PITCH IN

Microplastic loss from artificial (3G) pitches in context of the ECHA proposed restriction of microplastics intentionally added to products.

Briefing by

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Supported by

Third generation (3G) artificial pitches use performance infill to make a more comfortable playing surface, loose elastic granules that are added between the 'grass' filament pile. In the vast majority of cases this infill is made of microplastic[1], often a rubber crumb made by grinding up end of life vehicle tyres (ELT). Using loose microplastic in an outdoor setting clearly creates a risk of microplastic pollution to the environment. This risk was only recently recognised meaning potential alternatives and technical mitigation techniques are only starting to be investigated. We know that infill can be lost from pitches by being carried off by players, migrating from the edges of the pitch into local surroundings, or entering drains and waterways. Storage and transport of granules, installation, removal and treatment of waste pitches all represent additional risks of pollution. Limited quantitative studies mean estimates of loss are variable and hard to constrain, but losses are evident at most pitches and there is sufficient evidence to suggest quantities are significant compared to other sources of microplastic pollution across Europe[2]. Knowing the potential hazard of these microplastics to soil, freshwater and marine water environments, action is needed to prevent this source of pollution.

Figure 1. Infill loss from pitches can be extreme in some cases leading to acute pollution of the local environment. This image from adjacent to a field in Norway shows black infill build-up following snow removal. (Photo: Trondheim commune / Mepex 2016)

1 **In 2017, only 3% of market share of FIFA certified 3G pitches used organic infill – the remaining 97% of infill would fall under the definition of a microplastic.**

2 **See Appendix A for a list of studies**

Considering these known impacts, infill is rightly included in the scope of the upcoming microplastics restriction under REACH. We see the best course of action as follows:

1) **We should stop using microplastic on pitches as there are many microplastic-free solutions on the market and mitigation measures are never going to be fully effective to stop loss.**

    a. The best way to stop microplastic pollution is by switching to alternative materials; a restriction is clearly the most effective solution from a risk-management perspective.

    b. A variety of alternative infills are widely available on the market and have been used successfully for years; costs are comparable to microplastic infills and many options provide broader environmental and socio-economic benefits. A restriction will promote market diversification and innovation toward more environmentally friendly options.

    c. Mitigation measures have not been proven effective in stopping losses – existing studies do not take all loss pathways into account and there can be no doubt that microplastic will continue to escape where it is still used as loose infill on a field. We do not support the concept of an allowable threshold of loss as this does not have a scientific basis[3], is not in line with other microplastic restrictions, and will be near-impossible to enforce.

2) **Existing pitches have been designed without mitigation in mind and should be required to minimise losses where they continue to use microplastics.**

    a. It is reasonable to assume that existing pitches will continue to use microplastic during any transition period and potentially even after the restriction comes into force, as pitch owners could obtain sufficient infill to ensure they can use their pitch until it is due for refurbishment.

    b. Mitigation measures should be used to reduce these losses, e.g. installing physical barriers and adapting maintenance regimes. Where these measures have been proven effective, they can continue to be useful as barriers to loss of organic infills, reducing resource waste, therefore we encourage implementation of such measures as standard wherever infill is used.

    c. Mitigation should factor in end of life, installation, and removal of pitches, as these processes can contribute significantly to microplastic loss.

3 Considering the extreme persistence of microplastics, there is no acceptable threshold at which microplastic can be acceptably lost to the environment.

1. RISKS, EMISSIONS ESTIMATES AND FEASIBILITY OF SOLUTIONS

1.1. Though current estimates of loss are uncertain, significant losses do occur; not only to drains but also to the local environment.

Initial estimates of infill loss have been made by examining the total quantity of infill that is required to be 'topped up' each year at an individual pitch[4]. Microplastic pollution from pitches is well-documented. Field studies indicate that it is not unusual for several hundred kilograms a year to migrate from the edge of pitches into nearby soil & grass, with infill regularly found in stormwater and local watercourses. Particular practices, such as poorly managed snow removal, have led to far greater losses and larger required top-ups over a single season, with clear evidence of pollution of local land & aqueous ecosystems (Figure 1)[5]. However, major losses are not limited to cold climates; a recent suspected spill event in Hong Kong (Figure 2a) has led to hundreds of kg of material washing up on a coastal bay[6], with nearby pitches discovered to be losing infill directly to drains (Figure 2b).

Figure 2a Rubber crumb material washed up on a beach in Hong Kong, suspected to originate from a nearby pitch. Photo: Dana Winograd, Plastic Free Seas

4 E.g. Lassen et al. (2015) Occurrence, effects and sources of microplastic releases to the environment in Denmark.

5 Sundt, Schulze and Syversen (2016), Sources of microplastic-pollution to the marine environment. *Report by mepex to the Norwegian Environment Agency*

6 https://hongkongfp.com/2020/07/29/black-rubber-like-crumbs-wash-ashore-around-lantaus-discovery-bay/

Figure 2b – Infill entering a drain at a pitch in Hong Kong, local to the recently discovered rubber crumb on the beach. Photo: Plastic Free Seas

Most studies assume that not all of this ‘lost infill’ necessarily leaks to the environment, as some enters the waste stream and some potentially stays on the pitch through compaction or redistribution[7]. One recent desk-based study used mass-balance calculations comparing monitored losses from field studies to the total weight of infill top-up to suggest that up to 75% of infill top-up is due to compaction[8]. Another recent pilot study by Ecoloop claims that mitigation measures can effectively reduce emissions to zero[9]. Both studies were commissioned by tyre recycling organisations and were limited in scope. We consider these revised figures are likely to be under-estimating loss for the following reasons:

- Though compaction could be the cause of some required infill top-up, this is not a proven theory and unlikely to be a significant sink, as this would lead to an unwanted hardening of the pitch surface over time and pitches undergo regular decompaction treatment to avoid this[10]. New research is due to be released, assessing the weight of pitches entering recycling centres at the end of their lifespan and showing no difference between the weight of a pitch at the start and end of its life. This strongly suggests that ‘lost infill’ does not remain on the pitch[11].

7 See detailed review of studies in Hann et al. (2018), Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products. *Report for DG Environment of the European Commission by Eunomia Research & Consulting*

8 Lokkegaard et al. (2019) Mass balance of rubber granulate lost from artificial turf fields, focusing on discharge to the aquatic environment. *Report by Danish Technological Institute for Genan A/S*

9 Regnell, F. (2019) Dispersal of microplastic from a modern artificial turf pitch with preventive measures. *Report by Ecoloop to Ragnsells tyre recycling*

10 Paul Fleming, pers. comm. and Fleming et al. (2015) Understanding the effects of decompaction maintenance on the infill state and play performance of third-generation artificial grass pitches. *Journal of Sports Engineering and Technology 229 (3) 169-182*

11 Bjorn Aas, Study in preparation, Norwegian University of Science and Technology, Center for Sports Facilities and Technology

- No reports have quantified potential losses during installation and removal, storage and transport of infill, which are all likely to be additional routes of loss[12] (see Figure 3). A recent study highlights how rubber crumb can be stored precariously in outdoor locations, close to the marine environment with few apparent barriers to stop environmental leakage[13].
- Wear and tear of rubber crumb, EPDM and TPE readily creates smaller particles and dust (<~0.1mm)[14], which are not stopped by most filters, and can be transported further and via different pathways to larger particles. Technical limitations mean their losses have never been monitored.
- Any infill ending up in waste disposal is not guaranteed to be contained and remains at risk of loss to the environment[15]. These potential losses have not been factored into studies estimating environmental emissions.

Appendix A provides a table of reviewed studies, the estimates of loss they give and key notes regarding methodology.

Figure 3 EPDM granules (green) near a drain shortly after installation of a pitch. Photo: Fidra

12 Regnell 2017 Mikroplaster från konstgräsplaner: Orsaker till spridning av mikroplaster samt en kvalitativ analys av spridningen till dränerings- och dagvattenbrunnar Masters Thesis, KTH

13 See figure 1 in Halsband et al. 2020 Car Tire Crumb Rubber: Does Leaching Produce a Toxic Chemical Cocktail in Coastal Marine Systems?

14 Olofsson & Lyu (2019) A Pendulum Rig study on airborne migration of particles from artificial football turf. *Proceedings of BALTTRIB'2019*

15 RAC notes that municipal solid waste pathway has an overall release factor of approximately 0.5%

1.2. Hazard of infill to both terrestrial and aquatic ecosystems is of sufficient concern to warrant action to stop MP loss.

The specific ecotoxicology of *microrubber* particles (which include SBR and TPE particles) has been assessed in a recent review paper summarising existing knowledge of the impact these particulate elastomers can have on ecosystems and organisms through both particle toxicity and association with harmful chemicals[16]. ELT rubber granules are known to contain a range of hazardous chemicals, including benzothiazoles, phthalates, metals[17], bisphenol A, PAHs and emerging contaminants such as chlorinated paraffins[18], and *microrubber* properties mean they are more likely to associate with any persistent organic pollutants in the environment[19]. Potential additive effects of these chemical mixtures have not been explored[20]. Rainfall on rubber crumb has been shown to lead to run-off containing significant quantities of harmful substances as leachate from rubber crumb, and volatile substances have been detected in the air above pitches[21]. Leachates are already known to impact the environment and can increase with ageing of the particles[22] suggesting their impact could increase as they persist in ecosystems. Leachate and particles have been shown to have impacts on organisms. Examples from laboratory studies include evidence of impact on chicken foetuses[23], earthworms[24] and freshwater fish[25].

1.3. Technical mitigation has the potential to reduce (but not stop) losses to the environment. Existing measures have not yet been assessed sufficiently to prove effectiveness.

A number of mitigation measures have been proposed to reduce microplastic from pitches including fitting physical barriers, adapting maintenance techniques and changing user behaviour. A set of guidelines collated by Fidra and KIMO international in 2018 attempt to summarise potential techniques, as well as considering alternative infill or pitch-types to reduce losses[26]. The goal of collating these practices was to encourage further refinement, testing and standardisation of these techniques by industry or academia and promoting uptake of best practice into industry standards. Though industry have shown significant interest in taking up mitigation measures, there has been insufficient emphasis on testing these measures to ensure their effectiveness.

16 **Halle L. et al. (2020) Ecotoxicology of micronized tire rubber: Past, present and future. *Science of the Total Environment***

17 **E.g. Particularly high concentrations of zinc have been detected, which may be partly due to zinc oxide used in vulcanisation process of rubber (e.g. [Celeiro et al., Determination of priority and other hazardous substances in football fields of synthetic turf by gas chromatography-mass spectrometry: A health and environmental concern, *Chemosphere,* 2018)]**

18 **Sicco H. et al. (2019) Chlorinated Paraffins in Car Tires Recycled to Rubber Granulates and Playground Tiles. *Environmental Science and Technology*, 53 (13) 7595-7603**

19 **Op cit. Halle et al. 2020**

20 **Op cit. Sicco et al. 2019**

21 **Op cit. Celeiro et al. 2018**

22 **Verschoor, A. (2015) Leaching of zinc from rubber infill on artificial turf (football pitches), *RIVM report 601774001/2007***

23 **Xu et al. (2019) Artificial turf infill associated with systematic toxicity in an amniote vertebrate. *Proceedings of the National Academy of Sciences of the United States of America*, 116 (50) 25156-25161**

24 **Op. cit. Pochron et al.**

25 **Kolomijeca, A. et al. (2020) Increased temperature and turbulence alter the effects of leachates from tire particles on fathead minnow (Pimephales promelas) *Environmental Science and Technology* (just accepted)**

26 **https://www.fidra.org.uk/artificial-pitches/cleaner-pitch-guidelines/**

The 2019 study of a pitch in Kalmar represents the first attempt to quantify effectiveness of technical mitigation measures[6]. The study suggests that measures tested have potential to be highly effective, but we note that the study has not been peer-reviewed, and we observe significant limitations to its applicability:

- The study does not assess losses to soil/ pavements, where most pollution has been observed in other field studies, but instead focuses only on stormwater.
- The pilot involved using very stringent measures and participation of all users & maintenance teams involved in the pitch. It is highly unrealistic for these measures to be followed so carefully every time they are used, across all pitches in Europe.

With certain regions beginning to implement such measures on pitches, further monitoring studies should be possible and ought to be a requirement where RMMs are taken on as a solution. With so many potential pathways to loss, mitigation techniques will never stop 100% of infill loss across all pitches.

1.4. Basic similarities in technical mitigation between rubber crumb and pre-production plastic pellets does not mean that Operation Clean Sweep is a model solution for artificial pitches.

Within the ECHA documentation certain parallels are drawn between technical mitigation measures and best practice used to contain pellet spills, as outlined in the Operation Clean Sweep[27] toolkit. There are similarities between OCS and some of the handling requirements for granulated microplastic, for example in storage and transport of infill, as many similar rules apply in terms of ensuring storage is safe and will not lead to spills.

However, the comparison does not lead us to support mitigation measures as an option. A 3G pitch requires large volumes of microplastic to be kept loose outdoors, something that would not be acceptable according to OCS guidelines, for example. OCS measures are intended for large industrial facilities that are maintained by professionals, which is not comparable to sports pitches regularly used and maintained by volunteers / the public. We wish to highlight that OCS has been in place for almost 30 years and has not been successful in stopping industrial plastic pellet loss, and further legislative measures are called for[28]. *With a range of alternative materials available, we would see microplastic infill as a non-essential microplastic ingredient, which should be removed from the market.*

1.5. 3G pitches are not a solution to the end of life disposal of tyres – end of life disposal of rubber crumb continues to create environmental problems.

End of life is a key issue that has been overlooked for artificial pitches and infills and this has a direct impact on the microplastics problem. Stockpiling has been shown to be commonplace and have been shown to be further sources of microplastic loss[29], alongside other pollution problems, including fires[30]. Certain pitch 'recycling' companies offer segments of turf or loose refill to be reused in landscaping or as animal substrate[31]. This older material is likely to disintegrate over time, creating finer powders that are more easily dispersed by the wind/ water and more likely to be emitted[32]. The use of ELT tyres as infill is often labelled as an inherent environmental benefit, an assumption that needs closer interrogation (see B2).

27 See www.opcleansweep.eu

28 FFI, Fidra, EIA, Rethink Plastic (2019) Our Oceans Need Actions not promises: Towards a regulatory approach to pellet loss.

29 Zembla (2018) What happens to plastic and polluting artificial turf?

30 See notes to specific fires in California & Washington in this US blog article.

31 E.g. loose 'recycled rubber crumb' offered as playground or animal substrate https://www.chapsmithservices.co.uk/synthetic-surfaces-astroturf-removal-and-disposal/

32 Magnusson, Kerstin, Karin Eliasson, Anna Fråne, Kalle Haikonen, Johan Hultén, Mikael Olshammar, Johanna Stadmark, and Anais Voisin. "Swedish Sources and Pathways for Microplastics to the Marine Environment. A Review of Existing Data." IVL Svenska Miljöinstitutet, no. C 183 (2016): 1–89.

2. SOCIO-ECONOMIC IMPLICATIONS

2.1. A variety of alternative infills are available on the market, often marketed as having significant advantages over microplastic alternatives. An impending restriction will help to guide innovation toward truly environmentally friendly products.

Some municipalities and cities are increasingly aware of environmental issues surrounding microplastics and are taking the decision to avoid SBR rubber crumb infill[33], meaning the market for alternative infills is already growing. Cork has been used in Europe for at least 10 years, with hundreds of pitches using the material across Europe. In addition to options such as cork and coconut husk, newly available infills include other waste products such as wood, hemp, cellulose fibre and olive stones.

- There are technical advantages and disadvantages to all infills, including crumb rubber and other microplastics. For example, cork infills are described as additive free, 100% recyclable, anti-microbial, flame resistant, lower density having a similar feel to soil, odour free, and providing a cooler playing surface than microplastics[34]. Regular conversations with pitch users indicate that many see SBR rubber crumb as unpleasant, unhealthy and a nuisance to deal with after training. Complaints include bad smells, high surface temperatures, and how dusty the material can get over time. Health concerns arise from the knowledge of a high chemical load[35] and the fact that players can end up ingesting granules, getting them stuck in cuts and scrapes or inhaling dust. Opinions from a range of infill manufacturers suggest that continuous influx of cheap and ubiquitous SBR rubber has somewhat suppressed innovation in the field toward alternative infills, not only to reduce environmental harm but also to improve the player experience, and a ban is seen by some as an opportunity to diversify to new products[36].
- Many infills are marketed as environmentally friendly. These include those made from 'biodegradable plastics' (e.g. 'biofill'), and blends of microplastic and organic material (e.g. Super Natural – a mixture of hemp and EPDM polymer). As there is currently no stringent testing for infill material, this can create confusing messaging for consumers seeking fully biodegradable alternatives. Infill products should undergo the same rigorous testing as other ingredients replacing microplastic in the REACH restriction, helping customers to navigate potential greenwashing and ensuring that infill innovation leads to truly environmentally friendly products.
- During the public consultation, ECHA received many contradictory claims about alternative infills, their availability, cost and technical performance. We have since endeavoured to find out more about these infills in order to fill apparent knowledge gaps. An updated list of infills is included in Appendix B, with information about their technical specifications gathered through direct communication with infill manufacturers[37].

33 E.g. municipalities in Germany and Norway are removing subsidies for pitches using SBR rubber crumb – see information in Lassen et al. (2020) Kunstgræsbaner. Alternativer til gummigranulat som infill og erfaringer med banepleje Report for Miljostyrelsen, DK

34 https://www.lesuco.be/wp-content/uploads/2017/04/Domo-NaturaFill.pdf

35 For example, the threshold limit value for PAH in infills (10mg/kg) is very high compared to eg. toys 1 mg/kg (3-14 years); or 0,5 mg/kg (0-3 years); The Scientific Committee on Food recommends that the content of PAHs in foods should not be measurable. If present in a measurable amount, the food is unacceptable. https://www.foedevarestyrelsen.dk/Leksikon/Sider/PAH-i-f%C3%B8devarer.aspx ; https://mst.dk/service/nyheder/nyhedsarkiv/2018/sep/ny-undersoegelse-af-pah%C3%A9r-i-forbrugerprodukter/

36 Personal communication with infill manufacturers, and E.g. https://news.brockusa.com/artificial-turf-our-bodies-of-water-a-war-on-microplastics

37 Also available online at https://www.fidra.org.uk/artificial-pitches/plastic-pitches/solutions/#infills

2.2. The costs of replacing pitches with alternative infills appear to have been overestimated compared to mitigation measures

- We agree with the SEAC committee's analysis that original costs of pitch replacement have been overestimated for RO2. The 6 year transition period means that 80-90% of pitches will be due to be replaced in that time anyway, meaning many costs of replacement can be factored into standard upkeep costs. However, SEAC analysis does not emphasise sufficiently that a 6 year transition period should drastically reduce societal cost. What is also unclear from our perspective is whether any pitches will be required to replace their surfaces prematurely, considering that the ban is specifically focused toward infill sale, rather than use. This should be considered within emissions calculations as it extends the window of microplastic pollution by several years.

- SEAC and the Dossier Submitter have used estimates based on an earlier analysis of a ban on ELT rubber crumb due to levels of polyaromatic compounds (PAHs) within SBR crumb specifically[38]. This earlier analysis assumes that most pitches will switch from ELT (the cheapest infill) to other forms of microplastic, which are far more expensive than organic alternatives. Cork is the only non-microplastic alternative used in the assessment. This is more expensive than ELT per tonne, but its lower density means less infill is needed overall (see Table 1)[39]. The upfront cost of using cork, according to the costings given, is in fact lower even than ELT granules if calculated per m2.

Table 1 Cost of infills taken from PAH restriction Annex XV report p. 22

Infill	ELT Granules	EPDM	TPE	Cork
Cost per tonne (Euros)	220 (180-500)	1750	1600	1350
Tonnage needed	15 kg/m2	6	7	1.3
Microplastic?	**Y**	**Y**	**Y**	**N**
Total Cost per m2 (Euros)	**3.30**	**10.50**	**11.20**	**1.76**

- We agree with the SEAC assessment that costs of alternative infills will reduce over time. Through conversations with infill providers, we understand that a key factor in the cost of alternatives is lower demand. Alternatives are often tailor-made and specifically sourced, increasing costs. They are also marketed as premium 'green' products, which may allow producers to charge higher prices[40].

- The cost of other infrastructure has also been included in the estimated costs of replacing infills. For example, cost analysis has factored in the costs of shockpads to the replacement of infills with replacement costs estimated at E200,000. This is slightly misleading. Though we understand that alternative infills do generally need shockpads, these are being promoted for all new pitches whatever infill is used. They are seen as a cost-effective measure to increase durability of pitches[41], improve player safety[42] as well as a potential mitigation measure to reduce microplastic loss (shockpads reduce the amount of infill needed, which is thought to reduce total migration from pitches)[43]. As mentioned in BD Annex D, p. 353, RIVM highlighted that 'most modern pitches have a shockpad'. Furthermore, there are alternative infill systems that do not use shockpads but still meet required industry playing standards[44].

38 https://echa.europa.eu/registry-of-restriction-intentions/-/dislist/details/0b0236e181d5746d

39 See p. 220, Annex XV report, ECHA PAHs restriction [https://echa.europa.eu/registry-of-restriction-intentions/-/dislist/details/0b0236e181d5746d]

40 E.g. Cork infill described as 'eco-friendly' https://www.lesuco.be/wp-content/uploads/2017/04/Domo-NaturaFill.pdf

41 E.g. https://www.sportslabs.co.uk/field-notes/2018/2/1/5-things-you-need-to-know-about-shockpads

42 http://www.brockusa.com/concussions/

43 See Fidra guidelines, and draft CEN guidance on infill loss mitigation measures.

44 E.g. Sprinturf Natural, Greensport Synthetic Turf System meets STC /One Turf standard – see Greenplay technical data sheet.

- A new study examining costs of pitches over 10 years indicates that infill-type is not actually a major factor impacting costs. Shockpads require a higher initial spend, but are shown to be cost-effective over the lifetime of the pitch, while pitches with alternative infills come out as cheaper overall than most microplastic options over a 10-year lifespan (See Figure B1, Appendix B)[45].

2.3. Environment and Socio-economic 'Benefits' of SBR have not been fairly compared with potential benefits of moving to alternative infills

- The SEAC opinion mentions the potential 'lost benefits' of losing a pathway to reuse of old tyre waste. The issue of waste tyres is an undeniable problem, but we do not see the use of tyres on pitches as a solution – rather a delay to dealing with this waste issue. We appreciate that there are often lifecycle benefits to re-use of material - if the material was replacing virgin plastic for example - but in this case, the organic materials replacing ELT can often also be a waste product from a different process. Instead, the use represents a delay to landfill, with the granulation, use on pitches and later disposal in fact leading to greater risk of dispersal to the environment. Reuse of tyres simply has simply shifted the burden of final disposal on the artificial pitch producers and users, removing responsibility from tyre producers and users.
- As highlighted in the Dossier Submitter's background document, there may be opportunity to use the black crumb rubber in a consolidated form as a shockpad under the pitch[46], or other alternative uses, which would represent less risk of loss to the environment[47]. However, the restriction should also place further much needed pressure on tyre manufacturers to innovate their products to fit more effectively into a future circular economy.
- Many alternatives are examples of waste product streams including coconut husks, 85% of which are currently claimed to be burnt or sent to landfill[48], and may provide additional income for rural coconut farmers[49]. Infill made from olive stones and walnut shell are also examples of products created from wasted biproducts. For example, 2.4 tonnes of waste are created for every 3 tonnes of olives picked for oil[50], with olive stones representing 25% of waste. Stones have been considered for a variety of construction options including performance infill that has already successfully been installed in pitches across Europe[51]. Cork infill could also be made from waste cork wine stoppers; it has been estimated that approximately 500 tonnes of cork stoppers would be available in Catalonia alone[52].
- Use of organic infills can provide additional environmental and socio-economic benefits. Cork farming is important economically and environmentally in Mediterranean regions[53] – it uses sustainable farming techniques that support forest ecosystems. In Portugal, cork exports reached a value of a billion euros in 2018[54]. In Greece as one example, 250,000 tons of table olives are produced annually, with their export accounting for 9.2% of total agricultural product exports[55].

45 Bjorn Aas, Study in preparation, Norwegian University of Science and Technology, Center for Sports Facilities and Technology

46 See recent example in Norway, https://medium.com/@ValueActs/teie-if-norwegian-sports-club-brings-us-an-environmentally-friendly-turf-solution-576c28e21322

47 ECHA Dossier Submitter Background Document, Annex D, Figure 14

48 As claimed by Cocopallet https://www.cocopallet.com/why

49 https://farmfolio.net/articles/waste-not-putting-coconut-husks-good-use/

50 Martin et al. 2020 *Energetic Valorisation of Olive Biomass: Olive-Tree Pruning, Olive Stones and Pomaces.* Processes 8 (5):511. 10.3390/pr8050511

51 E.g. https://www.connexionfrance.com/French-news/french-football-stadium-replaces-environmentally-dangerous-rubber-infill-grains-on-synthetic-pitch-with-olive-stones-made-in-provence

52 Cork Infills Report ICSuro, 2020

53 Eunomia Research & Consulting (2017) Environmental Impact Study on Artificial Football Turf Report for FIFA

54 APCOR Cork Yearbook 2018/19

55 Ordoudi S et al. (2018) The Potential of Tree Fruit Stone and Seed Wastes in Greece as sources of bioactive ingredients Recycling 3, 9; doi:10.3390/recycling3010009

2.4. How do costs to pitch owners compare to costs and benefits to different industry sectors? How has this been assessed by SEAC?

- Analyses by ECHA and the SEAC committee do not clearly differentiate between costs to communities investing in sports pitches, and the costs that may be incurred by certain companies. We are concerned that the implementation of mitigation measures, for example, may fall more on communities (particularly where effective mitigation requires significant behaviour change and new physical boundaries incorporated) compared to switching to alternatives.
- The analysis does not appear to consider potential economic benefits achieved by opening up markets to alternative infills, or to sales of physical barriers, which will inevitably increase profits for certain industry actors.
- We would like to see more clarity regarding the distribution of costs in SEAC's assessment.

Appendix A

investigating microplastic loss from pitches

Table A1 below aims to review existing studies investigating microplastic loss from pitches. The list is non-exhaustive.

Estimates of loss	Notes on methodology / other information	Study
300-700kg of infill lost to soil or drains per pitch per year [Using same estimate of no. of pitches as Eunomia this equates to 16,800-39,000 tonnes per year across EU] Suggests 10-200kg/ year lost by discharge to water per pitch per year	**Mass balance estimates (review)** - Have used mass balance to assess the relative compaction rate relative to other losses. - Rubber crumb could also be adding to the depth – adding 1-1.9 tonnes over a year will only add btw 3-5mm to thickness. Bases mass balance on other surveys, though the authors have not used the full range of studies reviewed: - Use Linberg estimate of 2.2 tonnes per year added to pitches - Compaction calculated at 13-17% (compared to field measures of compaction 8.2-14.6%) - Norwegian survey: 40kg /course /yr by clothing - Danish: 250kg to soil - Measure of loss to sewage – dutch: 6-10kg, Swedish – 200-340kg (but this study only 10-200kg?) o Does not account for potential indirect routes, such as via poor waste management and sewage sludge reuse. o Not peer reviewed	Lokkegaard et al. (2018) Mass balance of rubber granulate lost from artificial turf fields, focusing on discharge to the aquatic environment – Danish Technological Institute (DTI) *Report for* GENAN A/S tyre recycling
18,000-72,105 total losses across EU – (includes losses to waste streams) 1-5 tonnes per year per pitch Incl. waste disposal (45%), surface & internal drains (10%) & soil/ grass (45%)	**Review study** - Based on total of 51,616 pitches across Europe (2018 -estimate from ESTC market vision) – and infill of 1.8 million tonnes (assuming all pitches use SBR rubber). - Desk-based study – uses previous studies – mainly Netherlands study for % of loss? - Fibre losses of 0.5-0.8% annually – based on Sharma et al. 2016 assessments assuming loss of 0.32mm per year. - Dismisses compaction as studies indicate a well-maintained field should negate compaction (Fleming et al. 2015)	Hann et al. (2018) Investigating options for reducing releases in the aquatic environment emitted by (but not intentionally added in) products. Report for DG Environment of the European Commission by Eunomia Research & Consulting
1.5-2.5 tonnes per year per pitch lost to environment.	**Mass balance estimate (review)** - Top-up of 3-5 tonnes. - Half of the estimated top-up is estimated to be due to releases to the environment.	Lassen, 2015 – Occurrence, effects and sources of releases to the environment in Denmark
1640-2460 tonnes per year nationally (not including indoor arenas)	**Mass balance estimate (review)** - Based on quantity of Top up every year: Original estimate @ 3-5 tonnes per pitch/yr, revised to 2-3 tonnes /yr (Lun-dquvist, pers. Comm.) – half of this is estimated to enter environment. - Does not account for any compaction or waste disposal.	Magnussen 2016 – Swedish sources and pathways for microplastics to the marine environment (2017 revision)

Estimates of loss	Notes on methodology / other information	Study
3.6 tonnes per year **per pitch**.	**Mass Balance using mass of pitch at start vs. end of life, and quantities topped up each year.** - Compared weight of pitch at end of life (transfer to recycling) to initial weight and avg weight of top-up	Bjorn Aas, in preparation, Norwegian University of Science and Technology, Center for Sports Facilities and Technology
Max 340-370kg into drainage wells. Max 0.003kg down to its drainage system.	**Field Study** investigating potential losses - Also highlights that granules can be lost during handling while refilling, which could explain some gap between infill top up and total losses… (this could be another data gap) - Focus on drainage wells – not to local soils. - Based on total particles within size-range of microplastic found in samples from inner drainage system, extrapolated to total areas of football fields.	Regnell (2017) Mikroplaster från konstgräsplaner: Orsaker till spridning av mikroplaster samt en kvalitativ analys av spridningen till dränerings- och dagvattenbrunnar *Masters Thesis*
Losses to drains and from players only, not to surrounding soils – Potential spread: 15.6kg Spread that can be prevented - >99% Other routes to environment: Potential spread from player socks/shoes ~26.8kg Maintenance – 0.1 – 24.1kg	**Field study** testing best practices - Based on a small no. of measurements, and only on one pitch - Reporting on a brand new pitch that has been designed with mitigation measures in place. - Study highlights significantly more losses in first 6 months after installation. - Paper does not document migration onto surrounding soil off the edges of the pitch, where majority of infill is likely to be lost. This is the ONLY study where mitigation measures have been tested – will the same level of stringency be applicable to all sites?	Regnell, 2019 Dispersal of microplastic from a modern artificial turf pitch with preventive measures Report by Ecoloop for Ragnsells tyre recycling
Socks and shoes – 12kg/yr Roads – 0-40kg/yr Waste water 0.3-0.9kg (only 2 measures) Surface water – 0-100kg Grass – 4-260kg 'hardening'(compaction?) – 1-60kg	**Field study** assessing individual losses - Also compared to data using mass balance - NB study found SBR granules in sewage sludge and soil surrounding a cork field – left from previous pitch. **mats not always effective Not all pitches topped up infill each year – varied from 0 to 2200kg (avg 500kg?) - **Workshop highlighted that maintenance staff use leaf blowers and blow infill off the side of pitches** - "Insight into the extent of the spread of microplastics with various maintenance measures is lacking." - Soil contamination could mean that land is not viable for reuse (20-25% of non-soil additions to soil). - Study found significant vertical migration of infill on pitches that have been there for a long time. - Estimate compaction at a rate of 400kg/year by comparing densities of infill at various sites around the field.	Weijer, and Knol (2017) Verspreiding van infill en indicatieve massabalans, Report for Branchevereniging Sport en Cultuurtechniek, May 2017
Total to stormwater – 2-4 tonnes Total to sewage – 0.75 tonnes Total to surrounding nature – 1-3 tonnes	**Field Study** - Flow model based on Alvsjo football club in Stockholm - Total replenishment for 4 pitches of 6-10 tonnes per year. - Heavy snowfall doubled necessary top-up rates of pitches. 11% of infill loss from snow removal.	Wallberg, P., Keiter, S., Juhl Andersen, T., Nordenadler, M. (2016). Däckmaterial i konstgräsplaner. Rapport. Sweco Environment AB.

Review of performance
Infills available on the market

During public consultation on the topic of microplastic loss from pitches, ECHA have clearly received competing claims regarding the availability, usability, and environmental impact of alternative infills. Our own investigation through research and personal communication with alternative infill manufacturers reveals that many negative claims are exaggerated, or unfounded.

In this appendix we attempt to examine some of these claims to (hopefully) clarify some of the potential advantages of alternative materials.

Table B1. A non-exhaustive list of microplastic-free alternative infills on the market, including material description - see https://www.fidra.org.uk/artificial-pitches/plastic-pitches/solutions/

Product Name	Material Description
Amorim Nature 130	Pure granulated cork (130kg/m3 density)
Amorim Nature 190	Pure granulated cork (190kg/m3 density)
Amorim Organic 201	Processed cork and olive components
Geo Plus	Processed organic plant material
Purefill	Cork
Pureselect	Olive cores: Made from European sources.
Shell Tech	Walnut shells
Safeshell	Walnut shells
Corkonut	A combination of coconut fibre and cork
BrockFILL	Engineered wood chip
eCork	Expanded (heat treated) cork
Zeofill	Deoderising infill and alternative to sand – made from clinoptilolite zeolite (a type of silica).
ZChill / ZCap	Zeolite mineral infill

Quality and durability of organic infills

FIFA Quality Pro or FIFA Quality programme tests artificial playing surfaces in the laboratory and on the field according to stringent criteria. This means they test the **whole system**, including the shock pad, yarn, and infills (sand and / or performance infill), for specific performance criteria[56]. Individual components of a system are not individually given a FIFA Quality Pro or FIFA quality mark. Contrary to claims that organic infills do not meet playability standards, there are multiple artificial systems using organic infills which have been awarded FIFA quality pro and FIFA quality marks[57] and a total of 53 pitches currently using cork infills are FIFA certified[58]. Where they have not yet been awared a FIFA quality mark, it may be more due to the lack of pitches installing these infills as opposed to them being poor quality.

56 https://football-technology.fifa.com/en/media-tiles/fifa-quality-programme-for-football-turf-1/

57 https://www2.mst.dk/Udgiv/publikationer/2020/02/978-87-7038-164-2.pdf

58 https://football-technology.fifa.com/en/resource-hub/certified-product-database/playing-surfaces/football-turf/turf-products/

Alternative infill manufacturers have carried out extensive testing on systems using their infills, providing information on heat creation, force reduction, skin / surface friction, G-Max, vertical deformation, energy restitution, critical fall height, rotational resistance and ball rebound[59,60]. Results indicate that many organic infills perform at least as well, if not better, in many performance criteria, proving their safety and playability standards.

Test results also indicate benefits relating to lower temperatures and increased safety[61]. Abrasion values, for example, are comparable to natural grass on systems using cork-coconut mixes, and significantly less than SBR rubber with walnut shell[62].

Heat Reduction

Urban heat island effect can be exaggerated by rubber crumb fields in dense urban environments, where artificial fields could increase the surrounding temperature by 4 degrees[63]. The socio-economic impact of creating artificially elevated temperatures on playing fields could be felt through negative impacts on player health or reduced playing time. Many organic infills are known to reduce surface temperatures of fields to values similar to natural grass[64]. In a society where climate change is creating rising temperatures, considerations such as these stack in favour of organic or natural turf systems.

Biocides / use of chemicals

ECHA's background document claims that organic infills are often 'treated with antimicrobial application to prevent deterioration of the infill over time'[65]. Multiple discussion with organic infill manufacturers repeatedly countered these claims suggesting that this was untrue and not required on artificial systems using cork (due to its natural antibacterial properties[66]), coconut husk, walnut shells or olive stone infill.

Floating

Density of alternative infills is variable and generally lower than rubber, meaning infills could float where water pools. However, for infill to float on water requires formation of puddles, which would indicate poor drainage. Infill contractors have told us that whether floating occurs depends mainly on the quality of the subbase under the turf system. If the base is permeable and well-draining, whether vertically, horizontally with the shockpad or a combination of both, infill should remain in place[67]. It is worth noting that even SBR rubber, with a density greater than rainwater, can become displaced with heavy rainfall if drainage is inefficient[68].

Lifecycle analyses of organic infills

In a 2017 study for FIFA , the environmental impact of cork at end of life was found to be equivalent or lower than SBR rubber for all assessed end of life routes from a carbon footprint perspective, compared to far higher carbon footprints for other microplastic options[69]. Composting was not assessed as an option but should be feasible for end of life of organic materials, further reducing potential environmental impacts at end of life.

Cork products such as cork stoppers as well as granulate have been calculated to have a negative carbon footprint during production. 18tm of CO2 is fixed for each ton of cork removed from the forest[70]. Olive oil production has also been shown to have the potential to be carbon negative[71].

59 **GreenplayUSA Natural / ProNatural technical data sheet**

60 **USGreentech Safeshell technical data sheet**

61 **GreenplayUSA FAQs https://www.sprinturf.com/wp-content/uploads/2019/10/Sprinturf-Naural-FAQ-4.pdf**

62 **Greenplay USA Natural Greensport technical data sheet – abrasion index 21, vs. SBR systems 30+ ; Safeshell technical datasheet – abrasion index 24**

63 **https://journals.ametsoc.org/jamc/article/49/3/332/13351/Modeling-the-Thermal-Effects-of-Artificial-Turf-on**

64 **GreenplayUSA ProNatural data sheet**

65 **ECHA Dossier Submitter Background document, D.13.5.2**

66 **https://academic.oup.com/femsle/article/363/3/fnv231/2594523**

67 **Personal communication with alternative infill manufacturers e.g. Saltex Biofill**

68 **E.g. https://www.montclairlocal.news/2018/08/15/montclair-athletics-massive-rainfall-causes-infill-displacement-on-mhs-fields/**

69 **Eunomia Research & Consulting (2017) Environmental Impact Study on Artificial Football Turf Report to FIFA**

70 **Rives, J., et al., Integrated environmental analysis of the main cork products in southern Europe (Catalonia, Spain), Journal of Cleaner Production (2013).**

71 **https://www.internationaloliveoil.org/731-application-for-the-calculation-of-c02-balance-in-olive-farming/**

Availability

Respondents to the ECHA consultation have highlighted potential issues of limited availability of alternative materials, though often responses have referenced cork specifically. Our conversations with cork manufacturers do suggest that cork production is unlikely to provide sufficient infill for all pitches across Europe. However, considering the range of alternatives available, and the millions of tonnes of waste material available from other production processes, and the tonnages required, we do not see availability to be an issue, particularly considering the long transition period proposed by ECHA. For example, 20 million tonnes of olives are produced per year globally[72] with around 1.45 million tonnes of olive stones produced in 2013[73]. Around 2.1 million tonnes of walnut shell material are created annually from global walnut production[74].

Cork, and other organic infills, can often be much lighter than SBR, requiring less material (by weight) than SBR. Where 100,000 tonnes of plastic SBR is used on EU fields annually, the equivalent cork infill required, for example, would be far less, closer to 25,000-30,000 tonnes. This should be factored into availability and cost assessments.

Costs

As highlighted above, the cost of infill cannot be compared directly according to cost per tonne. Costs should also include an assessment of – how much infill is needed to fill the pitch, how much top-up is required, and other structural features that can impact durability.

A recent Danish review concludes that alternative infills can vary in price to be more or less expensive than SBR-based pitches, with overall costs not varying more than 20% between different materials (Table B2)[75].

Norway has also carried out cost comparisons. Table B3 shows initial costs of infill, per tonne, on the Norwegian market. Analysis across a longer timespan has shown that the initially higher costs of infrastructure such as shockpads, is balanced out over the lifespan of a pitch, and in fact, where alternative infill is installed, the costs over a 10 year lifespan are in fact lower than for SBR rubber and other microplastics (see Figure B1).

72 Martin et al. 2020 ***Energetic Valorisation of Olive Biomass: Olive-Tree Pruning, Olive Stones and Pomaces*. Processes 8 (5):511. 10.3390/pr8050511**

73 **Murat Dogru (2013) EXPERIMENTAL RESULTS OF OLIVE PITS GASIFICATION IN A FIXED BED DOWNDRAFT GASIFIER SYSTEM, International Journal of Green Energy, 10:4, 348-361, DOI: 10.1080/15435075.2012.655351**

74 http://givemebid.com/en/walnuts-world-production-consumption-exports-imports-usda-annual-report/

75 **Lassen et al. (2020) Kunstgræsbaner. Alternativer til gummigranulat som infill og erfaringer med banepleje Report for Miljostyrelsen, DK**

Table 2 Table of infills assessed in Lassen et al. (Op cit. 75). The study examined costs of infill, construction of turf systems and operation costs of pitches using a variety of alternative infills, with information provided by suppliers. Results show that overall investment and operating costs are variable, but microplastic infills, including SBR rubber, are not always more expensive. See original document for list of references and detailed methods used.
https://www2.mst.dk/Udgiv/publikationer/2020/02/978-87-7038-164-2.pdf
† PLA= Polylactic acid (Saltex Biofill) M= Microplastic

Material	Cost of infill, in Danish Krone, DKR per kg	Infill consumption per field, tonnes	Construction costs for infill (1000 DKR/ field)	Total investment (million DKR/ field)	Expected refill (% of original volume on field)	Operating Costs (1000 DKR per year)
SBR^M	1.4-1.85	90-120	171	4 - 5	2%	~145
Coated SBR^M	3.7-5.5	50	230	4.4 - 4.5	<5%	70
TPE^M	11-15	50-70	780	-	6-8%	115-200
EPDM^M	5.1	50-70	306	-	6-8%	-
PE^M	19	44	836	5 - 5.5	2%	~134
Infill-free	0	0	0	5.1	0	~77
Cork	7	24	168	4.5 - 5.5	-	> 145
Expanded Cork	*5000 per m^2	*100 m^2	500	~4	8%	150-200
Mixed organic	20	50	1000	4.7 - 5.7	<5%	115
PLA$^{†, M?}$	*8000 per m^2	*100 m^2	800	~4.4	6%	200
Olive stone	13	25	325	4.7	16%	~143
Coconut husk	7.5	40	300	~4	15%	~180

Infill	Refills needed (tonnes/yr)	Price (NOK/tonne)
Sand		2,000
SBR Granulate	5	5,000
TPE	3	28,000
EPDM	3	23,000
Cork	3	28,000
Bioflex coated sand	2	7,400
Bioinfill/geo+(cork+coconut husk)	2.5	15,000
Bioplastic$^{M?}$	1.4	30,000
Olive granulate	1.5	12,000

Table B3. Estimates of costs per tonne for a number of infills available on the Norweigan market, and their relative top up (refill) amounts required annually when used in an artificial turf system; M= microplastic (Bjorn Aas, Norwegian University of Science and Technology, Center for Sports Facilities and Technology)

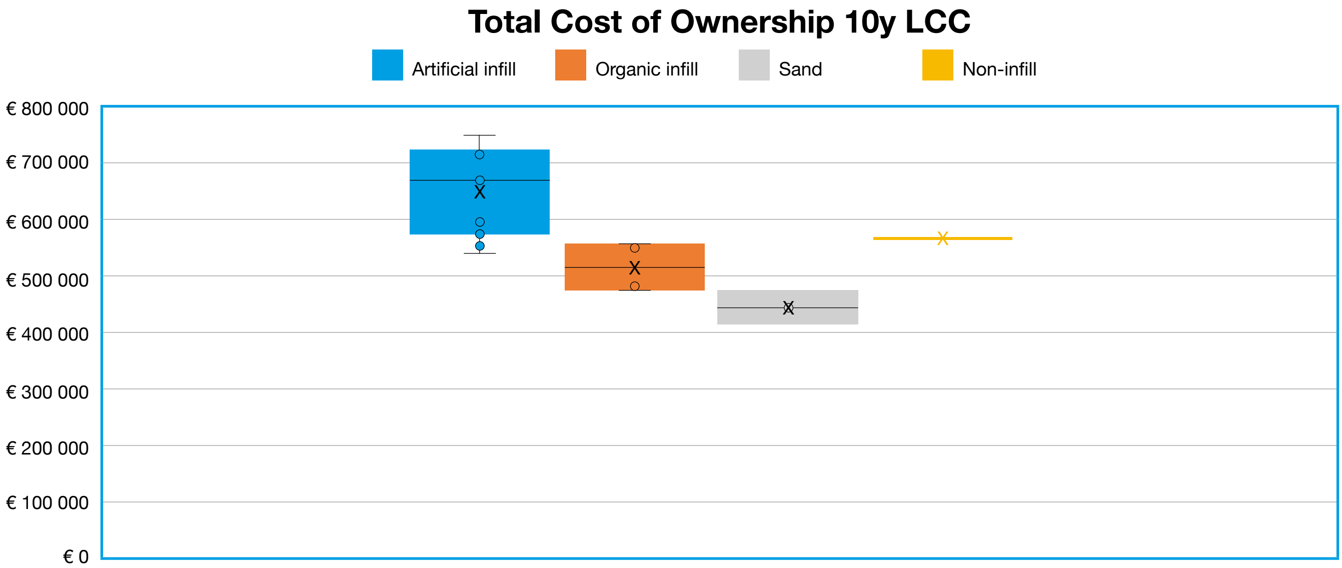

Figure B1 Preliminary results from a 10 year lifecycle cost assessment of a variety of turf systems. Results clearly indicate that the systems tested here using organic infills result in lower costs to those investing in pitches. The organic infill pitches investigated here use shock pads, requiring a higher initial investment, but results in lower maintenance costs over the pitch lifespan. Bjorn Aas, Study in preparation, Norwegian University of Science and Technology, Center for Sports Facilities and Technology