Answers to Questions following the

U.S. HOUSE OF REPRESENTATIVES SUBCOMMITTEE ON WATER, OEANS, AND WILDLIFE
COMMITTEE ON NATURAL RESOURCES

HEARING: "Plastic's Impact on Oceans"

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Questions from Rep. Alan Lowenthal

1. **Why is it important to work with local communities to identify their sources of plastic pollution and possible solutions?**

It is important to work with local communities because plastic inputs and waste are created and managed at the community level, i.e., our communities are on the front lines. So understanding their needs, context and situation is important. Even if a federal policy is enacted, the communities will be impacted. Disposal and recycling are commonly different from community to community. Community engagement, including co-creation, or at least buy-in, on potential solutions is critical to implementation and participation. While local solutions can scale to make them larger and more impactful, exploring what communities need can inform federal legislation.

As referenced in my written testimony, one example is the Circularity Assessment Protocol (CAP), developed in the Center for Circular Materials Management (the only center of its kind in the USA), in the New Materials Institute at the University of Georgia. Conducted in collaboration with a community and eventually by the community itself, the CAP characterizes seven community components: 1) inputs, 2) consumers, 3) product design, 4) use, 5) collection, 6) end-of-cycle management (e.g., waste management), and 7) plastic leakage into the environment. Various influencing factors drive this system including governance, economics, policy and legislation. Furthermore, multiple stakeholders exist at every level of the CAP influencing the complex system and these include citizens, government, industry, NGOs and academia. While a simple hub and spoke model illustrates the CAP, and data collection is rapid and easy to collect through a collaborative effort by the community members and researchers, it is a complex system with components inherently interconnected to each other.

One of the largest benefits to CAP is that it can help to inform and empower a community by giving them a starting assessment to work from and direct potential actions to take to improve the areas that most need it, and to answer specific questions they have about their own community. The CAP can inform and support the government to define policies and good practices related to solid waste management and infrastructure, including facilitating an understanding of solid waste and plastic management through both and technical *and* social lens. This can provide an understanding of people's actions (both local and transient) which will inform policy and interventions.

Other community-based work that I have participated in is the National Geographic Sea to Source Expedition along the Ganges River in India. This expedition focuses on plastic pollution in three key areas: land, water and people. On land, we collect data about the input and use of plastic in communities, how waste is collected and managed, and characterize the movement and type of plastic in the environment. The water team studies plastic pollution in the air, water, sediment and species in and around the river. The socioeconomic team surveys local communities along the expedition route to better understand awareness and perceptions of plastic pollution, household plastic waste management and local solutions for addressing this issue. During the expeditions, we engage the local community, and work with stakeholders to empower then to find context-sensitive solutions that can help drive a long-term positive change. This kind of interdisciplinary and community-based work, incorporating easy-to follow citizen science methods and cutting-edge technology can be a spark for continued change on this issue. Similar kind of work could be conducted in major river waterways in the USA as well. Previous data on the USA is only an estimated model based upon reported solid waste infrastructure. And, as one of the largest waste generators in the world, we really don't know (except for a few exceptions where collection takes place, like Mr. Trash Wheel[1]) what plastic leaks into and from our waterways in our own backyard.

2. **There was a lot of discussion on the societal relevance of plastic as it is. What innovations and alternatives are available or coming very soon?**

I think the USA was sold short by the hearing discussion that there was no alternatives and no other material to use besides traditional plastic. E.g., we have solved the "what to do without plastic to hold toothpaste problem" and there are solid toothpaste "chews" in several different brands available packaged without plastic, including one very successful women-owned and operated US-based company called Bite[2]. The USA in many ways is, and can continue to expand, in leading the world on innovative materials and alternatives to traditional plastic. Already polylactic acid (PLA) exists and a large amount of R&D has been conducted in the USA on it. While it does not avoid all unintended consequences of traditional plastic, it does avoid using fossil fuels as a feedstock and serves as an example to the economic growth and development of a new material that serves the needs of traditional plastics but is different from it in some ways. As stated in the testimony though, an important distinction should be made with PLA, as it will not biodegrade in home composting or in the ocean. It will not biodegrade if littered on land. It has to reach a high temperature (reached in industrial composting) to be able to biodegrade.

Also included in my testimony is an entire section on Innovation summarized here:
Overall, I think Green Engineering principles,[3] if followed during material development and product design, would help to avoid many of the externalities of plastic that we are dealing with currently. In addition, circular economy concepts, emerging all over the world now, will be important to also apply to plastic materials. Both of these guiding principles promote non-toxic materials, ultimately with the capability of biodegrading and/or being recycled. Materials and products made with more homogenous compounds would make recycling more efficient and effective. Materials and products can be designed to retain their value, for collection, recovery and recycling. The University of Georgia has combined

[1] https://www.mrtrashwheel.com/
[2] https://bitetoothpastebits.com/
[3] http://www.acs.org/content/acs/en/greenchemistry/what-is-green-chemistry/principles/12-principles-of-green-engineering.html

environmental engineering and polymer chemistry in a successful and rapidly expanding New Materials Institute with centers on biodegradable polymers and circular materials management to develop and test materials to reduce the flow of plastic into the ocean. NMI has become part of a National Science Foundation (NSF) Industry–University Cooperative Research Centers (IUCRC) that has over 30 corporate partners interested in more sustainable and biodegradable polymer products. These industry-research groups participate in pre-competitive research and development as new materials need to scale to be economical for all to use. There is no doubt that developing alternative materials without the unintended consequences of traditional plastics will spark innovation and economic growth in the USA where truly biodegradable polymer production facilities (e.g., Polyhydroxyalkanoates (PHA)), like the ones in Georgia owned by Danimer Scientific and RWDC are creating jobs (see more in the answer below to question 3). Specific points for redesign and material substitution are:

A. Sustainable packaging associations (pre-competitive collaborations)
    a. E.g., UGA's New Materials Institute IUCRC, Sustainable packaging coalition, Green-Blue: These pre-competitive environments could help develop alternatives, standardize packaging and help packaging retain value so that it is easier to recycle and less leakage will occur if it has value.
B. Truly biodegradable alternatives (e.g., PHA)
    a. PHA is expanding in the market in the USA and is creating economic value (new facility opening in Kentucky – several open in Georgia already). While it may biodegrade if littered in the environment, it should still be managed in the solid waste system and be thoughtful about where used (in currently non-recyclable items, for example). But it has the possibility of being home-composted as well. The USA is currently a leader in the development of this material.
    b. Danimer Scientific in collaboration with Frito-Lay is working on PHA packaging as well, so a major brand is making this shift too, scaling this to more USA-based economic growth.
C. Packaging with more value (e.g., single, homogenous materials, design for recycling/end-of-life)
    a. This can be helped by collaborations between industry, brands and waste managers/experts
D. Design out problematic items/materials (e.g., caps/lids)
    a. Similar to how aluminum can "pop-top" opening was changed to a tab that stayed on (so the pull tabs did not get littered), we can innovate design for items that leak into the environment (if data is collected at last chance capture).

3. Is there a positive economic impact from the development of alternatives to traditional plastic?

Yes, while there is an economic component to traditional plastics to the economy and jobs, the alternatives can create similar output and work opportunities (see some in the answer to question 2, above). And the USA can be at the forefront of this change.

One specific example is a company called RWDC that works closely with the New Materials Institute at the University of Georgia. RWDC has just purchased a property in Athens, GA for their first production facility. They have already hired approximately 40 people and will bring 100 jobs to Athens-Clarke

County, Georgia (one of Georgia's 91 persistently poor counties) in the next year, and an estimated 210 jobs after 5 years. There is another site in Monroe, GA, where another 86 jobs will be created within the next two years. And this is just one company growing as quickly as it can in the USA.

4. What are some of the benefits and trade-offs from switching away from traditional plastics?

There is no doubt that plastic has changed our society and culture. It has brought us many things we rely on every day – this was the point of my 24-hour experiment. But, do we really need it for all those things? Some things yes, medicine, electronics, many what we call "durable goods" – but the single-use plastic, the packaging, and what ends up in the environment (the second and other critical part to the experiment I presented!) – how much of that needs to be plastic? We are not going to get rid of all plastic, but I think we need to be more thoughtful about where, when, and how we use it.

Here are some examples of trade-offs that we might consider while thinking about plastic. Certainly plastic has brought light-weight benefits to food packaging, transport and allows food to be stored in sanitary ways, protecting the embodied energy that went into that food. Many times the carbon footprint of that food is large. Something to ponder, where do we draw the lines in these analyses? Why does our food have such a high carbon footprint/embodied energy? Should all food be distributed through the current model if it requires plastic packaging? I encourage people to think "out of the packaging container" and outline all the ways we can change the delivery of products and design of packaging. But, the best thing, environmentally-speaking, is to not produce any waste in the first place, so that lends itself to reusable items. However, for when packaging is needed, what then, should it be made out of? Life-cycle assessments (LCA) were referred to in the hearing and I have conducted LCAs on various waste management scenarios myself[4]. More upstream, product LCAs can inform packaging choices, so we can compare carbon footprint, energy use, water consumption, etc. of two products, for example a plastic v. a reusable bag. While the energy input or carbon footprint for production, for example, may be more for the reusable bag, the fact that you do not have to manage waste after it's end-of-life is an energy and carbon off-set. While the plastic bag is light, it will have to be transported to a recycling or disposal facility and then managed there. In a carbon balance scenario, plastic does not release carbon at end of life, because as far as we know it does not practically degrade, so while it is not a benefit that it remains forever in a landfill, it does not release carbon while there. In addition, plastic bags have been known to jam up recycling systems at material recovery facilities (MRFs) and blow from landfills, making containment a challenge (and requiring human effort and machines to manage at landfills). These two situations do not fit into an LCA in a straight-forward way. And a last major limitation of this kind of LCA is that there is no way to include a littered plastic bag ending up in the ocean and a turtle eating it and dying. Animals killed from plastic litter does not fit into any LCA. So there are trade-offs that are a challenge to compare, and we need a better way to look at the systems holistically, even beyond our typical LCA. At a minimum, we need to be able to acknowledge, and talk through some of these tradeoffs, in a systematic way.

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[4] Jambeck, J., Weitz, K., Townsend, T., Solo-Gabriele, H., (2007). CCA-treated Wood Disposed in Landfills and Life-cycle Trade-Offs With Waste-to-Energy and MSW Landfill Disposal in the U.S., Waste Management, Volume 27, Issue 8, 2007, Pages S21-S28. http://www.sciencedirect.com/science/article/pii/S0956053X07000773
Thorneloe, S., Weitz, K., Jambeck, J., (2007). Application of the U.S. Decision Support Tool for Materials and Waste Management, Waste Management, 27 (2007) 1006–1020.
http://www.sciencedirect.com/science/article/pii/S0956053X0700058X

Questions from Rep. TJ Cox

1. **A recent study found 16 microplastic fibers in a single half-liter sample of water taken from the Capitol Visitor's Center. How did the microplastics get into the Capitol Visitor's Center drinking water or anybody's drinking water for that matter?**

I would have to see this study's methods to be able to comment on this specific result, but microfibers and microplastics have been found in freshwater, tap drinking water, groundwater and wastewater in published studies[5]. This same research was a review of these published studies, and they found that methods are still widely conducted and not standardized, and in order to really find out the risk to human health from exposure, these methods need to be standardized to high levels. So to properly answer your question, there needs to be more research conducted based upon common research methods and standards[5]. This would be a good role for the US EPA to play in in the USA, to direct the methods and standards for comparative purposes.

At this point without more data, we can only guess at the sources of the fibers and particles. We know fibers are generated from washing clothes and unless otherwise captured[6], these go out with our wastewater to either septic or treatment plants (when treated). In cases where not treated, they would be directly discharged to the environment. Although we know that typically over 90% of the fibers can be removed from the wastewater treatment facility[7], it means they end up in the sludge that settles out and then is either managed at a landfill or in some cases, applied to the land where run-off could reintroduce them to the environment again. We also know that fibers are transported by air, so atmospheric deposition (mostly regional, near-range likely) could be a transport into our freshwaters[8]. So, it can end up in our source water from point source (wastewater), run-off and from the air. And, although drinking water is treated and many particles are removed, it is possible that some could remain. There has not been an investigation into the drinking water distribution system and its contribution, if any, to microplastic in water, but it is doubtful for microfibers as far as I am aware. If water is stored in an open glass in a room, microfibers will very likely fall into it – they are in the air all around us. Identifying them as a polymer with FTIR or Raman, for example, is very important so that we correctly identify if they are plastic or not.

2. **What do we know about the human health impacts of ingesting microplastics?**

We really don't know at this point – there are likely studies underway on this topic, but the potential impacts are not easy to study and if some of the plastics are at the nanoscale level, they are not able to be analyzed or identified at this point with current analytical capability. We know we are exposed through beverages we consume (including water) and some of the food we eat (e.g., salt), but we don't

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[5] Albert A. Koelmans, Nur Hazimah Mohamed Nor, Enya Hermsen, Merel Kooi, Svenja M. Mintenig, Jennifer De France, Microplastics in freshwaters and drinking water: Critical review and assessment of data quality, Water Research, Volume 155, 2019, Pages 410-422.

[6] Hayley K. McIlwraith, Jack Lin, Lisa M. Erdle, Nicholas Mallos, Miriam L. Diamond, Chelsea M. Rochman, Capturing microfibers – marketed technologies reduce microfiber emissions from washing machines, Marine Pollution Bulletin, Volume 139, 2019, Pages 40-45.

[7] JingSun, Xiaohu Dai, Qilin Wang, Mark C.M.van Loosdrecht, Bing-JieNia, Microplastics in wastewater treatment plants: Detection, occurrence and removal, Volume 152, 1 April 2019, Pages 21-37.

[8] Steve Allen, Deonie Allen, Vernon R. Phoenix, Gaël Le Roux, Pilar Durántez Jiménez, Anaëlle Simonneau, Stéphane Binet & Didier Galop, Atmospheric transport and deposition of microplastics in a remote mountain catchment, Nature Geoscience volume 12, pages339–344 (2019).

yet know the impact to humans. I also recommend referring to Dr. Chelsea Rochman's recent testimony to the House on this issue[9].

3. **Oftentimes we turn to alternatives to address environmental challenges like plastic pollution. In the case of climate change, we might use renewable power instead of coal. In the transportation sector, we see people switching to electric vehicles. However, there are always bumps in the road when we make these transitions, and it's our job here in Congress to smooth those out. Take the idea of adopting alternatives to plastic as an example. Explain to the committee why we have not seen a more rapid transition to biodegradable plastics or plastic alternatives.**

I think the biggest reason here is cost. Traditional plastics are so inexpensive. There are alternatives developed and companies are working hard to scale them (see my answer to Rep. Lowenthal's Question 2, above). But the cost makes it challenging until they are able to scale. The development and manufacturing of alternative materials will have economic growth and provide job opportunities in the USA (also see my answers in Rep. Lowenthal's Question 3, above), so like your other examples for climate change, we can see transitions to different businesses and job growth, while making some of these changes. Policies that level the playing field for other materials and products would be helpful.

4. **What are some of the actions that Congress could take to allow for increased adoption of more recyclable and environmentally friendly alternatives to plastic?**

As mentioned above, policies to level the playing field in the cost of materials for use can help here. These could include a tax or fee on certain kids of traditional resins, bans, and required design and procurement standards. Again, I think that these kinds of actions should take into account the impact on all relevant stakeholders to be able to move forward with a balance in terms of compromise. In some cases, end-of-life policies have an upstream impact, e.g., depending on how a product stewardship policy is written, it can impact design of products and materials chosen as well. The example from Norway that I often talk about it is the Extended Producer Responsibility (EPR) law in Norway influenced upstream design and recyclability of products. By requiring a certain percent of PET to be recycled, a company formed to help make this happen and in order to reach the needed recycling rates in the most efficient way, the design of PET bottles were changed so that they could be recycled bottle-to-bottle by Infinitum[10].

<u>Questions from Rep. Nydia M. Velazquez</u>

1. **In your testimony you highlight corporate commitments made at the Our Ocean meeting in Oslo, can you describe what steps exactly are in motion to help reduce plastic pollution in the environment? Is it enough?**

The Our Ocean Commitments are available here: https://ourocean2019.no/wp-content/uploads/2019/10/20191025-Commitments-1616.pdf
For the first time that I can recall a company, Unilever, committed to an absolute reduction of plastic use. They are finding alternative ways of delivering products, as PepsiCo announced purchasing Soda

[9] https://docs.house.gov/meetings/AP/AP06/20190919/109934/HHRG-116-AP06-Wstate-RochmanC-20190919.pdf
[10] https://infinitum.no/english/about-us

Stream an alternative delivery mechanism for carbonated beverages as well. Other companies and governments made commitments too (and my mentioning those two companies by no means is an endorsement in any way). But no, these commitments are still not enough for a couple reasons. First, the corporations have the capacity to go further with these commitments and make them more impactful, but the commitments continue to get stronger each year, so they do indicate movement in the right direction. Another reason it is not enough is that I think multiple entities need to be involved to create a larger positive impact. No one "group" (e.g., industry, government, NGO) can do this alone. For example, corporations designing and using packaging need to speak with the waste management companies and these two systems, the input and the management, should be better integrated. I still see a lot of issues related to design and management that could be addressed by these two end-of-the-spectrum entities working together. For example if product stewardship or extended producer responsibility is considered, the impacts to the waste management companies – and their input – needs to be considered and heard. For all groups working on, and involved in, this issue -- if each group makes some compromises, the shift each entity needs to make can be smaller in order to meet in the middle, yet still creating a truly impactful way forward. I recommend a US-based summit where the relevant stakeholders can gather together to actively negotiate how new federal policies could be endorsed in order to better protect the environment for all.