each of the seven field locations) will be completely filled with tire crumb rubber material. Equal portions of these samples will be composited at the laboratory prior to analysis."[26] Although it is unclear from the methodology, it appears a 0.25 gram sample of the composite was pulled and digested that for the ICP-MS lead testing. This will result in diluting any high lead shreds.

Because lead and other metals occur in hot spots across any one field, and it is completely unknown which individual piece of rubber crumb will be ingested by an athlete or a child, it is not scientifically defensible to composite the crumbs before testing them. EPA must re-test individual rubber crumbs in sufficient numbers to get an idea of the lead levels in a particular field.

Moreover, the FRAP incorrectly creates a straw man to explain the presence of lead. The FRAP states, "One synthetic turf field had a substantially higher measured concentration of lead (160 mg/kg i.e., ppm) in its composite tire crumb rubber infill sample than other fields, while another field had similar levels in two of seven individual location samples. These results suggest sources of lead other than tire crumb rubber may be present at some locations."[27] Given that the lead testing was done by compositing the crumbs, it is very possible that the compositing masked high lead levels in some pieces. EPA must remove statements suggesting that there are low lead levels in the crumb rubber and that any high lead readings are coming from external sources.

ii. The FRAP Failed to Consider Effects of the Various Chemical Components of Tire Crumbs in combination as well as individually. The FRAP found 355 chemical compounds potentially associated with recycled tire crumb rubber, only 167 of which had toxicity information available.[28] Therefore, the FRAP ignores the 53% of chemicals for which they have no toxicity information. Tire crumb rubber is a toxic chemical soup; in fact, the FRAP states, "because of the complexity of the material, many chemicals were found to be associated with tire crumb rubber collected from tire recycling plants and tire crumb rubber infill collected from fields across the United States, including a range of metals, PAHs, phthalates and other tire rubber related chemicals." This vast range of chemicals makes assessing exposures incredibly challenging. EPA admits that "[t]he presence of many chemicals in combination with low bioaccessibility suggest the complexity and challenge to accurately assess cumulative exposures for synthetic turf field users that can occur through different exposure pathways."[29]

The FRAP was designed to evaluate tire crumb constituents in order to understand potential exposure. However, EPA admits that tire crumb constituents are so complex, and there is such limited toxicity data available on the majority of constituents, it is impossible to characterize all of the individual chemicals, let alone any synergistic effects between them.

iii. The FRAP Is Not Reliable Due To Inadequate Temperatures When Testing For VOCs And SVOCs. By subjecting crumb rubber to high heat, EPA is attempting to determine the potential for chemicals associated with tire crumb rubber to be released into the air and to become available for inhalation. However, the FRAP erroneously used 60 degrees Celsius as the upper-temperature limit when testing for volatile organic compounds (VOCs) and semi-volatile organic compounds (VOCs). Specifically, the FRAP tested differences in 25 °C and 60 °C emission factor distributions for chemicals such as formaldehyde, benzothiazole, methyl isobutyl ketone, styrene, pyrene, the sum of 15 PAHs, benzothiazole, and 4-tert-octylphenol. The tests were run at temperatures that would recreate actual temperatures on a synthetic turf field, so EPA could allegedly determine what athletes are exposed to. However, since temperatures on artificial turf have been shown to reach 90 °C or even 95 °C,[30] 60 °C is clearly inadequate. In fact, peer reviewers also flagged this as a concern. Specifically, the FRAP states reviewers questioned, "how the 60 °C test condition was selected and whether it adequately represents 'upper end' temperature conditions."[31] In response, the FRAP "acknowledge[s] the uncertainty as a potential limitation in whether this best represents upper-end conditions."[32]

The upper-temperature limit is far too low, and will not mimic actual field conditions. As such, any conclusions about chemicals available for inhalation are incorrect.

iv. The FRAP Fails to Consider Constituents Of The Carpet. EPA made the conscious decision to not test the synthetic turf carpet (the grass blades and backing). Specifically, the FRAP states, "Another design constraint was a decision to focus characterization research on the recycled tire crumb rubber infill and not to include other synthetic turf field materials (e.g., synthetic grass blades and backing material) due to the expanded scope that would be needed for a high-quality characterization of all these materials."[33] The grass blades and the backing may also be exposing athletes and children to a variety of toxic chemicals, and failing to examine the constituents of this material, EPA is rendering any conclusions about artificial turf as a whole incomplete.

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v. The FRAP Fails to Consider Fine Particulate Matter. The FRAP admits that "[t]he analysis approach did not allow study of potential tire crumb rubber particles < 5-µm nominal diameter, which limits current understanding about the presence of, and potential for exposures to, fine particles and nanoparticles."[34] It is likely that people utilizing these fields would indeed inhale these particles; the ~~FRPAP~~ FRAP states, "People may also inhale small particles of tire crumb rubber at fields; this type of exposure was not assessed in the chamber emission testing."[35]

Recent studies show that long-fiber carbon nanotubes which are found in rubber crumb "replicate asbestos-induced mesothelioma in humans."[36] Artificial turf is filled with these nanoparticles; specifically, "[c]arbon black nanoparticles make up 30 percent or more of car tires; the same tires that are pulverized for creating the tire crumb used on artificial turf playing fields and on playgrounds for children."[37] None of the risk assessments done on artificial turf or rubber crumb playgrounds to date have taken the fact that carbon black nanoparticles have been added to rubber tires into consideration,[38] and this FRAP perpetuates that data gap. In fact, engineered carbon nanotubes are only one example of the lack of knowledge of "secret" "proprietary" tire ingredients (that may be of significant harm) to test for. Because of this and unknown manufactured origin and composition of, and substantial variability in any tire waste source material, it is in fact impossible for the FRAP or any such study to be promoted as a complete catalog of tire constituents at all and cannot be promoted as more than a partial catalog of constituents in the samples collected. As such, it is scientifically unsound for EPA to conclude that the chance of exposure to toxic chemicals is low.

Conclusion The FRAP should not be relied upon by the public, other governmental agencies, or by the synthetic turf industry. The lead testing methods used by the EPA were inaccurate.[39] The FRAP's upper limit for temperature when assessing emissions from VOCs and SVOCs was too low and consideration of "real-world conditions" such as was done for "active use" in the 2009 scoping study is missing.[40] The FRAP ignores the 53% of chemicals for which they have no toxicity information.[41] and failed to consider the as yet unknown, COMBINED effects of the various chemical components of tire crumbs The FRAP also failed to consider the effects of various chemical components of the carpet and backing.[42] Finally, the FRAP failed to look at inhalation of fine particulate matter.[43] For these reasons, the study's findings are unreliable and should be retracted, or at the very least heavily caveated, eliminating any unsupported statement of opinion. Extension of limited findings circumscribed by limited conditions must not be used to make sweeping, unsupported conclusions about exposure or bioavailability.

B. The Study Does Not Follow EPA's Guidelines for Utility

The FRAP does not meet the EPA Guidelines for utility. The EPA defines utility as the "usefulness of the information to the intended users."[44] Part 1 of the FRAP purported to display findings for the tire crumb rubber characterization research (i.e., what is in the material). Part 2, to be released at some unknown later date, will allegedly characterize potential human exposures to the chemicals found in the tire crumb rubber material while using synthetic turf fields. However, because the characterization of the material is so incomplete and flawed, it cannot possibly form the basis for human exposure.

The FRAP also states that "[n]either Part 1 nor Part 2 of this study, separately or combined, will constitute an assessment of the risks associated with playing on synthetic turf fields with

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recycled tire crumb rubber infill. The results of the research described in both Part 1 and Part 2 of the final report can be used to inform future risk assessments."[45] Since the study is not intended to be a risk assessment, and the flaws listed above, and because the research "has limitations, and risks cannot be inferred from the information and conclusions found in this study,"[46] it is unclear what the utility of Part 1 of the FRAP is.

Despite the FRAP's own cautions against relying upon only the FRAP because of its limitations and repeated statements that it cannot be used as a risk assessment, it conveys to the public and the synthetic turf community that the EPA has stated a low level of concern in synthetic turf fields. The press has already seized on this incorrect conclusion. To reiterate, the FRAP reaches a conclusion that is not supported by the evidence, and that is outside the scope of the assessment. In particular, despite the fact that the report repeatedly states that it is NOT a risk assessment, their conclusion is: "While there are many chemicals associated with recycled tire crumb rubber, our laboratory experiments suggest that the amount of chemicals available for exposure through release into the air and simulated biological fluids is relatively low."

Relief Requested

These challenged statements should be retracted because they violate EPA Guidelines for Information Quality. Accordingly, PEER asks that the EPA take the following steps to comply with the Information Quality Act:

1. Remove Synthetic Turf Field Recycled Tire Crumb Rubber Research Under the Federal Research Action Plan Final Report: Part 1 - Tire Crumb Characterization, US Environmental Protection Agency, Centers for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry from official publication and cease further distribution.

1. Issue a public statement, posted on official websites, that the FRAP has been withdrawn from publication due to violations of the Information Quality Act.

1. Either undertake an adequate testing protocol that cures the flaws enumerated above, or reissue the report with explanations of these additional limitations and removal of all conclusory statements about low exposure to the chemicals associated with artificial turf.

We look forward to receiving your response within 90 days, according to the EPA Information Quality Guidelines.[47] Thank you in advance for your prompt attention to this complaint.

Sincerely,

Kyla Bennett, PhD, JD
Director of Science Policy
PEER

Jeff Gearhart, MS
Research Director
Ecology Center

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[1] Treasury and General Government Appropriations Act, Pub. L. No. 106-554, §515 (Fiscal Year 2001).

[2] Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies, Republication, 67 Fed. Reg. 8452 (Feb. 22, 2002).

[3] US Environmental Protection Agency, Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by the Environmental Protection Agency, available at http://epa.gov/quality/informationguidelines/documents/EPA_InfoQualityGuidelines.pdf

[hereinafter *EPA Guidelines*].

[4] https://www.epa.gov/sites/production/files/2019-07/documents/synthetic_turf_field_recycled_tire_crumb_rubber_research_under_the_federal_research_action_plan_final_report_part_1_volume_1.pdf

[5] *Id.* at ii

[6] *Id.* at ii, 9, and 43.

[7] https://chemicalwatch.com/register?o=80391&productID=1&layout=main

[8] EPA Guidelines 3.

[9] 44 USC. § 3516(b)(2)(B).

[10] EPA Guidelines A3.7, 8.2.

[11] EPA Guidelines 5.3.

[12] EPA Guidelines 5.3.

[13] EPA Guidelines 5.3.

[14]https://www.epa.gov/chemical-research/federal-research-recycled-tire-crumb-used-playing-fields.

[15] EPA Guidelines 6.2.

[16] EPA Guidelines 6.2.

[17] EPA Guidelines 6.2.

[18] 42 USC. § 6914.

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[19] 42 USC. § 6962(a). The procurement standards are mandated under RCRA and apply to purchases with federal funding of items in a value above $10,000. *Id.*

[20] 66 C.F.R § 45256 (2001). The EPA mandates that agencies purchase specified products with the highest quantity of recycled material "as practicable" and that recycled tire crumbs be utilized in artificial turf purchased with federal funds. *Id.*

[21] Scrap Tire Workgroup, Summary of Action Plans (2007), *available at* http://www.epa.gov/osw/conserve/materials/tires/workgroup.htm. *See also Ground Rubber Applications*, US Environmental Protection Agency, http://www.epa.gov/osw/conserve/materials/tires/ground.htm (last visited July 20, 2012) (listing uses for Ground Rubber).

[22] A Scoping-Level Field Monitoring Study of Synthetic Turf Fields and Playgrounds Prepared by the National Exposure Research Laboratory Office of Research and Development US Environmental Protection Agency with contributions from the Agency's Tire Crumb Science Workgroup

[23] See Benoit, G. & Demars, S., *Evaluation of Organic and Inorganic Compounds Extractable by Multiple Methods from Commercially Available Crumb Rubber Mulch*, Water Air Soil Pollut (2018) 229: 64).

[24] https://www.epa.gov/sites/production/files/2019-07/documents/tire_crumb_characterization_study_field_collection_and_laboratory_standard_operating_procedures_sops.pdf at p. 3

[25] https://www.epa.gov/sites/production/files/2019-07/documents/synthetic_turf_field_recycled_tire_crumb_rubber_research_under_the_federal_research_action_plan_final_report_part_1_volume_1.pdf at p. 154

[26] *Id.*

[27] *Id.* at 12.

[28] https://www.epa.gov/sites/production/files/2019-07/documents/synthetic_turf_field_recycled_tire_crumb_rubber_research_under_the_federal_research_action_plan_final_report_part_1_volume_1.pdf p. 18

[29] *Id.*

[30] https://www.mdpi.com/2504-3900/2/6/279

[31] https://www.epa.gov/sites/production/files/2019-07/documents/synthetic_turf_field_recycled_tire_crumb_rubber_research_under_the_federal_research_action_plan_final_report_part_1_volume_2.pdf at p. 436

[32] *Id.*

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[33] *Id.* at 41.

[34] *Id.* at 114.

[35] *Id.* at 15.

[36] T. Chernova, et al., *Long-Fiber Carbon Nanotubes Replicate Asbestos-Induced Mesothelioma with Disruption of the Tumor Suppressor Gene Cdkn2a (Ink4a/Arf)*, Current Biology, Vol. 27, Issue 21, 3302-3314 (2017).

[37] https://www.turfandrec.com/agronomy/exposure-to-crumb-rubber-nanoparticles-could-lead-to-serious-health-issues-researchers-2986?fbclid=IwAR1XpTcKzjX-RqMBAJWJr4u7pxyXVNM7N8Er0U-IpFIZoQppIDKmAN45W5o

[38] *Id.*

[39] *See Infra* part A.

[40] *See Infra* part B.

[41] *See Infra* part C.

[42] *See Infra* part D.

[43] *See Infra* part E.

[44] EPA Guidelines 5.1.

[45] https://www.epa.gov/sites/production/files/2019-07/documents/synthetic_turf_field_recycled_tire_crumb_rubber_research_under_the_federal_research_action_plan_final_report_part_1_volume_1.pdf p. xxxii

[46] *Id.* at xxxiii

[47] EPA Guidelines A55.

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