June 26, 2020 (updated July 8, 2020 with a correction to an inadvertently made and incorrect statement in regards to PFCAs as incineration products).

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RE: Review of the May 2020 narrative ESPR draft titled "Product – Chemical Profile for Treatments Containing Perfluoroalkyl or Polyfluoroalkyl Substances for Use on Converted Textiles or Leathers

I have reviewed the May 2020 narrative ESPR draft titled "Product – Chemical Profile for Treatments Containing Perfluoroalkyl or Polyfluoroalkyl Substances for Use on Converted Textiles or Leathers", which DTSC based on the literature and in consultation with stakeholders for external scientific peer review (ESPR) supporting their proposed adoption of converted textiles and leathers containing perfluoroalkyl or polyfluoroalkyl substances (PFAS) as a Priority Product. My understanding of converted textiles is that these are products that refers to the process of converting the textile fabrics to varying size and shape according to the requirement of the product. The product can be anything from a stylized garment to any home furnishing product. The proposed rule in regards to PFASs then includes any product containing PFASs placed into commerce in California that may be marketed or sold for the purpose of eliminating dirt or stains from carpets, rugs, clothing, shoes, upholstery, or other converted fabrics; or repelling stains, dirt, oil, or water from carpets, rugs, clothing, shoes, upholstery, or other converted fabrics. In addition it includes PFAS-containing 'subproducts' such as a cleaner product marketed or sold for the purpose of eliminating direct or stains; a protectant product marketed or sold to protect the surface from soiling when in contact with dirt or other impurities, or to reduce liquid absorption; a spot remover product marketed or sold to clean localized areas, or to remove localized spots or stains; and a water proofer or water repellant product marketed or sold to repel water. I understand that the CA Safer Consumer Products Regulatory Program requires DTSC to identify product-chemical combinations that pose risks to people or the environment and to adopt them as Priority Products. For the latter designation, this product chemical combination must meet the following two general regulatory criteria: (1) potential sources of exposure to humans and other environmental biota; and (2) these exposures have potential to cause significant or widespread adverse impacts.

In the case of PFAS and PFAS-containing converted textiles and leathers, DTSC's review determined that there is overwhelming evidence to support the required regulatory criteria, specifically: (1) PFASs or their degradation products are extremely persistent and ubiquitous in the environment, leading to ubiquitous human and ecological exposures; 2) humans, including sensitive subpopulations such as infants, children, and upholstered furniture cleaners and workers, as well as other living organisms may be exposed to PFASs throughout the life cycle of treatments for converted textiles or leathers; and 3) these human and ecological exposures to the PFASs associated with treatments for converted textiles or leathers have the potential to contribute to or cause significant and widespread adverse impacts due to the numerous hazard traits displayed by members of this class of chemicals (e.g., extreme environmental persistence, endocrine toxicity, developmental and neurodevelopmental toxicity, immunotoxicity).

Consistent with the evidence in support of the required regulator criteria, which is similar but updated to the evidence for PFAS-containing carpets being labeled a Priority Product previously acquired and reviewed, DTSC's over overarching conclusions are:

> **Conclusion 1.** Humans and biota may be exposed to members of the class of perfluoroalkyl and polyfluoroalkyl substances (PFASs), including perfluoroalkyl acids (PFAAs), through the manufacturing, normal use, handling, recycling, or disposal of the treatments containing PFASs for use on converted textiles and leathers, as well as disposal of the treated textile or leather products themselves
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> **Conclusion 2.** Exposure to any PFASs found in treatments intended for use on converted textiles or leathers or to their degradation products, during product manufacturing, use, or at its end-of-life, may contribute to or cause significant or widespread adverse impacts to humans or biota.

My review of the ESPR draft is based on the directive to determine whether the scientific portion of the proposed regulation is based on sound scientific knowledge, methods and practices. I was already familiar with most of the literature cited in the ESPR draft. I had reviewed the previous ESPR document on PFAS-containing carpets and rugs, which pertained to products where PFAS introduction occurred during the initial manufacturing, any associated literature that was new to me. As part of my assessment of the current ESPR document, any key citations that were new to me, of which there were only a few, I accessed for a quick review at a minimum and sometime as more detailed review.

I am most qualified to address Conclusion 1 based on my training and the majority of my research over the past 30+ years; however, I have also been directly involved in research associated with Conclusion 2 for the past 6 years. I found all major claims made to be consistent with sound scientific knowledge or a reasonable extrapolation of what is known in cases where clear data gaps exist, which were acknowledged. In some cases, I had knowledge of recent literature not cited in the ESPR draft that provided additional support for the overarching conclusions identified. There were a couple claims that I found less supported by science. In

these cases, I did not find that these claims to weigh heavily on the decision to propose adoption of PFAS-containing converted textiles and leathers as Priority Products or I identified other literature not cited better that better supported the claims.

There is no doubt to DTSC's statements in support of Conclusion 1 regarding the extreme persistence and presence of PFAS and their degradation products in all environmental compartments including soil, water, plants, animals, humans and indoor air and dust. There discharges into the environment are not limited to industrial discharges and landfill leachate, but also from discharges of or irrigation with wastewater treatment plant (WWTP) effluent and land-application of nutrient-rich biosolids derived from WWTP sludge. PFAS entering WWTPs are not just from industrial sources and landfill leachate, but from consumer use of PFAS-containing products. Likewise, PFAS found in indoor air and dust are from consumer products used or worn in the home, office and school environments. In addition, recent work by Letcher's group in Canada (Chu and Letcher, 2017, *Sci. of the Total Environ*. 607–608:262–270; Letcher et al., 2020, *J. Hazard. Mat*. 388, 122044) revealed the presence of side-chain PFAS-containing polymers extensively used in textiles and furniture in soils, sediments and biosolids at levels that well exceed the sum of the traditional suite of PFAAs targeted in quantitation. This is additional evidence above what was provided in the ESPR draft that these side-chain PFAS-containing polymers are indeed released from consumer products during their use and care by consumers.

It is well-established from multiple studies that PFAS including side-chain polymers only degrade in the environment to just other PFAS subclasses, e.g., perfluoroalkyl acids (PFAAs) and numerous intermediates prior to the terminal PFAA metabolites, which tend to be more mobile than their precursors. Even chemical means to trap or degrade PFAS are limited and expensive. Some of the intermediates will include volatile PFAS such as the fluorotelomer alcohols (FTOHs). Therefore, although FTOH residuals in consumer products have been reduced substantially in the manufacturing process, FTOHs can eb generated from the degradation of precursor PFAS such as the side-chain fluorinated polymers that are heavily used in consumer products (textiles, carpets, leather, etc.). These polymers will degrade at different rates depending on the side chain and use conditions with FTOH being the intermediate on the way to PFAAs. For example, Dasu and Lee (2015, *Chemosphere*, 144:2482-2488) report estimated aerobic biodegradation half-lives for two fluorotelomer urethanes half-lives of 3–5 months and 16 to 22 months, respectively, FTOH being generated first followed by a suite of PFAAs. While side-chains bound to polymers will likely degrade relatively slowly, one cleaved the estimated half-lives of the cleave chains will be rapid as exemplified for acrylate and methacrylate by Royer et al. (2015, *Chemosphere*, 129:54-61) with half-lives of < 1 week and ~ 2 weeks, respectively. With many textiles and leathers having a long use time, FTOHs may still be continually released over time, thus continue to contribute significantly to exposure.

Also there are new PFAS hitting the market on a regular basis and other residuals, manufacturing impurities or degradation products may be present and released relatively easily during product use, etc. even if less volatile than the FTOHs. This coupled to the likely large percentage of end-of-life destination being landfills, thus with high potential to create legacy problems, any action that will remove PFAS use in converted textiles and leathers and foster exploration of safer

alternatives, should be taken as is done in the current proposal. We cannot afford to wait until the toxicological science is developed for each new PFAS subfamily before making decisions especially since we know that even 10+ years after they are phased out, there will still be a significant presence (e.g., PFOS), thus the proposal to address the overall class of converted textiles, leathers and associated products is germane.

In addition, to achieve long-term sustainable treatment of various PFAS-contaminated media, a treatment train at best will be required and will be expensive. Realization of the expense and potential negative consequences of trying to minimize PFAS entry into our environment from our municipal wastes are growing as lower and lower PFAS levels are being considered a threat to human and ecosystem health. For example, more and more states are considering banning of the land application of biosolids to reduce PFAS inputs into the environment, which is problematic on many fronts. Land-application of biosolids is a widespread practice, with ≥ 50% of the biosolids in the USA alone reported as land-applied (NEBRA et al., 2007, https://www.nebiosolids.org/about-biosolids/; Seiple et al., 2017, *J. Environ. Mgmt.* 197:673-680). This translates to ≥ 3.6 million dry metric tons of biosolids annually that may need to be land-filled or incinerated with the banning of land-application, thus increasing cost (up to almost an order of magnitude in some cases) to the municipal tax payers from whom the hardest hit will once again be low-income populations that are already struggling.

In addition, it also means the loss of a large sequestered carbon source with numerous macro and micro-nutrients. Most all other anthropogenic contaminants in our wastes readily degrade when land applied, but as noted, this process does not reduce PFAS loads applied to soils. Their persistence coupled to their ability to transport large distances through air and water are what has led to ubiquitous presence and multiple exposure pathways to humans and environmental biota. Their extreme persistence means that even if we stopped using PFAS for all uses, PFAS presence from previous and current direct discharges as well as long-term use and disposal of existing consumer products will remain indefinitely in the environment although presumably become increasingly dilute over time with various dissipation mechanisms (not natural degradation processes). Therefore, it is imperative to minimize nonessential uses of PFAS, which include their use in converted textiles and leathers, otherwise we will continue to be subject to both known and not yet fully realized health and economic consequences from their use.

For about the first decade starting just before 2000, PFAS publications focused on PFOA and PFOS and primarily occurrence. However, in the past decade, numerous other PFAS have been identified routinely in various environmental compartments especially water. Just in the past few years, the number of PFAS estimated to be in use has risen from 3000 to nearly 5000 (Wang et al 2017b, *ES&T*, 51:2508-2518; Henry, 2020, https://news.bloomberglaw.com/environment-and-energy/insight-finding-a-middle-ground-on-pfas-using-a-four-step-process). In addition, numerous more PFAS have been identified with most being either being PFAS degradation products (e.g., the suite of PFAAs and microbial intermediates from precursor PFAS) and major components in PFAS-containing aqueous film forming foams (AFFFs). However, much is still unknown about the PFAS that have entered the environment and are used and released from consumer products.

In relation to persistence but also potential toxicities, PFAS alternatives (typically referring to alternatives to PFOS and PFOA) are just other PFAS with shorter-chains or slight variations in their structure, e.g., a different terminal functional group, addition of oxygen atom(s) in the perfluoroalkyl chain or replacing a F atom with a Cl atom. These 'alternative' are just as persistent as the PFAS they are replacing, may be equally bioaccumulative in some cases, and may have similar toxicities, albeit data are limited in this regard. For example a PFOS replacement used in China does not degrade biologically or chemically and sorbs to soils as well as bioaccumulate similar to PFOS (Chen et al., 2018, *ES&T*, 52:9827-9834; Shi et al., 2015, *ES&T* 49:14156−14165).

Although currently EPA has only initiated the regulatory development process for listing PFOA and PFOS as CERCLA "hazardous substances", it is wise to treat the overall PFAS class of compounds as a whole because of the pervasive persistence of all PFAS. In addition, although long-chain PFAS are currently considered to invoke greater toxicity in humans than shorter-chain PFAS, studies on the toxicities of short-chain PFAS to both humans and other environmental biota are growing and indicate similar types of adverse effects, albeit often at higher concentrations. In addition, with shorter-chain PFAS being one of the most common PFAS alternatives currently, their global production and use is increasing, thus there are concomitant increases in their presence in the environment, thus exposure to humans and biota. They are also more mobile in soil and water, which makes them harder to remove from drinking water with common adsorptive processes and increases their plant uptake relative to PFOS and PFOA. Therefore, even if limited science currently available suggests that much higher levels are needed of the shorter-chain PFAS to cause adverse effects comparable to PFOS and PFOA, they may end up in being present in greater concentrations in water and plants, thus posing similar net risks especially given their use in a vast number of consumer products. Currently, the C6 perfluorocarboxylate (PFHxA) concentrations are increasing in land-applied biosolids while PFOS and PFOA are generally decreasing and PFHxA is the dominant PFAA in compostable food packaging (Choi et al., 2019, *ES&T Letters*. doi:10.1021/acs.estlett.9b00280). GenX, ADONA and other replacements are also now routinely found in many of the biosolids we have been analyzing in our research group. Given their growing presence coupled to their similar persistence and recent literature indicating they invoke similar adverse impacts in laboratory studies, PFAS-based replacements or alternatives are equally problematic as the longer-chain PFAS they replaced.

In evaluating the DTSC's summary of the literature, the conclusion that incineration of the treated converted textiles or leathers can result in emissions of PFCAs is correct. In addition, Wang et al.'s *(*2015, *ES&T* 49:5672-5680) laboratory-based data indicate that at even much higher temperatures typical of incineration, complete decomposition of PFAS in PFAS-containing products will not occur, thus contributing to PFAS- emissions during incineration. Lastly, while the CA report on incineration did not address PFAS directly, it did highlight how poorly incineration products are regulated including nanoparticles, and that many unknowns still exist, e.g., what is actually emitted during incineration in general is not well researched yet.

I also support the conclusions made in support of the overall Conclusion #2 regarding that exposure to any PFASs found in treatments intended for use on converted textiles or leathers or to their degradation products, during product manufacturing, use, or at its end-of-life, may contribute to or cause significant or widespread adverse impacts to humans or biota. Again, while the concentrations that appear to cause measurable adverse effects varies with PFAS, we cannot ignore additivity, which is still not well researched. Also as noted, although the shorter chain PFAS and some of the other subfamilies of PFAS-based replacements such as the ethers (e.g., GenX and ADONA) may note bioaccumulate like PFOS and PFOA, they are being found to invoke similar adverse effects. In addition to the numerous effects summarized in the ESPR draft, data on adverse effects are growing. For example, I have been involved in the collection and analysis of data revealing neurodegeneration signs in frogs (Foguth et al., 2019, *Neurotoxicology and Teratology;* Foguth et al. 2020, *Toxicol. & Applied Pharm.,* https://doi.org/10.1016/j.taap.2019.114623); and C. elegans (Sammi et al., 2019, *Tox. Sci.* 172(2):417-434. doi:10.1093/toxsci/kfz191) as models for evaluating effects on biota or humans, respectively. This research showed that developmental environmentally relevant exposure to PFAS changes neurotransmitters as well as heightened dopamine neuron vulnerability and significant reductions in dopamine-dependent functions in response to some PFAS.

The ESPR support of the DTSC's conclusion and recommendation included the inhalation and ingestion of PFAS in indoor air and dust from the treatment and use of converted textiles or leathers. While this is most certainly true and supported by the literature, this may not be true, publications that put this in perspective of other exposure pathways ranked these exposure pathways as low and generally not of concern. However, it is a viable exposure pathway and additive to other exposure pathways, thus efforts to reduce it or worthwhile. The ESPR draft also noted dermal exposure from the use of converted textiles or leathers. While this would seem to me an obvious conclusion given dermal contact with clothing, furniture and carpets, research is limited in this area and currently significant exposure at any level through dermal contact is not well supported. However, recent dermal exposure to assessments to amphibians post metamorphic do show some effects on body indices (snout-vent length and scaled mass index), which varied depending on the body index being evaluated and the particular PFAS treatment (Abercrombie et al., 2020, *ETAC*, doi:10.1002/etc.4711).

Overall, the well-documented science in the peer-reviewed literature of the inherent persistency of PFAS of the original PFAS or the subsequent terminal metabolites (PFAAs) is sufficient to warrant PFAS-containing converted textiles and leather products as well as the PFAS-containing subproducts leading to their stain and water resistance be adopted as Priority Products. In addition, this is further supported by the multiple exposure pathways to humans and the environment that are also well-known and the growing body of evidence indicating that PFAS alternatives will likely have similar toxicity profiles.