Sports Turf Alternatives Assessment: Preliminary Results
INTRODUCTION

Massachusetts Toxics Use Reduction Institute
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The Massachusetts Toxics Use Reduction Institute (TURI) conducts alternatives assessments as part of its overall mission to help Massachusetts companies, communities, and municipalities identify and implement toxics use reduction options that will provide safer solutions to the use of toxic chemicals.

TURI has received numerous requests for information about artificial turf fields as an alternative to natural grass fields. In response, TURI is developing an alternatives assessment for sports turf. Preliminary sections of the assessment are being published in the order in which they are developed.

This introductory section provides background on the types of turf analyzed in this report. It also includes background information on the history of artificial turf use and existing literature that is relevant for this report. The information presented here may be updated over time as new information becomes available.

Municipalities, educational institutions and others frequently face complicated choices related to the human health and environmental effects of synthetic turf as well as a range of questions related to costs, maintenance, technical performance, and player safety. This alternatives assessment is designed to provide a compilation of key information on these issues, and is intended as a resource for decision makers.

Types of turf analyzed

This alternatives assessment report provides information on natural grass turf and synthetic turf. Within the broader category of natural grass turf, the report considers both organically managed and conventionally managed turf. Within the broader category of synthetic turf, the report considers several types of synthetic turf infill.

Organic turf. Key elements of organic land care, as applicable to turf, include the following: no synthetic pesticides, including herbicides, insecticides, or fungicides; no synthetic fertilizers; no genetically engineered organisms; building healthy soil that can support diverse soil life and cultivate healthy grass; reducing the potential for nitrogen or phosphorus pollution by limiting the amount of organic fertilizers applied and adjusting the timing of application; using good cultural practices to encourage the growth of healthy grass and reduce the need for irrigation and other inputs; and increasing diversity of plant cultivars and species where appropriate. Certain fertilizers and soil amendments are allowed; these include compost and compost teas, cover crops and green manures, and organic fertilizers that meet NOFA standards for organic lawn care. A full definition of organic land care can be found in the Northeast Organic Farming Association (NOFA) *Standards for Organic Land Care: Practices for Design and Maintenance of Ecological Landscapes* (NOFA of Connecticut 2011).

Conventional turf. Conventional turf management involves the use of synthetic fertilizers and/or pesticides (which may include insecticides, herbicides, fungicides, or other biocides). The use of these synthetic inputs can range from spot application, in which pesticides are applied infrequently and only to trouble areas, to the use of routine, calendar-based applications of synthetic fertilizers and pesticides, which may include fungicides, herbicides, and insecticides. Integrated Pest Management (IPM) employs a variety of tactics to keep turf healthy and can include occasional pesticide applications. The present analysis assumes a moderate use of pesticides and considers the pesticides used most commonly on turf.

Synthetic turf. This assessment provides an overview of a variety of types of synthetic turf infills that are available on the market today. Contemporary synthetic turf systems are composed of a top layer of plastic grass blades supported by infill; support and backing materials; and drainage components (Synthetic Turf Council 2015). The most commonly used infill is crumb rubber made from recycled tires. Other synthetic materials used to make artificial turf infill include EPDM rubber, thermoplastic elastomers (TPE), and Nike Grind (a proprietary rubber product made from recycled athletic shoes). Infill can also be made from sand, cork, and coconut hulls, among other materials. Each infill type presents its own set of considerations related to environmental health and safety, performance, and cost.

Categories of analysis

Alternatives assessments consider a number of parameters. For athletic fields, these can include the following.

- Chemical hazards: Health effects of chemicals that may be found in synthetic turf infill and grass blades, or in chemical inputs used on conventionally managed grass fields, include neurotoxicity, carcinogenicity, mutagenicity, reproductive toxicity, asthmagenicity, sensitizing potential, irritant potential, and endocrine disruption.
- Physical and biological hazards: This assessment includes information on hazards related to heat, biomechanical injury, and infections.
- Environment: Categories of environmental impacts can include persistent, bioaccumulative, toxic (PBT) characteristics; aquatic toxicity; soil impacts; wildlife/habitat impacts; heat island effects; and greenhouse gas related impacts
- Performance characteristics: Performance characteristics of sports fields can include durability and usability in various weather conditions, as well as other factors affecting play experience.
- Financial considerations: Cost parameters for athletic fields include installation, maintenance, and (in some cases) disposal/replacement.

- Regulations: Potential regulatory areas which could affect the installation, use, and disposal of a turf field, or management of a natural grass field, include: regulations related to runoff; hazardous waste disposal requirements; the Massachusetts Children and Families' Protection Act; and local ordinances specific to synthetic turf or to natural grass management.

Background on synthetic turf

A 2010 study noted that there were more than 3,500 synthetic turf fields in use across the United States (Wright & Webner 2010). A 2012 study noted that more than 2/3rds of National Football League teams, more than 100 National Collegiate Athletic Association Division I football teams, and more than 1,000 high schools in the United States had installed synthetic playing surfaces (Taylor et al. 2012).

History of synthetic turf. The first generation of synthetic turf was developed in the 1960s. The material was a carpet matrix made from nylon fibers (10-12 mm) (Drakos 2013). In some cases, a shock-absorbing pad was added beneath the playing surface to reduce injury. The surfaces were sometimes sprayed with water to limit friction (Taylor et al. 2012).

The second generation of synthetic turf was introduced in the 1970s. The fibers used were longer (20-25 mm), made from a softer polyethylene, and spaced farther apart to accommodate sand filler, creating a more resilient surface (Drakos 2013 and Taylor et al. 2012).

The third generation came onto the market in the late 1990s, and was designed to more closely replicate natural grass playing surfaces. The fibers are longer (40-65 mm) and made from textured and coated monofilaments. The fibers are more widely spaced than those in the second-generation product, leaving room for rubber and/or other infill materials (Drakos 2013 and Taylor et al. 2012).

A fourth-generation material has been cited in some literature. At least one manufacturer indicates it is marketing a new product that uses a veined fiber with no rubber infill (Domo 2015). This generation of turf is not included in this report as little information is available about it.

Existing literature relevant for this alternatives assessment. A substantial body of literature exists on some of the topics discussed in this report. For example, many studies have examined the environmental health and safety characteristics of crumb rubber infill made from recycled tires. These are summarized in the relevant sections of this report.

For some topics, very little is available in the way of peer reviewed literature. For example, for the discussion of turf maintenance costs, this report relies on a combination of "gray literature" (vendor information, unpublished studies developed by universities and other institutions in the process of making purchasing decisions) and raw cost data from institutions currently managing sports fields.

A few articles, reports, and other documents explicitly undertake a multifactorial comparison among turf options, with some structural similarities to the assessment undertaken in this report. These resources are briefly summarized here.

Gale Associates, a consulting firm specialized in "repair, renovation and adaptive reuse of existing buildings, sites and infrastructures" (Gale Associates 2015), has developed a table that compares multiple types of infill. The table compares infill options based on the following parameters: material, color, shape, abrasiveness, UV stability, typical turf pile height, availability, need for a resilient shock pad, need for irrigation, expected life span, typical mixture, and approximate cost. It also provides a summary of pros and cons of each infill option. The information in the table is based on "online data, manufacturers literature and conversations with turf and infill distributors," and Gale Associates does not guarantee its accuracy (Gale Associates 2015a). The Gale Associates comparison does not include information on natural grass, or on the other components of a synthetic turf system.

A study published in *Environmental Science and Technology* provides two comparisons: an overview comparison of synthetic turf with natural grass, and a comparison among multiple types of infill. The comparison of synthetic turf with natural grass includes comments on cost, visual appearance, smell, durability, installation conditions, field availability, drainage, irrigation requirements, maintenance, player safety, and environmental functions. The comparison among infill types covers, in general qualitative terms: advantages, limitations, cost, recyclability, and field performance (Cheng et al. 2014).

Many other resources provide comparisons on one parameter, e.g. chemical emissions or life-cycle costs. These are presented in the relevant chapters of this report.

References

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