55 Walkers Brook Drive, Reading, MA 01867 (HQ)
Tel: 978.532.1900

January 4, 2022

Diane O'Neil
Director of Facilities & Grounds
Nantucket Public Schools
10 Surfside Road
Nantucket, MA 02554

Cc: Mr. Richard Webb

Re: Synthetic Turf and Environmental Questions

Dear Ms. O'Neil:

Weston & Sampson Engineers, Inc. (Weston & Sampson) has prepared this letter regarding the potential for environmental impacts related to synthetic turf at your request. The focus of the information provided is poly and perfluorinated alky substances (PFAS) that may be present in the synthetic turf system proposed in the school's master plan. The evolving scientific understanding of the complex chemistry, environmental fate, exposure routes and lack of regulatory limits, makes presentation and discussion of PFAS presence and potential risks challenging. Below, we have briefly summarized some key information regarding PFAS. At the end of this letter, we provide a concise set of takeaway points that should assist in providing answers to frequently asked questions regarding PFAS in synthetic turf fields.

PFAS BACKGROUND

PFAS are a manmade suite of compounds utilized in many consumer products to provide durable waterproof coatings and in aqueous film forming foam (AFFF) used for firefighting. The scientific community is rapidly evolving its understanding of PFAS in the environment. Many PFAS have been shown to be very resistant to water, oil and degradation under typical environmental conditions. Some PFAS are water soluble and can be ingested via this exposure route. These soluble PFAS have also been shown to bioaccumulate in plants, animals and humans. Therefore, PFAS are considered to be contaminants of emerging concern (CECs), which are those chemicals that present potentially unacceptable human health effects or environmental risks, and either: (1) do not have regulatory cleanup standards, or (2) regulatory standards are evolving due to new science, detection capabilities or pathways, or both.

PFAS are contained in thousands of commercial daily use products including food packaging, cookware, and waterproof textiles used in jackets and boots. Due to their presence in so many products and their environmental persistence, PFAS are now ubiquitous in the environment. PFAS has been detected in human blood, surface water sediments, surface and groundwater, and wildlife across the globe. Although the scientific research into PFAS is evolving, there is evidence there may be adverse health effects associated with long-term exposure to some PFAS compounds. The primary focus of USEPA and other regulatory agencies for exposure to PFAS is through consumption of soluble PFAS in

contaminated drinking water. Based on the limited research studies to date and what is known about the chemical composition of PFAS, dermal (skin) contact with PFAS containing materials is expected to pose minimal health risk. Similarly, based on available research and chemical composition, most PFAS compounds do not appear to be volatile and are expected to pose minimal health risk through inhalation.

SYNTHETIC TURF MANUFACTURE

Synthetic turf grass is made by extruding a mixture of primarily polyethylene plastic into a mold shaped as blades of grass. Typically, a processing agent is utilized within the polyethylene mixture to assist with effective plastic injection into a mold and ease removing the blades from the mold. It is our understanding that the predominant processing agent being used by the plastic grass manufacturers is polyvinylidene fluoride-co-hexafluoropropylene (PVDF-HFP). PVDF-HFP is a polymeric PFAS. This copolymer is a very large molecule and not soluble in water. In addition, because the processing aid is mixed into the plastic being molded, it becomes bound into the polyethylene blade as part of the plastic matrix.

A review of the potential toxicity of PVDF-HFP does not bring up any relevant toxicity data. There is no reference to PVDF-HFP in EPA Integrated Risk Information Systems (IRIS) or the CDC's Agency for Toxic Substances and Disease Registry (ATSDR). This is likely because PVDF-HFP is considered inert. PVDF-HFP is a common component used in medical devices – stents, meshes, replacement joints, etc. Studies documented from Boston Scientific and others indicate PVDF-HFP is biocompatible, inert and insoluble. It appears to be very commonly used in medical devices It has many different uses including food packaging and water purification (used within the plastic in water filters). Based on current information, high molecular weight fluoropolymers are believed to be too large to cross cell membranes and are therefore believed to pose less risk to human and ecological health relative to nonpolymer PFAS.

To our knowledge no other PFAS are being intentionally utilized in the manufacture of synthetic turf system components.

PFAS REGULATION

Drinking Water

The USEPA has set a health advisory for perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) in drinking water of a sum total of 70 parts per trillion (ppt). Massachusetts Department of Environmental Protection (MADEP) has developed drinking water standard of 20 ppt for the sum of six PFAS compounds (PFAS6) including both acid and anionic forms of the following:

- perfluorohexanesulfonic acid (PFHxS)
- perfluoroheptanoic acid (PFHpA)
- perfluorooctanesulfonic acid (PFOS)
- perfluorooctanoic acid (PFOA)
- perfluorononanoic acid (PFNA)
- perfluorodecanoic acid (PFDA)

Surface Water

Currently neither the USEPA nor MADEP have set a surface water guidance/standard concentrations for PFAS. There is draft MADEP Method 1 GW-3 groundwater standards that are protective of migration of constituents in groundwater to nearby surface water bodies.

Soils

MADEP has set standards for the PFAS6 in soil. Method 1 S-1/GW-1 concentrations are protective of potential leaching into groundwater and Method 1 S-1/GW-2&3 is protective of direct contact exposure. The table below summarizes the soil limits.

MADEP Soil Standards - parts per billion

PFAS	Leaching to Groundwater	Direct Contact
perfluorohexanesulfonic acid (PFHxS)	0.30	300
perfluoroheptanoic acid (PFHpA)	0.50	300
perfluorooctanesulfonic acid (PFOS)	0.72	300
perfluorooctanoic acid (PFOA)	2.00	300
perfluorononanoic acid (PFNA)	0.32	300
perfluorodecanoic acid (PFDA)	0.30	300

Consumer Products

No federal standards or regulatory limits are presently set for consumer products containing PFAS. The European Union regulates chemicals contained in consumer products via the Registration, Evaluation, Authorization and restriction of Chemicals (REACH) regulation. REACH is a European Union regulation (1907/2006/EC) restricting the levels of specific chemical substances in all imported goods. PFOS and PFOA are listed as restricted compounds by REACH. California Prop-65 provides a list containing a wide range of naturally occurring and synthetic chemicals that are known to cause cancer or birth defects or other reproductive harm. If a product contains chemicals on this list, a warning must be provided on the product. PFOA and PFOS have been on the Prop-65 list since 2017. As of December 31, 2021, PFNA and PFOS transformation and degradation precursors will be added to the Prop-65 list.

The majority of synthetic turf manufacturers, including Greenfield (TenCate), have provided certifications that their products meet EU REACH and Prop-65 requirements (2017) regarding the absence of PFOS and PFOA in the manufacture of their products.

TESTING METHODS

There are thousands of PFAS compounds. Because PFAS are emerging contaminants, accredited laboratories only have the ability to test drinking and surface water for 30 specific PFAS compounds via two EPA accredited methods at this time. Both methods quantify the PFAS6 regulated by MADEP.

No EPA approved methods exist for testing of environmental media other than drinking water and surface water or for consumer products. This has led laboratories to develop their own modifications to the EPA methods to test these materials. Many of these modified method results are accepted by state regulators for reporting of 30 specific PFAS compound concentrations, including the PFAS6. It is these methods that must be used when analyzing artificial turf grass, shock pads and infill materials.

SYNTHETIC TURF TESTING RESULTS

A number of communities in Massachusetts and New Hampshire have engaged in synthetic turf sampling and analyses for PFAS. The test methods utilized identify 24 to 30 individual PFAS. A summary of the testing results by various preparation methods is included below. As there are no federal or state regulatory standards for PFAS in or leaching from synthetic turf, the results are compared to the MADEP soil standards for leaching to groundwater and direct contact and to the Vermont Department of Environmental Conservation (VTDEC) PFAS in Background Soils study. The VTDEC study collected samples across the state to determine what the "background" levels of PFAS are away from known PFAS sources. Analyses results from the synthetic turf system materials proposed for this project and soils collected from the existing athletic fields are summarized below:

PFAS6 Concentration Summary
(parts per billion)

PFAS	Greenfield Turf	Brock Fill In-Fill	Brock Shock Pad	NPS Soil 1	NPS Soil 2	VTDEC Bkgd (median)	MADEP S-1/GW-1 Leaching	MADEP S-1/GW-2&GW-3 Contact
PFHxS	*ND/3.08*	*ND/2.84*	*ND/9.52*	*ND/0.273*	*ND/0.291*	0.120	0.30	300
PFHpA	*ND/3.08*	*ND/2.84*	*ND/9.52*	*ND/0.273*	*EST/0.137*	0.190	0.50	300
PFOA	*ND/3.08*	*ND/2.84*	*ND/9.52*	*EST/0.091*	*EST/0.272*	0.400	0.72	300
PFOS	*ND/3.08*	*ND/2.84*	*ND/9.52*	0.696	0.399	0.680	2.00	300
PFNA	*ND/3.08*	*ND/2.84*	*ND/9.52*	*EST/0.115*	*EST/0.191*	0.160	0.32	300
PFDA	*ND/3.08*	*ND/2.84*	*ND/9.52*	*EST/0.208*	*EST/0.102*	0.095	0.30	300

ND – None Detected at Reporting Limit
EST – Estimated Value Below Reporting Limit

Review of the testing results indicates:

- None of the PFAS6 were detected in the synthetic turf system components.
- Several Non-PFAS6 compounds were observed in the synthetic turf system components at "estimated" concentrations below the reporting limit (<1ppb).
- The soil samples collected from the existing athletic field areas (NPS Soil -1 and 2) reported the PFAS 6 compound PFOS at concentrations comparable to those seen in the VTDEC Background Soil study and well below the MADEP concentrations for leaching to groundwater or direct contact.
- Several "estimated" concentrations of PFAS6 and other individual PFAS were also reported in both soil samples.
- The PFAS concentrations in the existing athletic field soils appear to be related to the ubiquitous presence of PFAS in our environment (i.e. "background").

The study completed for Martha's Vineyard also performed testing for PFAS leaching from the same synthetic turf materials proposed for Nantucket. This test submerges the materials in water that has

been augmented to reflect typical rainwater in the northeast and stirs it for 24 hours. The water is then tested for PFAS. The results of these tests indicate that "estimated" or very low levels of PFAS6 and other individual PFAS leach from the proposed synthetic turf materials. These concentrations are well below the MADEP drinking water standard.

Destructive testing of the synthetic turf components was also performed during the Martha's Vineyard study (TOP Assay). This analysis exposes the materials being tested to a caustic (think something like Draino) and high heat (185 F) to breakdown "precursor" PFAS into PFAS that are measurable by the laboratory methods. Please note the preparation of the sample does not represent natural conditions. Also, this is a very simplified description of the method and data interpretation. The TOP results reported 1 of the PFAS6 and 2 other PFAS at "estimated" concentrations.

The Martha's Vineyard consultant indicates that the concentrations of PFAS observed by all of the analyses performed on synthetic turf components are "…*consistent with background concentrations in natural soil or at concentrations well below referenced risk-based standards*…" .

Weston & Sampson Conclusions regarding Synthetic Turf Testing Results:

Based upon the information we have reviewed to date we have made the following conclusions:

1. Individual PFAS compounds were detected at concentrations generally below laboratory reporting limits in the synthetic turf system materials.
2. The "estimated" PFAS concentrations in synthetic turf components are similar to background soil levels and are indicative of the ubiquitous nature of PFAS.
3. The PFAS concentrations in synthetic turf are not indicative of their use as a manufacturing additive which would be expected at much higher concentrations.
4. The PFAS concentrations in the synthetic turf are below published background concentrations in natural soils and below the measured PFAS concentrations in soil at the existing Nantucket athletic fields.
5. Leaching testing of the synthetic turf system components indicate PFAS do not leach at concentrations near or above MADEP drinking water regulation levels.
6. Aggressive TOP assay testing reports "estimated", low levels of PFAS, similar to "background". This appears to indicate that the PFAS processing aid PVDF-HFP is not broken down into soluble PFAS, under the aggressive testing method conditions.

It is the opinion of Weston & Sampson that the trace concentrations of PFAS were consistently at or below laboratory detection limits calling into question the precision and validity of the results. Therefore, we believe the trace levels of PFAS identified pose No Significant Health Risk to field users or the environment.

Suggested Discussion Points

While the science regarding PFAS is evolving, the following points of discussion represent our understanding based on the science that is currently available.

- No standards exist for PFAS concentrations in consumer products.
- The synthetic turf grass is likely manufactured using a polymeric PFAS (PVDF-HFP) as processing aid. PVDF-HFP is a common component used in medical devices and is biocompatible, inert and insoluble.
- Multiple tests performed on the synthetic turf system components proposed for the project report PFAS concentrations as either "none detected" or so low they are "estimated". All regulated PFAS (PFAS6) and unregulated PFAS concentrations reported are well below the MADEP drinking water and soil exposure standards.
- PFAS6 concentrations in soil samples collected at the existing athletic fields are higher than those reported from the synthetic turf system components. The soil concentrations are similar to "background" concentrations seen in a Vermont study and well below the MADEP concentrations for leaching to groundwater or direct human contact.
- PFAS in soil is likely to be more bioavailable than PFAS in synthetic turf. The PFAS in soil can be ingested as dust and dirt on the skin. In order to liberate detectable levels of PFAS from the synthetic turf, aggressive laboratory extraction methods were required. It is unlikely the installed synthetic turf system would see such conditions in real life.
- We believe the trace levels of PFAS identified in the synthetic turf system components pose No Significant Health Risk to field users or the environment.

If you have any questions or comments regarding this letter or need any additional information, please do not hesitate to contact our office at 617-412-4480.

Sincerely,
WESTON & SAMPSON ENGINEERS, INC.

Marie Rudiman
Senior Risk Assessor/Toxicologist

Steven LaRosa
Team Leader

\\wse03.local\wse\projects\ma\nantucket ma\nantucket public schools\pfas letter nantucket 12.30.2021.docx