
The National Tribal Toxics Council (NTTC) appreciates the opportunity to provide comments on the above subject in the attached document. As an EPA Tribal Partnership Group (TPG) supported by the EPA Office of Pollution Prevention and Toxics, the NTTC works on issues related to chemical safety, toxic chemicals, and pollution prevention for Indigenous people of the U.S. Through this partnership, we assist OPPT with education and outreach to tribes, and in turn, educate and inform EPA about effects of chemicals and pollution upon tribal people. The NTTC looks forward to our future partnership meetings with OPPT regarding these comments and the incorporation of tribal risk scenarios in the risk evaluations for the 10 chemicals of the dockets identified above.

We look forward to the Agency’s written response to these comments. Should you or your staff have questions or comments regarding our letter, please contact myself, Dianne Barton, NTTC Chair, at (503) 731-1259 / bard@critfc.org or Fred Corey, NTTC Vice-Chair, at (207) 764-7765 / fcorey@micmac-nsn.gov.

Sincerely,

Dianne C. Barton, Chair
National Tribal Toxics Council

Note: The Members of the Council are offering their opinions on toxics issues and do not speak for individual tribes.
Tribes as the Representative Subpopulation:
A Case for Tribal Populations to Represent Subpopulations at Greater Risk of Adverse Health Effects from Exposure to a Chemical Substance or Mixture of Chemical Substances

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Executive Summary

Affirmed by the Supreme Court, it is the law of the land that federal agencies must fulfill a legally-binding trust responsibility to protect tribal trust resources and must uphold U.S.-Tribal treaty agreements. As the federal regulatory agency charged with environmental protection, this duty is relevant to EPA’s implementation of TSCA because tribes have high exposure to the natural environment, dietary reliance on local wild foods, and unique customary and traditional practices. Thus, under TSCA, tribes meet the definition of an exposed subpopulation, and EPA must adequately and transparently evaluate these exposures.

The National Tribal Toxics Council (NTTC) is the Office of Pollution Prevention and Toxics (OPPT) Tribal Partnership Group to represent the collective interests of the 576 federally-recognized sovereign tribal nations across the United States, located within all 10 EPA regions. Together, 6.1 million tribal members are represented.

A risk assessment based on the HBCD Problem Formulation will not be protective of tribal, rural, or urban subsistence populations as it fails to identify exposed subpopulations. Consequently, unless the Problem Formulation is changed to explicitly address these populations, the EPA Administrator will fail to carry out requirements as mandated by Congress in TSCA, as amended, June 22, 2016.

NTTC takes issue with the methodology used in identifying relevant literature for the scoping document. Arguably, the greatest change in TSCA is the mandate of health-based assessment and the inclusion of sensitive and exposed subpopulations in identifying the health risk of chemicals to the American people. Yet, while tribal based risk scenarios are readily available, they are not addressed in the Problem Formulation, and there is no evidence that an attempt was made to include them. Tribes are simply not mentioned, whether it be in the literature search or bibliography, the narrative, or conceptual model. The same holds for ethnic-urban subsistence and rural subpopulations.

The EPA Office of Solid Waste is aware that permitted unlined municipal, and construction and demolition landfills are prevalent in Indian Country. The practice of open burning in burn barrels is widespread, and in Alaska Native villages the entire community wastestream is regularly burned without emissions control under a RCRA permit. Wild foods that the tribes depend on for their diet can be contaminated with HBCD via leachate and smoke, and whole communities can be exposed via inhalation and direct contact with wastes.

Extruded and Expanded Polystyrene (XPS and EPS) insulation products are ubiquitous in Alaska and are used in ceilings, floors, interior walls, outside finished exterior walls, foundations and foundation wings, road beds, and more. The construction and demolition waste products, both residential and commercial, are brought to the unlined municipal landfills and dumpsites, or to unlined project-specific dumps. Nearly three-quarters of villages are within one mile of these disposal sites and their diets are dependent on locally hunted, fished, and gathered foods. Over eighty percent of these villages practice open burning, and because the sites are proximate, smoke from these disposal practices is commonly smelled by village residents.
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Even under the EPA’s narrow Conditions of Use requirement, the resultant exposure scenarios for Alaska tribes, as well as Alaska rural residents that comprise more than half the population of the state, are left out.

Many tribes are small communities with members being exposed in multiple ways. For example, the same worker who helped in the sawing of EPS board may be the landfill worker that carries the board to the dump and burns it, then goes home to their family where, now part of the community’s “bystander” population, they have additional exposures by breathing the smoke, and consuming food and water that is contaminated from leachate.

Beyond the clear primary issue to Tribes of the absence of tribally-specific risk scenarios in the problem formulation, NTTC further takes issue with the following critical points that relate to the problem formulations in general and prevent the performance of a valid health assessment for tribes and other Americans as intended by Congress:

- Omission of legacy use, particularly the use and disposal of products that are still in active service life. For example, it is unclear why the widespread use and disposal of millions of computers and other electronics known to contain HBCD is not considered in the problem formulation.
- Omission of conditions of use considered to be under the purview of other Federal Environmental Statutes that focus primarily on priority pollutants. TSCA was amended specifically because Congress found that these same existing environmental laws did not adequately protect the American people.
- Omission of products knowingly or reasonably foreseen to incorporate HBCD and the complete omission of recycled products due to a perceived ‘lack of intention’ in fitting the Administrator’s narrowly defined Conditions of Use. For example, the use and disposal of picture frames, food trays, coolers, and other products knowingly made with recycled EPS of high HBCD content is not considered.

The decisions taken by EPA on these points were spurious and each are clearly inconsistent with the science and purpose of risk assessment and TSCA itself.

NTTC provides the following comments in the expectation that EPA will understand how their current conceptualization of the chemical risk posed to tribes is inadequate and will not meet the intent and purpose of the law. The wide range of tribal concerns listed are organized as a narrative, not by priority or interest. The comments in totality are a priority and each point contributes as a piece and sum of the chemical’s risk to tribes. Additionally, please see the attached petitions of support which were signed by 49 tribal environmental and natural resources staff and tribal leadership from 37 tribes and two tribal organizations.
1. Potentially Exposed or Susceptible Subpopulation as Defined by TSCA, as Amended

The following relevant language is excerpted from the Toxic Substances Control Act of 2016, as amended, pertaining to potentially exposed or susceptible subpopulation and to high-priority substances, and from the U.S. EPA Office of Chemical Safety and Pollution Prevention’s May 2018 Problem Formulation for Cyclic Aliphatic Bromides Cluster (HBCD) respectively, with emphasis added relevant to the below comments.

The term "potentially exposed or susceptible subpopulation" means a group of individuals within the general population identified by the Administrator who, due to either greater susceptibility or greater exposure, may be at greater risk than the general population of adverse health effects from exposure to a chemical substance or mixture, such as infants, children, pregnant women, workers, or the elderly.

The Administrator shall designate as a high-priority substance a chemical substance that the Administrator concludes, without consideration of costs or other nonrisk factors, may present an unreasonable risk of injury to health or the environment because of a potential hazard and a potential route of exposure under the conditions of use, including an unreasonable risk to a potentially exposed or susceptible subpopulation identified as relevant by the Administrator.¹

For HBCD, EPA considers workers, occupational non-users, consumers, and bystanders and certain other groups of individuals who may experience greater exposures than the general population due to proximity to conditions of use to be potentially exposed or susceptible subpopulations. EPA will evaluate whether groups of individuals within the general population may be exposed via pathways that are distinct from the general population due to unique characteristics (e.g., life stage, behaviors, activities, duration) that increase exposure, and whether groups of individuals have heightened susceptibility, and should therefore be considered potentially exposed or susceptible subpopulations for purposes of the risk evaluation.²

2. Irrelevance of Proposed Risk Evaluation Process

As currently practiced, the proposed conceptual models of the first ten problem formulations issued May 2018 do not meet the standard of relevance and representation for Tribal peoples, and therefore the model implementation process is essentially moot, and the applicability of the model to the 6.1 million people that Tribes represent is irrelevant. We use the commonly accepted definitions of key terminology in risk assessment science. The following excerpts are drawn from the International Programme on Chemical Safety (IPCS) glossary (2004)³ and the Principles of Characterizing and Applying Human Exposure Models (2005)⁴ as published by the World Health Organization.
Exposure assessment is “The process of estimating or measuring the magnitude, frequency, and duration of exposure to an agent, along with the number and characteristics of the population exposed. Ideally, it describes the sources, pathways, routes, and the uncertainties in the assessment” (IPCS, 2004). Exposure assessment is used in epidemiological studies to relate exposure concentrations to adverse health outcomes. Exposure assessment is also an integral component of risk assessment, the process that provides scientific information for risk management. Exposure assessment is based on exposure scenarios, which are defined as “A combination of facts, assumptions, and inferences that define a discrete situation where potential exposures may occur. These may include the source, the exposed population, the time frame of exposure, microenvironment(s), and activities. Scenarios are often created to aid exposure assessors in estimating exposure” (IPCS, 2004).

An exposure model is a computational framework designed to reflect real-world human exposure scenarios and processes. A conceptual model is often illustrated by a block diagram, and it defines the physical, chemical and behavioural information and exposure algorithms by which the model mimics a realistic exposure scenario. ... The implementation of an exposure model should reflect the underlying conceptual model. Whenever the exposures of different subpopulations are expected to be different from each other, the exposure assessment probably needs to treat these subpopulations separately.

Model evaluation can be seen as a three-step process:

1. The conceptual model must be validated. ...The (causal) relationships between the model input events and the output events must be real, and the nature, or shape, of these relationships must be known — at least approximately.

2. The model implementation must follow the conceptual model. The definitions of input and output variables must effectively describe the events of the conceptual model, and the algorithms and equations must sufficiently follow the true (causal) relationships of these events.

3. Assessing the applicability of the model to a set of specific problems is possibly the most difficult step. This includes evaluating how well the input values really describe the target system. Usually the input values have been measured and contain random or systematic measurement errors. The measured input data range is a combination of data uncertainty and true inherent variability, and in some new applications it is essential to be able to differentiate between the two (e.g. when one or the other dominates the distribution). Sometimes other models, questionnaire data or expert opinions are used in place of measurements to assign values to input variables Each of these inputs may or may not accurately describe the characteristics of the target system. Thus, even when the model is conceptually valid and carefully implemented, the model outputs may not agree with the system outputs.

In several of the following sections, the NTTC provides wide-ranging explanation of the vast extent of activities within tribal lifeways, aspects of “the system” (as referenced above) that needs to be
modeled in the risk assessment process. In section 7 NTTC provides a graphic image of tribal lifeways, to provide a visual sense of the realm of all natural resources within tribal lifeways, and multitude of exposure scenarios and exposure pathways by which tribal populations are put at greater risk because their tribal lifeways have not been contained with TSCA risk assessment and risk evaluation processes. Also, in section 7, NTTC proposes the draft Possible Tribal Exposures Conceptual Model which received preliminary review and informal comment in an NTTC meeting with EPA OPPT earlier this year. Though in draft form, NTTC emphasizes that by using this conceptual model when evaluating unreasonable risk of injury to health (or their environment) to a potentially exposed and susceptible subpopulations, EPA will thereby protect both tribal populations and other subpopulations.

In terms of subpopulations, consider how Barzyk (2010) discussed community-based risk assessment: “One of the primary differences between communities is in their patterns of exposure. ... Tools that isolate exposure routes and pathways for a given community and then incorporate toxicity information will lead to a better characterization of risk”. 5 This is key when considering potentially exposed and susceptible subpopulations, such as tribal groups whose patterns of exposure can be considered to be the “community” of an eco-region, e.g., the Pacific Northwest could encompass tribes and their lifeways from northern California, northerly along the Pacific coast into British Columbia, Canada and as far as the Prince William Sound in southcentral Alaska, U.S.

1. As currently practiced, the proposed conceptual models of the first ten problem formulations issued May 2018 do not meet the standard of relevance and representation for Tribal peoples, and therefore the model implementation process is essentially moot, and the applicability of the model to the 6.1 million people that Tribes represent is irrelevant.

2. Risk assessment of Tribal peoples for TSCA contaminants found in environmental media is relevant because Tribes are in contact with soil, sediment, and water as much or more than other population groups.

3. But the proposed problem formulations, and the risk assessments are not representative because they do not reflect nor model Tribal lifestyles. An entire population of people (6.1 million strong6) are not represented in any USEPA risk assessment work to date.

### 3. Tribal Cultures are Synonymous with their Lands

For millennia, tribal cultures were completely synonymous with and inseparable from the land and its resources.7 Tribes (used throughout this document) includes tribal people, resources, and other interests; interests (as sovereigns, seeking to govern/regulate tribal resources and as proprietors, i.e., holders of rights to land, water, fish, etc.) and the interests of individual Native people (whether they are tribal citizens or not; whether they live on a reservation or not); it is important to encompass tribal members who do not reside on tribal land, usual and accustomed areas, as well as treaty-protected resources; tribal lands as used in this report includes reservations, ceded lands, Usual and Accustomed areas (U&A) as well as communities inclusive of the Alaska Native Villages and Islanders and those without land bases.
Continuing today, many tribes, tribal people and their clans are identified in their Native languages and in English translations as the name of singular or multiple seasonal locations or specific animals or insects, e.g. Water’s Edge Clan (Navajo), People of the Herring Rock (Tlingit), Where the Water Cuts Through (Po-wo-ge-weenege), Red Willow Place (Tua-Tah), People of the standing of projecting rock or stone (Seneca), The Place where the locusts were taken out (Cayuga), The River with the two logs across it (Chickaloon).

3.1 **The Tribal Lifeway is the prime lifeway for those tribal members.** Like a prime number cannot be formed by multiplying two smaller natural numbers, the prime Tribal Lifeway cannot be replaced by adapting other lifeways.

3.2 **There are no viable or acceptable alternatives to subsistence resources, cultural-spiritual resources, and other resources of tribal lifeways.**

Tribal people cannot buy meat, seafood or plant-based foods that are equivalent in calories and nutrients to their traditional and subsistence foods.

Replacing resources based solely on calories or nutrition disregards the cultural and ceremonial aspects of the traditional resource.

- I.e., children and young adults learn to hunt, fish, gather, and then process the resources with an adult and/or elder. They learn the significance of the resource in relation to their ancestry and culture. They learn the inter-dependence of generations, or clans, or villages, or species. They learn the values and priorities of their culture. They learn traditional stories, the purpose of which includes cultural preservation, historical knowledge, and instilling moral values.

3.3 **“Tribal lifeways” are inclusive of, but not limited to, economic, cultural, ceremonial, societal, political, recreational, and subsistence practices.** Examples of tribal lifeways that may influence tribes’ exposure to chemicals in consumer products and the environment include but are not limited to:

- Hunting, fishing, gathering, including accessing locations, processing collected items in the field and at home,
- Constructing blinds in the field, drying racks, smoke houses
- Husbandry (farming/growing)
- Gathering, consumption, and everyday use of plants and plant materials (food, teas, medicines, salves, different types of combustibles for smoke generation, collection of firewood or tipi poles, etc.)
- Water collection (untreated)
- Collecting and processing materials for, and making baskets and other weaving, arts, tools, clothes (using feathers, skin, bones, hides, oils, antlers, etc.; wood, ivory and stone carvings)
- Building/carving canoes, sweat lodges, fish weirs and traps, other structures
- Bathing/sweat lodge use
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- Traditional medicine
- Ceremonial or powwow activities (dancing, traditional games)
- Smoke houses and ceremonies with smoke (fire, locally-harvested wood, sage, etc.)
- Making and use of traditional pottery (made from local clays, dyes, etc.)

4. Tribal Lifeways, Resources and Rights Are Treaty-Protected Rights

Current Federal Indian Policy recognizes Tribal Sovereignty, Federal Trust Responsibility, and Government to Government Relationship, yet tribes today suffer health disparities, experience exposure pathways through tribal lifeways. Treaties are legally binding contracts between sovereign nations that establish those nations’ political and property relations. Article VI of the U.S. Constitution holds that treaties “are the supreme law of the land.” In return for taking vast Indian holdings and resources (i.e. land), the U.S. promised:

- Reservation Lands,
- Continued Sovereignty,
- Protection,
- Health Care,
- Education,
- Religious Freedom,
- Some Monies.

Through the treaties they negotiated, tribes retained rights of self-government and jurisdiction.

“...the right of taking fish at all usual and accustomed places, in common with the citizens of the Territory, and of erecting temporary buildings for curing them: together with the privilege of hunting, gathering roots and berries....”

—1855 Treaty with Yakama

Tribal sovereignty means that tribes are independent nations with the right to govern themselves by:

- Forming their own government,
- Adjudicate legal cases within its boundaries,
- Levy taxes within their borders,
- Establish its membership, and
- Retain government-to-government relationship with the U.S.
5. All U.S. Agencies Share in Federal Trust Responsibility

5.1 Federal Trust Responsibility to Tribes and Tribal People

The Federal Government has a trust responsibility to protect tribal lands, assets, resources, and treaty rights, and uphold the promises made when treaties were made. With these recognized responsibilities and rights, Tribes have a unique legal status with the U.S. government. They are neither foreign nations, nor states. Tribes are distinct political communities defined in law as “domestic dependent nations.” In the 1831 Cherokee Nation v. Georgia decision, the Supreme Court described the obligation of the U.S. to tribes as that of a guardian to his wards. Subsequent decisions have made it clear that the agencies of the federal government are to be held to the most stringent “fiduciary” (trust) standards. “Trust lands” describe lands held in trust by the U.S. for the benefit of a tribe or individual tribal member which cannot be alienated or confiscated through eminent domain.

Additional case law since that 1831 Supreme Court decision confirms federal trust responsibility and protection tribal culture, identity, and ways of life.

“Moral obligation of the highest responsibility and trust”

The United States is the trustee of Indian reserved rights, including fishing rights.
– See, e.g., Joint Board of Control v. United States, 862 F.2d 195 (1988)
– 198 (9th Cir. 1988); Muckleshoot Indian Tribe v. Hall, 698 F. Supp. 1504, 1510-1511 (W.D. Wash. 1988)

The obligation of the United States as trustee of Indian resources and rights extends to all agencies and departments of the Executive Branch.
– See Pyramid Lake Paiute Tribe v. Department of the Navy, 898 F.2d 1410, 1420 (9th Cir. 1990)
– Covelo Indian Community v. FERC, 895 F.2d 581, 586 (9th Cir. 1990)

“The right to resort to the fishing places in controversy was a part of larger rights possessed by the Indians, upon the existence of which there was not a shadow of impediment, and which were not much less necessary to the existence of the Indians than the atmosphere they breathed.”
“...the Indians reiterated...that they wished to reserve the privilege of using the land for gathering, hunting, and fishing activities. They said that they could not live, deprived of these means of sustenance.

– Lac Court Oreilles Band of Chippewa Indians v. Leter P. Voigt, Seventh Circuit Court (1983)

Tribal nations, their governments, and their enrolled tribal members and tribal descendants are present in the United States and continue their ancestral tribal lifeways. There are 573 federally recognized tribes: 229 in Alaska, 110 in California and 234 in 33 other states. There are 61 state recognized tribes in 12 states. As of 2017, the U.S. Census Bureau’s annual estimate of the Native American and Alaska Native population was 6.1 million which is 1.7% of the total U.S. population. Further, the Bureau projects that by 2050 the Native American and Alaska Native population will be 8.6 million, 2% of the total U.S. populations. The tribal nations with the largest populations include: Cherokee, Navajo, Choctaw, Chippewa, Sioux, Apache, Blackfeet, and Pueblo. The tribal lands—both trust lands and non-trust and non-reservation lands—accumulate to a collective geographical area today of 56 million acres which is equivalent to the size of Idaho state.

Unfortunately, tribal people are afflicted by some of the least desirable statistics in the U.S.: the highest rates of suicide of any racial or ethnic group including white; highest rates of violence against women at more than double the rates of women of other races; overrepresentation in U.S. prisons and jails; historical and generational trauma from loss of people, lands and culture; post-traumatic stress disorder; more likely to have poorer overall physical and mental health and unmet medical and psychological needs; overrepresentation in the U.S. foster care system; and predisposition to heart disease, diabetes, and substance addiction. Many of these physical and mental health disparities are related to the historic and generational traumas, related to poverty induced by loss of people, lands, and language, related to the unmet obligations of the U.S. Government. These health disparities are exacerbated by environmental contaminants and pollutants in and around tribal resources. There is a legacy of toxic pollution on tribal lands and resources:

More than a century of hard rock mining has left a legacy of >160,000 abandoned mines in the Western USA that are home to the majority of Native American lands. ...Similar articles could be written focusing on impacts to tribal lands from coal strip mining, from the legacy of military bases, and from oil and gas development.

Ineffective policies and the lack of infrastructure lead to environmental contamination through permitted exemptions to waste disposal allowing unlined landfills that accept household hazardous waste and unfiltered emissions from on-the-ground or other open burning. These exemptions also allow waste managers non-collection and non-treatment of landfill leachate. Additionally, tribal lands are commonly used for illegal waste dumping due to the significant void of law enforcement presence.

Despite attempts to disconnect tribes from traditional resources and tribal lifeways, tribal populations maintain a close relationship to the environment. The chemical exposures experienced by tribal people are not extremes of a general population range but consist of many discrete activities with legal protections.
NTTC recognizes that prior to the Lautenberg Act, the burden of proof of toxicity was on the U.S. consumer. This is not adequate for the tribal community, especially considering the high-level consumption by tribal members of wild and natural resources as well as the U.S. government’s trust responsibility and inability to provide safe water and sewer, and solid waste disposal on many Indian reservations and in many Alaska Native villages.

6. Exposures through Tribal Lifeways

6.1 Risk Exposure Pathways:

“Nonstandard exposure pathways occur under four circumstances:

(1) qualitatively nonstandard exposures (e.g., dietary, medicinal, or cosmetic use of unusual plants),
(2) quantitatively nonstandard exposure (i.e., high consumption rates, children eating dirt, a very large meal [e.g., feast of fish, whale, deer], high exposure relative to other foods, body size, or age),
(3) both nonstandard and excessive exposure (i.e., applying a chemical or cosmetic to skin, potential exposure to chemicals through cultural activities such as sweat baths), and
(4) inadvertent exposure as byproducts of other consumptive, social, or cultural practices (i.e., mercury exposure from cultural practices).”

6.2 Due to Tribal lifeways, as a whole, Tribal people ingest, inhale, contact, and dermally absorb chemicals from the natural environment more frequently, for longer periods of time, and in different ways, than the general population. Because Tribal lifeways are unique, these exposures are both qualitatively nonstandard (how people are exposed, such as basket grass softening via mouth) and quantitatively nonstandard (e.g. the amount of fish consumed).

6.2.1 Tribal people spend longer periods of time and engage more often in the environment conducting unique outdoor traditional activities. Examples:

◆ Traditional water use (untreated water collection and consumption)
◆ Hunting, fishing, gathering
◆ Ceremonies
◆ Social activities

6.2.2 Tribal people engage more often and spend more time interacting with environmental media, resources, and derived objects. Examples:

◆ Ceremonial objects (e.g., ceremonial feathers),
◆ artifacts (from generations past used for display, special ceremonies, repatriation)
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- art, tools from media (clay pots, reed baskets, baleen carving, etc.)
- food preparation and storage
- steam baths with untreated water and full body immersion in untreated water

6.2.3 Tribal people are substantially more likely to consume locally and regionally-obtained biota, whether plants, animals, or fish, and in greater quantities and greater diversity. Examples:
- plants
- animals, large land mammals
- fish, shell fish
- large marine mammals

6.2.4 Regionally, certain traditional styles of housing and practices, may present substantially greater exposures.
- E.g., adobe houses present durable dust and soil ingestion exposures off the charts.
- E.g., fish drying in Alaska with open burning of the community dump site several times per week, less than one quarter mile away, or fish, marine mammal, land animal dried and stored without a protective barrier in the arctic entryway where opened vehicle care products, paints, and other hazardous products are stored. Village housing, school, and landfill are all proximate within a compact area. Children playing in open space available like near vehicles, landfill sites, waste collection sites.

6.2.5 There are a number of facets related to traditional/cultural practices that are not reflected in the activity profiles currently used. Examples:
- Tribal people’s lifestyles are largely seasonal and that dependence on season permeates their daily lives. Seasons are defined not by dates but by changes in the environment and the cycles of plants and animals tribes depend on.
- Work is often at home, and home environments reflect tribal lifestyles as do the handicraft or ceremonial objects they or extended family members may make. Dust is created by making handicraft and ceremonial objects, mixing with dust accumulated from dirt and gravel roads, furniture, and household products. Thus, dust inhalation and ingestion are major exposure pathways.
- Age groups are affected. Young children hunt and gather, elders may be more active in the environment longer than their peers in the general populations and serve as babysitters more often, usually living in the same home.
7. Conceptual Model of Tribal Exposures

The below Graphic illustrates the unique exposures that Tribes face and that should be considered in any risk assessment procedure. The conceptual model that follows is intended for use in formulating the scope of any EPA chemical risk assessment.
8. Tribal Exposures

Exposure measures or models aspects of frequency, duration, and intensity. As such there are multiple additional exposure routes that EPA must evaluate. NTTC maintains that resource use is another important factor to the risk paradigm which EPA is overlooking. EPA must consider whether tribes use different resources that results in different exposure routes(s) than the general consumer. For example, plants uptake the pollutants or pollutants adhere to plants, tribal members harvest those plant resources for customary and traditional foods and medicines, and for traditional arts such as basketry, thus demonstrating multiple exposure pathways including ingestion, dermal absorption on the hands, and in some cases, dermal absorption in the mouth from splitting roots or softening materials.

The three steps in the process are

1. Identifying exposure pathways based on the media and resource that is contaminated,
2. Identifying the route of exposure (what is the portal of entry into the person), and
3. Developing exposure factors (the numerical representations of the exposures).

8.1 Exposure assessments, ideally, incorporate total exposure and all sources of human contact with a chemical (e.g., a person may contact a given chemical through use of a product, through occupational encounters, through dietary intake, and through activity proximate to a contaminated site).
8.2 Thus, exposure assessors must consider data about three prime exposure factors, frequency, duration, and contact rate:

8.2.1 what products Tribes use in their daily lives (e.g., PBDE and/or HBCD-laden older upholstered furniture or bisphenol A (BPA)-infused plastics);

8.2.2 aspects of where they reside that may be non-standard, including but not limited to:

- proximity to an industrial emissions source, transportation corridor and utilidors,
- proximity to waste disposal burning and leachate,
- downriver of or adjacent to a contaminated site,
- closely-housed communities with only dirt roads
- arctic entries where hazardous chemicals are co-located with food and water
- aged home furnishings containing long-since banned chemicals breaking down into dust and thus increased inhalation and ingestion,
- rural locations more likely near open burning and more likely to have vehicles and other solid waste illegally disposed of in their environment
- incomplete plumbing and incomplete kitchens—which are found in 7 percent of tribal homes compared with less than 2 percent of all U.S. households. For example, 36 percent of Alaska tribal area households have incomplete plumbing, incomplete kitchens, or overcrowding.\textsuperscript{16}

8.2.3 how much time tribes spend engaged in various activities at differing levels of cardiovascular vigor (e.g., sleeping, sitting, exercising, hunting) in various locations (e.g., indoors at work, outdoors in a garden, gathering wild foods in a national forest or a utility right-of-way sprayed with herbicides);

8.2.4 the quantities of various food, drink, and traditional medicinal items ingested; and

8.2.5 how all of these vary over a lifetime.

8.3 Examples of subsistence, traditional, and ceremonial-spiritual activities that should be considered affected by chemicals in consumer products and the environment include but are not limited to:

8.3.1 Collection and use of edible and medicinal resources and cultural materials on public lands such as utility rights of way, streambeds, and marshes. This may include wading and constant soaking of feet and hands in water during collection activities.

8.3.2 Preparation of traditional materials, including cleaning in surface water and other activities such as chewing reeds, sinew, and fish skins for additional uses.

8.3.3 High consumption of plants gathered and fish and animals (including shellfish and other invertebrates) collected locally, including non-standard consumption such as fish skin,
fats and oils, or other parts of animals, most of which are not readily available in the supermarket.

8.3.4 Meditation, bathing, steam baths, cooking, cleaning, soaking traditional materials (also placed in mouth while conducting multiple activities), and drinking local surface and rain water and snow and ice melt.

8.3.5 Smoking fish/meats and hides, burning out canoes, cultural burning to stimulate material production, and heating rocks for cooking, shaping wood and sweat lodges.

8.3.6 Occupational and environmental exposures are also often overlooked. For example, a study of malignant mesothelioma found that Native American silversmiths routinely used asbestos mats to insulate worktables while making silver jewelry, which exposed them to a hazard, asbestos, that was seemingly unrelated to the occupational activity (silversmith).

9. Fish Consumption and Other Wild Foods

9.1 Regarding the population scenario, the tribal population scenario is the most appropriate to use for risk assessments by EPA because TSCA requires EPA to protect the population of highest risk. Additionally, it is a federal trust responsibility to tribes under the U.S. government’s moral and legal obligations to American Indians and Alaska Natives. EPA must use the fish consumption rates of subsistence fishers so that EPA accounts for aggregate exposure of those who rely heavily on locally sourced fish. Consider that EPA identified in the 2015 problem formulation for the HBCD cluster, the fish consumption rate of 142.5 grams based on subsistence fishers consumption rates (U.S. EPA, 2015a). Furthermore, there are EPA-accepted rates several times higher in Region 10.

9.2 NTTC supports EPA’s comments on the September 30, 2015 technical call (U.S. EPA, 2015b) that EPA will evaluate additive exposures, such as oral exposures including fish consumption, drinking water consumption, potential for dust consumption and mouthing in the flame retardant risk assessments. However, in such an evaluation of oral exposures, EPA must include the high-end exposure approach with fish consumption rates of subsistence fishers.

9.3 Food other than fish: In the past EPA has stated it would not assess food other than fish because it is the purview of other agencies. EPA would do well to clarify that in this statement “food other than fish” refers to processed or manufactured food products and not the foods represented in tribal lifeways and other subsistence means. Otherwise, EPA is specifically excluding tribal citizens who consume large amounts of land and marine mammal tissue and fats in traditional foods including several species of ungulates, whale and seal, walrus, and sea lion. It also disregards other traditional foods of sea food, migratory birds and their eggs, and certain reptiles. EPA needs to consider these subsistence food sources for which numerous data sources are available from research conducted in the U.S. and other Arctic countries, such as Canada, Greenland and Norway. EPA is a member agency of the White House Cabinet; it is capable of collaborating with its sister agencies that would assess food other than fish, as well as gathering data from such agencies.
10. **People-Based Versus Source-Based Models**

10.1 **Source-based model is inappropriate for Tribal exposures.**

In working with OPPT and in preparing the document Understanding Tribal Exposures to Toxics, the NTTC requested that OPPT include tribal exposure in their chemicals risk assessments. In response, OPPT staff has requested NTTC to provide the necessary data to consider tribal scenarios. Although some tribes may have data that OPPT is requesting, it became evident that funding for tribal-specific research is needed to provide multiple scenarios for consideration. Chemical-specific monitoring is also needed to determine if TSCA Work Plan chemicals that OPPT is conducting risk assessment on are present in subsistence foods and those resources handled, utilized, or consumed in tribal lifeways. It is unlikely that tribes can generate the necessary analytical data or compile the information OPPT needs to consider exposure pathways for TSCA Work Plan chemicals without specific project funding or technical assistance by EPA to complete tribal risk assessments.

Therefore, in addition to addressing OPPT-specific requests for tribal recommendations, NTTC expanded the scope of this report [NTTC 2015] to provide a foundation for requesting studies that could serve OPPT’s needs for incorporating tribal-specific data and exposure scenarios into TSCA chemical risk assessments.

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10.2 **The LifeLine Group, Software Models, and Data Compendiums**

The LifeLine Group, Inc. is a US 501(c)(3) non-profit organization that has developed people-based probabilistic modeling software that can account for non-standard diets and that has established peer-reviewed compendia of customized dietary files for the American Southwest and Mexican-Influenced diets, Alaska Traditional and Subsistence foods, and First Nations and Inuit in Arctic Canada traditional foods.

To identify subpopulations (e.g., children, women, etc.) that are at greater risk, the LifeLine™ Community-Based Assessment Software can use a community's dietary and activity files created with the Dietary Record Generator© and Activity Record Generator© together with the contaminant residue data to present a community-specific exposure and risk assessment.

The LifeLine Software can handle a full array of information and values, and describes how exposure and risk are distributed across a population as well as variability in exposure and risk due to day-to-day variation in contaminant or exposure levels. The LifeLine assessment can also examine health effects over the short and longer terms. The software is freely available and with appropriate expertise or assistance, can be used by communities as well as decision-makers at the local, state, provincial and national levels.

For instance, for the Compendium of Alaska Traditional and Subsistence Dietary Files©, The LifeLine Group constructed the food consumption database for Alaska Native populations from a diverse array of information about dietary habits, food availability, and economics of the populations for whom there are no detailed food consumption surveys. This and the Dietary Files for the American Southwest™ provide high-quality data that is scientifically accurate, relevant, representative, and quantifiable for uniquely exposed and susceptible subpopulations while reducing the burden of needing chemical-specific data for every single exposure pathway, which is unlikely or nearly impossible for either tribes or EPA to collect.
Further information on the relevance, data quality, and other principles to vet the data used in database construction is available at The LifeLine Group’s website.

11. The Durability

The durability of tribal environmental exposures may be orders of magnitude higher because Tribal peoples hunt and gather resources locally, then consume and use these local resources—not purchasing them at a grocery store where the meat, produce and other foods might come from any number of different sources and those locations vary over time. Further, for populations in urban areas, there are choices of various fish, meat, and produce in a grocery store, but not so from a subsistence area.

12. Mitigation by Avoidance or Replacement is Not an Option

When at least half of your diet is derived locally, you cannot stop eating that and switch to other foods. This type of mitigation action used in past risk management strategies, i.e., “don’t consume more than X amount in Y timeframe,” amounts to an unfunded mandate and forced cultural loss which is documented to lead to a range of societal ills that cause economic impact as well.

As Ocampo wrote: Many First Nations [Indigenous People] peoples embrace a shared group identity whose substance is formed not just by one’s relationship to the community but also to the land and one’s ancestors, which may include plants, animals and other elements of nature. For example, traditional Native Hawai’ians consider the taro, a root staple that nurtures them, a physical ancestor now under their guardianship. Thus, reduction or dispossession of land/loss of stewardship of one’s traditional plants and animals is experienced as an alienation or unmooring from the self, and in some communities is directly correlated with suicide (i.e., among the Guarani of Argentina - see Robinson, 2008).  

Whitbeck, Walls, Johnson,Morrisseau, & McDougall (2009) studied depression and historical loss among Indigenous adolescents, reporting that the measures of perceived historical loss and depression were separate but related constructs. Even when controlling for effecting influences such as family factors, discriminatory treatment, and proximal negative life events, an adolescent’s perceived historical loss had independent effects on their depressive symptoms. The construct of historical loss is discussed in terms of Indigenous ethnic cleansing: military defeat, relocation to approximate penal colonies, starvation, neglect, forbidden to practice traditional means of survival and spiritual traditions, forced assimilation, children kidnapped and reeducated in settings that ignored kinship patterns, traditional language use punished, and efforts to replace traditional religious beliefs with Christianity, no specific end to government policies of assimilation, and no acknowledgement of ethnic cleansing or apology for it from the U.S. government.
Reinschmidt, Attakai, Kahn, Whitewater, & Teufel-Shone (2016) developed the *Stories of Resilience Model* from interviewing and documenting Urban American Indian Elders’ experiences of historical trauma and resilience.25

For Indigenous people removed as children to boarding/residential schools or adopted by White families off reservation, this meant being removed from the tribal lands that were closely tied in with culture and traditions, including subsistence practices (farming and hunting), beliefs (traditional spirituality), and values (having respect for oneself and others). Separation from their families led to a loss of contact with relatives, especially elders, who passed on culture and traditions. Family members could no longer teach Native languages or engage children in family activities.

Despite these historic and generational traumas, tribes have maintained cultural practices and values, and many tribes—but not all—maintained their Indigenous languages, stories, songs, and millennia of history. Thus, contrary to the efforts of colonization, assimilation, and attempts of genocide, research of Indigenous survivors is demonstrating that traditional spirituality, traditional practices, and cultural identity are proven protective factors for Indigenous children and adults.26 Further, there is accumulating evidence that traditional spirituality and practices are associated with alcohol cessation, are negatively related to depressive symptoms and suicidal behaviors among adults, and that they are associated with academic success, self-esteem, and prosocial behaviors among adolescents.

Resilience strategies in the context of the community included being “connected to the community,” “involved in local community cultural activities,” and “knowing one’s Native language” were. Another elder’s story demonstrated the connection between personal, family, and community resilience:

I think the values that I picked up when I was growing up was making my baskets. That was one of the things that REALLY was good for me... I was taught by my mother and

I learned that it really did help me. She ...showed me how to prepare to make basket: first to go out and get the plants... I have to talk to the plants. You go up to the plants while you get them, so that it will help you, strengthen you, give you the courage to go on with your life and it’s really not just making baskets. It’s something that, it’s sort of like a sacred secret. So that’s what I did. I found out that that’s REALLY helped me a lot. Not just making baskets, but keeping up with our tradition, something that our people used to make and use for many things. And also, I sell my baskets a lot so that helped me in many ways...that was my income when I couldn’t work...30
The Indigenous notion of personhood connects individuals to larger contexts, including family, community, spirituality and history. As described by the elders in the study, and in the literature (Kirmayer et al., 2009, 2012), the Indigenous notion of the self (or person or individual) is one of connectedness. Individual resilience thus must be understood as systemic in nature, because it refers to Indigenous notions of the individual that are characterized by connectedness. In telling their stories, elders talked about people who served as role models for them, about being role models themselves, and about the importance of role models. Most elders fondly remembered their grandparents, parents, or aunts. These relatives imparted knowledge and skills, including gardening, butchering, counseling others, being medicine men, and knowing traditions around birth and death.

Healing among North American indigenous populations have common themes, shared health beliefs and a unified perspective of bio-psycho-socio-spiritual approaches and traditions, regardless of tribal-specific differences in healing practices, like feathers of different birds, sweat lodge or bonya steam bath, burning a dried herb or burning a fire dish of food. “The culture is the primary vehicle for delivering healing.” Bassett, Tsosie, & Nannauck. 2012).

“Native diets, ceremonies that greet the seasons and the harvests, and the use of native plants for healing purposes have been used to live to promote health by living in harmony with the earth.” Koithan & Farrell (2010). Food from the land gives people life and brings them wellness. (Youth Taking Action, no date (n.d.)

Alaska Natives have been nourished by foods from the land, air, and water for thousands of years (Alstrom & Johnson, n.d.). They have had a lifelong association with these foods, seeking them, harvesting them, cleaning them, preparing them to be eaten or stored, keeping the foods safe from loss of spoilage, and enjoying them as foods. People take great comfort from eating the foods they’ve grown up with. These foods can be very comfortable to eat in times of illness and healing, and are very rich in the nutrients necessary for good health. Native foods tend to be very good sources of nutrients like protein, iron, Vitamins A, D and E, and low in saturated fats and sugars. Native foods are the heart of culture and health. They provide close ties to the land and the seasons and the environment. Participating in harvesting, preparing, sharing and eating the foods along with others contributes to spiritual well being.

13. Disposal is a Condition of Use

Chemicals and/or their byproducts enter the natural environment via disposal of the consumer products. In the absence of considering disposal, EPA will not represent primary exposure pathways for Tribal populations, including the practice of traditional and customary activities, as well as for other populations. 13.1 Activity profiles are not representational.

It is known that chlorinated and brominated flame retardants (BFRs) are being released into our environment throughout the world (Bi et al., 2007; Kakimoto, Akutsu, Konishi & Tanaka, 2008; Tue et al, 2010; Vázquez & Rizo, 2014). Studies such as these include finding brominated flame retardants (BFRs) in multiple biological samples in exposed humans including in the breast milk of
mothers living at e-waste recycling sites in China and Vietnam. As noted below, similar practices of openly burning solid waste occur under approved exemption to federal law in Alaska tribal villages, and occur in and near other tribal communities where law enforcement is minimal and underfunded.

Not all disposal pathways are in lined landfills where hazardous material and construction and demolition (C&D) waste are disposed of in a separate landfill. There are 207 RCRA Subtitle D municipal waste unlined landfills in Alaska compared to nine lined landfills. The unlined landfills serve approximately half the population of the State and include most construction wastes. There are also occasionally site specific construction and demolition wastes that are universally unlined. Alaska rural landfills are unlined and allow open waste burning—two conditions that in 1976 were prohibited by federal statute for every other community in the United States because of the danger to community health, fire safety, and impact on the environment. In fact, half of Superfund sites today are the unlined, open burned municipal landfills from the 1960’s and 1970’s. The lack of liner or emissions treatment means the sites are not designed to accept hazardous wastes. Much of this reason relates to distance from towns to their dump site and from the dump site to community drinking water sources. Wastes form leachate, which drains to drinking and subsistence water. About one third of Alaska offroad village dumpsites are within one quarter mile of a drinking water source, and about half flood each year. If wastes aren’t discarded at the landfill, they are burned untreated and form toxic waste smoke and emissions, which is smelled in and around homes in about 80% of towns. About one fourth of these communities are breathing toxic emissions from their community’s dumpsite at home, in town, every day for hours. While not many health studies have been carried out specific to villages, in 2002, with the same conditions existing as they still are today, Zender Environmental conducted a retrospective study in four villages and found that people who visited their dump were 2 to almost 4 times more likely to experience faintness, fever, vomiting, stomach pain, ear and eye irritation, headache, and/or numbness (Gilbreath, Zender & Kass, n.d.). The more often people visited the dump, the more likely they were to experience the symptoms. In a 2006 study by Gilbreath and Kass, Alaska Native Village dump sites without a way to separate and backhaul their hazardous wastes were found to present increased risks for lower birth weight, shorter gestation, and 4.3 times greater risk for several types of birth defects.

It should be noted that multiple states across the country permit unlined construction and demolition (C &D) landfills under RCRA. These C & D landfills are nearly always in rural areas, where the vast bulk of tribes reside. Further, checkerboard jurisdiction on reservations means that open dumping by contractors and the general public occurs regularly.

In tribal communities and in rural and low-income communities across the country, citizens are recycling and recovering consumer products, like removing useable parts from dead vehicles, taking home the free sofa outside the landfill fence, fishing in the dikes and ditches. A study that could be potentially used as a surrogate for these types of activities was conducted by Athanasiadou, Cuadra, Marsh, Bergman, & Jakobsson (2008) where they looked at exposure to PBDEs and bioaccumulative hydroxylated PBDE metabolites in young people, including children, from Managua, Nicaragua. Our aim was to investigate exposure to polybrominated diphenyl ethers (PBDEs) in a young urban population in a developing country, with focus on potentially highly exposed children working informally as scrap scavengers at a large municipal waste disposal site. We also set out to investigate whether hydroxylated metabolites, which not hitherto have been found...
METHODS: We assessed PBDEs in pooled serum samples obtained in 2002 from children 11-15 years of age, working and sometimes also living at the municipal waste disposal site in Managua, and in nonworking urban children. The influence of fish consumption was evaluated in the children and in groups of women 15-44 years of age who differed markedly in their fish consumption. Hydroxylated PBDEs were assessed as their methoxylated derivates. The chemical analyses were performed by gas chromatography/mass spectrometry, using authentic reference substances. RESULTS: The children living and working at the waste disposal site showed very high levels of medium brominated diphenyl ethers. The levels observed in the referent children were comparable to contemporary observations in the United States. The exposure pattern was consistent with dust being the dominating source. The children with the highest PBDE levels also had the highest levels of hydroxylated metabolites. CONCLUSIONS: Unexpectedly, very high levels of PBDEs were found in children from an urban area in a developing country. Also, for the first time, hydroxylated PBDE metabolites were found to bioaccumulate in human serum.

Stephenson and Harrad published their critical review of BFRs emissions from waste soft furnishings in 2014 which contained their noteworthy recommendation that waste soft furnishings be treated with the same concern as e-waste containing BFRs. Use of brominated flame retardants (BFRs) in soft furnishings has occurred for over thirty years with the phase out of [PBDEs] and [HBCD] only relatively recently begun. As products treated with BFRs reach the end of their lifecycle they enter the waste stream, thereby constituting an important and increasing reservoir of these chemicals. This review highlights the dearth of data on the extent and potential mechanisms of BFR emissions from waste soft furnishings. However, insights into what may occur are provided by scrutiny of the larger (though still incomplete) database related to BFR emissions from electronic waste (e-waste). In many countries, municipal landfills have historically been the primary disposal method of waste consumer products and therefore represent a substantial reservoir of BFRs. Published data for BFR emissions to both air and water from landfill and other waste disposal routes are collated, presented and reviewed. Reported concentrations of PBDEs in landfill leachate range considerably from <1ngL(-1) to 133,000ngΣPBDEL(-1). In addition to direct migration of BFRs from waste materials; there is evidence that some higher brominated flame retardants are able to undergo degradation and debromination during waste treatment, that in some instances may lead to the formation of more toxic and bioavailable compounds. We propose that waste soft furnishings be treated with the same concern as e-waste, given its potential as a reservoir and source of environmental contamination with BFRs.

Flame retardants in commercial products eventually make their way into the waste stream (Morin, Andersson, Hale, & Arp, 2017). Herein the presence of flame retardants in Norwegian landfills, incineration facilities and recycling sorting/defragmenting facilities is investigated. These facilities handled waste electrical and electronic equipment (WEEE), vehicles, digestate, glass, combustibles, bottom ash and fly ash. The flame retardants considered included polybrominated diphenyl ethers (ΣBDE-10) as well as dechlorane plus, polybrominated biphenyls, hexabromobenzene, pentabromotoluene and pentabromoethylbenzene (collectively referred to as ΣFR-7). Plastic, WEEE and vehicles contained the largest amount of flame retardants (ΣBDE-10: 45,000-210,000μg/kg; ΣFR-7: 300-
13,000μg/kg). It was hypothesized leachate and air concentrations from facilities that sort/defragment WEEE and vehicles would be the highest. This was supported for total air phase concentrations ($\sum$BDE-10: 9000-195,000pg/m3 WEEE/vehicle facilities, 80-900pg/m3 in incineration/sorting and landfill sites), but not for water leachate concentrations (e.g., $\sum$BDE-10: 15-3500ng/L in WEEE/vehicle facilities and 1-250ng/L in landfill sites). Landfill leachate exhibited similar concentrations as WEEE/vehicle sorting and defragmenting facility leachate. To better account for concentrations in leachates at the different facilities, waste-water partitioning coefficients, $K_{waste}$ were measured (for the first time to our knowledge for flame retardants). WEEE and plastic waste had elevated $K_{waste}$ compared to other wastes, likely because flame retardants are directly added to these materials. The results of this study have implications for the development of strategies to reduce exposure and environmental emissions of flame retardants in waste and recycled products through improved waste management practices.

13.1.1 Leachate from Unlined Landfills

Waterborne – In rural areas, wastewater may go through primary treatment only, then is discharged to surrounding water bodies. But a wide range of chemicals has been found even in secondary treatment of wastewater from urban POTW’s. Only in the last five years or less, have the number and type of chemicals being sampled expanded to include a wider range of chemicals of concern.

Natural and synthetic organic contaminants in municipal wastewater treatment plant (WWTP) effluents can cause ecosystem impacts, raising concerns about their persistence in receiving streams (Barber et al., 2013). In this study, Lagrangian sampling was conducted in two streams to determine in-stream transport and attenuation of organic contaminants discharged from two secondary WWTPs. Integrated composite samples were analyzed for >200 organic contaminants including metal complexing agents, nonionic surfactant degradates, personal care products, pharmaceuticals, steroidal hormones, and pesticides. The highest concentration (>100 μg L−1) compounds detected in both WWTP effluents were ethylenediaminetetraacetic acid [used for industrial and medical purposes] and 4-nonylphenolethoxycarboxylate oligomers, both of which persisted for at least 7 km downstream from the WWTPs. Concentrations of pharmaceuticals were lower (<1 μg L−1), and several compounds, including carbamazepine and sulfamethoxazole, were detected throughout the study reaches. After accounting for in-stream dilution, a complex mixture of contaminants showed little attenuation and was persistent in the receiving streams at concentrations with potential ecosystem implications.

Sampling of leachate in Japanese samples in the early 2000’s sounded the alarm of BFRs leaching characteristics varying beyond expectations based on BFRs physical and chemical characteristics. Leachate samples were taken from seven different landfills and concentrations of brominated flame retardants (BFRs) were quantified. Three sites that not only had crushed material from bulk wastes such as waste electric and electronic equipment, but also were under
operation or within a year since closure, indicated a higher concentration of BFRs than the other sites. In particular, extremely high concentration of PBDEs was observed at a site with a large amount of organics. Considering the leaching characteristics of BFRs, there exists the possibility that leachability of PBDEs is influenced by the presence of dissolved humic matter (DHM) in the leachate. The high removal efficiency for BFRs in the leachate treatment process was also confirmed.

Thus, where leachate is not treated, BFRs are continuing into the local environment.

Five years later, Choki, Lee & Osako (2009) investigated the contents of several brominated compounds in TV molding plastics, as well as their leaching characteristics in the presence of dissolved humic material (DHM). From an overall perspective, it is clear that hydrophobic BFRs can leach out to a great extent in the presence of DHM, which is a matter of great concern in E&E waste as the potential contaminant source of BFRs, especially in landfills and open dump sites that provide the perfect conditions for exposure of BFRs to abundant DHM.

Other chemicals are also known to be part of landfill leachate and some clarity to specific contaminants of emerging concern (CECs) was brought out by Masoner et al. (2014). To better understand the composition of CECs in landfill leachate, fresh leachate from 19 landfills was sampled across the United States during 2011. The sampled network included 12 municipal and 7 private landfills with varying landfill waste compositions, geographic and climatic settings, ages of waste, waste loads, and leachate production. A total of 129 out of 202 CECs were detected during this study, including 62 prescription pharmaceuticals, 23 industrial chemicals, 18 nonprescription pharmaceuticals, 16 household chemicals, 6 steroid hormones, and 4 plant/animal sterols. CECs were detected in every leachate sample, with the total number of detected CECs in samples ranging from 6 to 82 (median = 31). Bisphenol A (BPA), cotinine, and N,N-diethyltoluamide (DEET) were the most frequently detected CECs, being found in 95% of the leachate samples, followed by lidocaine (89%) and camphor (84%). Other frequently detected CECs included benzophenone, naphthalene, and amphetamine, each detected in 79% of the leachate samples. CEC concentrations spanned six orders of magnitude, ranging from ng L−1 to mg L−1. Industrial and household chemicals were measured in the greatest concentrations, composing more than 82% of the total measured CEC concentrations. Maximum concentrations for three household and industrial chemicals, para-cresol (7 020 000 ng L−1), BPA (6 380 000 ng L−1), and phenol (1 550 000 ng L−1), were the largest measured, with these CECs composing 70% of the total measured CEC concentrations. Nonprescription pharmaceuticals represented 12%, plant/animal sterols 4%, prescription pharmaceuticals 1%, and steroid hormones <1% of the total measured CEC concentrations. Leachate from landfills in areas receiving greater amounts of precipitation had greater
frequencies of CEC detections and concentrations in leachate than landfills receiving less precipitation.

The following study addresses issues that are exactly emulated in Alaska village municipal landfills, and other rural and tribal dump sites. In developing countries, wastes are usually not separated before being disposed of in solid-waste landfills, most of which are open dumps without adequate measures to prevent environmental pollution (Kajiwara et al. 2014). To understand the leaching behavior of brominated flame retardants (BFRs) from waste consumer products in landfills, they have been conducting a long-term landfill lysimeter experiment since 2006 under conditions designed to mimic three types of landfill conditions in developing countries: aerobic, semi-aerobic, and anaerobic. They determined the concentrations of polybrominated diphenyl ethers, tetrabromobisphenol A, tribromophenols, and hexabromocyclododecanes in leachate samples collected from the lysimeters during the first 3.5 years of the experiment, to evaluate BFR elution behavior in early-stage landfills. Under all three conditions, BFR elution started at the beginning of the experiment. The BFR concentrations in the leachates from the aerobic lysimeter tended to be lower than those from the anaerobic lysimeter, suggesting that the presence of air inside landfills considerably reduces BFR elution to the surrounding environment. During the 3.5-year experiment, BFR outflow from the lysimeters was only 0.001-0.58% of the total BFRs in the loaded waste; that is, most of the BFRs in the waste remained in the lysimeters.

The levels of perfluoroalkyl substances (PFASs), polybrominated diphenyl ethers (PBDEs) and hexabromocyclododecane [HBCDs] were studied in Australian landfill leachate and biosolids (Gallen et al., 2016). Leachate was collected from 13 landfill sites and biosolids were collected from 16 wastewater treatment plants (WWTPs), across Australia. Perfluorohexanoate (PFHxA) (12-5700ng/L) was the most abundant investigated persistent, bioaccumulative and toxic (PBT) chemical in leachate. With one exception, mean concentrations of PFASs were higher in leachate of operating landfills compared to closed landfills. Polybrominated diphenyl ethers (PBDEs) and hexabromocyclododecane isomers [HBCDs] were detected typically at operating landfills in comparatively lower concentrations than the PFASs. Decabromodiphenyl ether (BDE-209) (<0.4-2300ng/g) and perfluorooctanesulfonate (PFOS) (<LOD-380ng/g) were the predominant PBTs detected in biosolids. Using data provided by sites, the volume of leachate discharged to WWTPs for treatment was small (<1% total inflow), and masses of PBTs transferred reached a maximum of 16g/yr (PFHxA). A national estimate of masses of PBTs accumulated in Australian biosolids reached 167kg/yr (BDE-209), a per capita contribution of 7.2±7.2mg/yr. Nationally, approximately 59% of biosolids are repurposed and applied to agricultural land. To our knowledge this study presents the first published data of PFASs and [HBCDs] in Australian leachate and biosolids.
13.1.2 Air Emissions from Open Waste Burning

This study investigated the occurrence of polychlorinated biphenyls (PCBs), and several additive brominated flame retardants (BFRs) in indoor dust and air from two Vietnamese informal e-waste recycling sites (EWRSs) and an urban site in order to assess the relevance of these media for human exposure (Tue et al. 2013). The levels of PBDEs, HBCD, 1,2-bis-(2,4,6-tribromophenoxy)ethane (BTBPE) and decabromodiphenyl ethane (DBDPE) in settled house dust from the EWRSs (130-12,000, 5.4-400, 5.2-620 and 31-1400 ng g(-1), respectively) were significantly higher than in urban house dust but the levels of PCBs (4.8-320 ng g(-1)) were not higher. The levels of PCBs and PBDEs in air at e-waste recycling houses (1000-1800 and 620-720 pg m(-3), respectively), determined using passive sampling, were also higher compared with non-e-waste houses. The composition of BFRs in EWRS samples suggests the influence from high-temperature processes and occurrence of waste materials containing older BFR formulations. Results of daily intake estimation for e-waste recycling workers are in good agreement with the accumulation patterns previously observed in human milk and indicate that dust ingestion contributes a large portion of the PBDE intake (60%-88%), and air inhalation to the low-chlorinated PCB intake (>80% for triCBs) due to their high levels in dust and air, respectively. Further investigation of both indoor dust and air as the exposure media for other e-waste recycling-related contaminants and assessment of health risk associated with exposure to these contaminant mixtures is necessary.

The open burning of waste, whether at individual residences, businesses, or dump sites, is a large source of air pollutants (Wiedinmyer, Yokelson, & Gullett, 2014). These emissions, however, are not included in many current emission inventories used for chemistry and climate modeling applications. This paper presented the first comprehensive and consistent estimates of the global emissions of greenhouse gases, particulate matter, reactive trace gases, and toxic compounds from open waste burning. Global emissions of CO2 from open waste burning are relatively small compared to total anthropogenic CO2; however, regional CO2 emissions, particularly in many developing countries in Asia and Africa, are substantial. Further, emissions of reactive trace gases and particulate matter from open waste burning are more significant on regional scales. For example, the emissions of PM10 from open domestic waste burning in China is equivalent to 22% of China’s total reported anthropogenic PM10 emissions. The results of the emissions model presented here suggest that emissions of many air pollutants are significantly underestimated in current inventories because open waste burning is not included, consistent with studies that compare model results with available observations.

13.2 Disposal pathway regardless must be considered because contamination of media occurs even with best practice and facilities.
Throughout Asia, non-PBDE BFRs like HBCD, have extensively polluted coastal waters (Isobe, Ogawa, Ramu, Sudaryanto, & Tanabe 2012). They used mussels as a bioindicator, as did studies by the US National Oceanic & Atmospheric Admi...
health effects not accounted for by single-chemical risk assessments. For instance, studies on PCB’s, a precursor flame retardant to HBCD, showed the synergism of PCB’s with other bromine-based chemicals. “Chemicals with similar structure or particularly those containing bromine should be considered synergistic unless it has been proven that they are not” (Pellacani et al., 2014).54

NTTC continues to urge EPA to move beyond just cancer risk or only toxicity, and assess more concerning endocrine disrupting health effects as levels of risk from known endocrine disrupter chemicals (EDCs). These EDCs are particularly dangerous and not adequately assessed in the most recent risk scenarios.

15. Flame Retardant Issues

In August 2015, EPA published for public comment its TSCA Work Plan Chemical problem formulation and initial assessment documents for the three flame retardant clusters Brominated Bisphenol A (TBBPA), Chlorinated Phosphate Esters (CPE), and Cyclic Aliphatic Bromides (HBCD) (US EPA 2015c).55 In response NTTC provided written comments to that docket which we recapture here in relevance to problem formulation and risk evaluation under the amended TSCA.56

NTTC appreciates EPA’s inclusion of fish consumption by subsistence fishers and their children when evaluating exposure pathways for CPE. We specifically highlight EPA’s commitment to account for the high-end fish consumption of subsistence fishers—including pregnant women, children and adults—the majority of whom are the tribal population.

NTTC agrees with the need to evaluate the hazard endpoints that go beyond cancer risk and include target organ effects, reproductive and developmental effects, and neurotoxicity (U.S. EPA 2015d, p. 32, 34).57

In CPE Problem Formulation of 2015, EPA stated it would exclude from further assessment the exposures of birds, terrestrial wildlife, or sediment-dwelling organisms as well as food other than fish. In our comments, NTTC noted its disagreement with EPA’s decision as these exclusions fail to account for the subsistence diets of tribal populations, which include these species and other resources that consume these species. In the CPE Problem Formulation, EPA noted that [m]onitoring studies have reported the detection of TCEP in aquatic species, mammalian species, herring gull eggs and pine needles. ...these materials are likely bioavailable and could be observed in a biological matrix.” (U.S. EPA 2015d, p. 22). The referenced studies showed detection of CPEs in the breast milk of women in Sweden, Asia, Japan, the Philippines, and Vietnam. These data demonstrate the need for consideration of the natural environment and food resources of tribal populations. Aquatic species, mammalian species and gull eggs are all natural resources upon which tribal populations subsist.

Yu et al. (2016) compiled and reviewed existing literature on the contamination status of BFRs in abiotic and biotic environments in China, including polybrominated diphenyl ethers (PBDEs), hexabromocyclododecane, tetrabromobisphenol A and new BFRs.58 Temporal trends were also summarized and evaluated.
Based on this review, it has been concluded that (1) high concentrations of PBDEs were generally related to the e-waste disposal processing, while the spatial distribution pattern of other BFRs was not necessarily in accordance with this; (2) extremely high concentrations of BFRs in indoor dust emphasized the importance of indoor contamination to human body burdens, while more work need to be done to confirm its contribution; (3) PBDEs in electronics dismantling workers were higher compared to the general population, indicating the occupational exposure should be of particular concern; (4) more data are now becoming available for BFRs in aquatic and terrestrial organisms not previously studied, while studies that consider the occurrence of BFRs in organisms of different trophic levels are still of urgent need for evaluating the fate of BFRs in the food web; and (5) limited data showed a decreasing trend for PBDEs, while more data on time trends of BFR contamination in various matrices and locations are still needed before the impact of regulation of BFRs can be assessed.

**Cyclic Aliphatic Bromides (HBCD), Specifically**

During problem formulation of HBCD, EPA identified inhalation, dermal and lifetime exposure assessments as data gaps that add uncertainty to EPA's risk assessment of HBCD.

NTTC continues to maintain that EPA must include tribal populations in its plans to “conduct additional risk analysis on potential worker, general population, consumer and environmental exposures under the TSCA Existing Chemicals Program” (U.S. EPA, 2015e, p. 11).59

EPA noted that HBCD is a persistent pollutant in environmental media, expected to occur primarily as particulates, which may undergo long range transport, and is highly bioaccumulative with measured fish Bioconcentration factor values of greater than 18,000 (U.S. EPA, 2015e, p. 22). Given this, EPA must consider the impact of consumption by tribal citizens who live in geographic ranges where the majority of industrial-sourced particulates are deposited, who rely on traditional foods of fish and marine mammals which bioaccumulate toxins via fish and algae consumption.

Further, on page 24 of the HBCD Problem Formulation, EPA referenced data of HBCD measured in the blubber and liver of various marine mammals; both of these tissues are a staple, consumed in large quantities, in Arctic tribal citizens’ diets (U.S. EPA, 2015e, p. 76). Then, regarding bioaccumulation, EPA referenced studies that note the widespread detection and high levels of HBCD in aquatic and terrestrial organisms: invertebrates, fish, birds and their eggs, and marine mammals, all of which are traditional food resources of tribes.

Finally, HBCD was detected in breast milk, adipose tissue, blood, and both maternal and umbilical serum (U.S. EPA, 2015e, p. 85). These references to EPA’s own work highlights NTTC’s principle that EPA must account for tribal populations, especially sensitive infant and child populations, in its risk evaluation of HBCD.

**Brominated Phthalates (TBPH/TBB), EPA-HQ-OPPT-2014-0491**

NTTC supports the EPA’s decision for comprehensive studies for many endpoints for all cluster members of the TBB/TBPH cluster. NTTC also supports the EPA’s statement of need for comprehensive studies on bioaccumulation of all brominated phthalate cluster (BPC) chemicals. Considering persistence and toxicity data on other brominated flame retardants,
bioaccumulation and persistence data are extremely necessary. With the potential for acute and chronic toxicity, reproductive toxicity, and negative health effects on fetal development and endocrine disruption, it is alarming that the U.S. allows continued use of BPC chemicals.

NTTC maintains its position that EPA must also consider chemical body burden, in addition to testing all cluster members individually and quantifying major degradation products. With suggested potential of long-term exposure of TBB/TBPH to wildlife, EPA stated that “chronic testing is recommended to address those organisms likely exposed in order to characterize potential population level effects”; and that suggested potential of “exposure and uptake by organisms present in water bodies including aquatic plants thus, hazard and bioaccumulation characterization is needed for these organisms” (U.S. EPA, 2015f, p. 39).

Therefore, NTTC reiterates that EPA must then also consider the effect of subsistence foods and traditional natural resources on the tribal population. This includes high-level consumption of marine mammals, such as whale, seal, walrus, and sea lion; fish and shellfish, such as salmon, herring, halibut, crab, and mussels; avian species such as duck, geese, and gull; and wildlife such as moose, deer, caribou, and elk.

Since the problem formulations noted above were released in 2015, NTTC has further researched these chemicals in commerce. Brominated flame retardants are found to be a frequent and at times high concentration of indoor dust in houses, apartments, daycare centers, and primary schools, and of the highest concentrations in North America and Europe (Malliari & Kalantzi, 2017). “Results from the studies showed that dust ingestion was the dominant exposure pathway for most studied BFRs compared to indoor air inhalation and dermal contact, especially for infants and toddlers who have higher exposures than older children.”

HBCD Toxicity testing has detected reproductive, developmental and behavioral effects in animals where exposures are sufficient (Marvin et al. 2011). Recent toxicological advances include a better mechanistic understanding of how HBCD can interfere with the hypothalamic-pituitary-thyroid axis, affect normal development, and impact the central nervous system defects.

Fish represents source of nutrients and major dietary vehicle of lipophilic persistent contaminants (Maranghi 2013). The study compared the effects of two legacy and two emerging fish pollutants (Hexabromocyclododecane HBCD; 2,2',4,4'-Tetrabromodiphenyl ether BDE-47; 2,2',4,4',5,5'-Hexachlorobiphenyl PCB-153; 2,3,7,8-Tetrachlorodibenzo-p-dioxin TCDD) in juvenile female mice exposed through a salmon based rodent diet for 28 days (dietary doses: HBCD 199 mg/kg bw/day; BDE-47 450 μg/kg bw/day; PCB-153 195 μg/kg bw/day; TCDD 90 ng/kg bw/day). Dose levels were comparable to previously reported developmental Lowest Observed Adverse Effect Levels. None of the treatments elicited signs of overt toxicity, but HBCD increased relative liver weight. All compounds caused changes in liver, thymus and thyroid; spleen was affected by BDE-47 and PCB-153; no effects were seen in uterus and adrenals. Strongest effects in thyroid follicles were elicited by PCB-153, in thymus and liver by BDE-47. HBCD and BDE-47 induced liver fatty changes, but appeared to be less potent in the other tissues. HBCD, BDE-47 and TCDD increased serum testosterone levels and the testosterone/estradiol ratio, suggesting a potential involvement of pathways related to sex
steroid biosynthesis and/or metabolism. The results support the role of toxicological studies on juvenile rodents in the hazard characterization of chemicals, due to endocrine and/or immune effects.

16. **Tribal People as Representative Subpopulation**

16.1 **Tribal people’s socioeconomic status and customary lifeways support a representative subpopulation role.** Some aspects of Tribal people’s lifestyle are shared by non-Tribal peoples living in the same or similar geographic area, and/or of similar socio-economic levels. These lifestyle aspects are not necessarily traditional in the sense of purposeful transfer between generations, and they often do not have the same weight of value, or a negative value. But their characteristics are still critical to ensure that risk assessments are relevant to tribal peoples. By making profiles that reflect these aspects of Tribal people’s lifestyle, risks of other subgroups that also were not represented can be more accurately assessed as well. The standard of relevance dictates that the risk assessment models used are applicable to the population being examined. As noted above, tribal lifeways result in people interacting with and consuming resources from the ecological environment more frequently and in greater volumes than the general population, and in some cases, what would orders of magnitude differences.

Extensive research indicates significantly concerning characteristics of brominated flame retardants (BFRs).

- BFRs are extensively present in environmental and biota samples worldwide,
- BFRs are persistent, bioaccumulative, and biomagnified, and
- BFRs have high potential toxicity to both ecological environment and human health.

Thus BFRs have an even greater potential toxicity to those who more frequently interact with and consume resources from the ecological environment. This is supported by Yu et al. (2016), Wang et al. (2010).

The particular relevance to tribal lifeways as representative of potentially exposed and susceptible subpopulations is especially demonstrated in Yu et al (2016) who, just two years ago, published their review of then existing literature on the contamination status of BFRs in abiotic and biotic environments in China, including polybrominated diphenyl ethers (PBDEs), HBCD, tetrabromobisphenol A (TBBPA), and newer brominated flame retardants (BFRs). Temporal trends were also summarized and evaluated. They concluded that

1. high concentrations of PBDEs were generally related to the e-waste disposal processing, while the spatial distribution pattern of other BFRs was not necessarily in accordance with this;

2. extremely high concentrations of BFRs in indoor dust emphasized the importance of indoor contamination to human body burdens, while more work need to be done to confirm its contribution;
(3) PBDEs in electronics dismantling workers were higher compared to the general population, indicating the occupational exposure should be of particular concern;

(4) more data are now becoming available for BFRs in aquatic and terrestrial organisms not previously studied, while studies that consider the occurrence of BFRs in organisms of different trophic levels are still of urgent need for evaluating the fate of BFRs in the food web; and

(5) limited data showed a decreasing trend for PBDEs, while more data on time trends of BFR contamination in various matrices and locations are still needed before the impact of regulation of BFRs can be assessed.  

16.1.2 The findings by Wang et al. (2010) are alarming when considered in relation to tribal lifeways and the disposal of electronics in unlined landfills or dumpsites and by open burning.

Brominated flame retardants (BFRs) in house dust from the electronic waste (e-waste) recycling and urban areas of South China showed that PBDE levels were comparable to the values found in North America. ...The distinct dust BFR profiles observed in the two studied areas were reflective of activities in these areas (electronics industry vs. e-waste recycling). The estimated daily intakes (EDIs) via house dust were much higher than those via other indoor pathways (air, fish, human milk, and toys). Despite the potentially low deleterious risk of PBDE exposure via house dust as suggested by the hazard quotients, this exposure pathway should be of great concern because of the higher BFR exposures for children and the presence of other BFRs (such as DBDPE) which have not yet been fully investigated.  

16.1.3 Housing-related exposures, for example. Used furniture and other items containing flame retardants, are gifted to others, purchased at thrift stores or yard sales, and found as free items on sidewalks, roadsides, and at the landfill. Furniture is kept longer than in urban and general populations, often well-passed typical time ranges and simply covered with sheets, blankets or other fabrics. Housing structures are older and smaller, similar to low-income and rural areas, and do not contain air conditioning systems, do not contain air filters, and residents rely on open windows and doors for summer cooling and for venting when cooking and cleaning. Dusting and vacuuming equipment is typically older, lesser quality, or non-existent. Inhalation and ingestion are major exposure pathways and EPA must account for these situations and factors when considering risk.

16.1.4 Public infrastructure: The tribal communities we discuss live with significantly outdated public infrastructure, e.g., private wells for drinking water, unplumbed homes, open dumping, kids playing around open dumps. They and others in rural America experience lifestyles much different from the urban centers: recreational swimming in natural water bodies, produce gardening and farming, living near open dumping, unpaved road dust, Arctic entry ways, living all or most of lifetime where they were raised, potlucks and social gatherings, sharing of harvested, grown, and
gathered foods. For rural Alaska villages, drinking water, showers, and laundry are accessed at the public watering point, often called the washeteria, where wastewater is handled with only primary treatment.

Schreder & La Guardia (2014) studied levels of flame retardants in residential house dust and laundry wastewater as a transport pathway from homes to the outdoor environment in communities near the Columbia River in Washington state (WA), accounting for influent and effluent from two wastewater treatment plants (WWTPs) servicing these communities. Of the 21 brominated and chlorinated compounds, including HBCD, detected in dust, 18 were also detected in laundry wastewater. Comparison of flame retardant levels in WWTP influents to estimates based on laundry wastewater levels indicated that laundry wastewater may be the primary source to these WWTPs.66

16.1.5 Lack of options in lifestyle. Food is gathered from land and waters locally and regionally. In the 2014 analysis update on subsistence in Alaska, rural residents harvested between 145 and 405 pounds per person per year of wild foods (Fall & Wolfe, 2016).67 The average per person per year amount was about 275 pounds for rural residents versus 19 for urban residents. That was about 0.75 pounds a day per person for rural residents versus 0.05 for urban residents. Costs of store items in Alaska villages and rural areas is prohibitive, often four or more times more expensive than in urban areas, so in general, there are less alternatives to food gathered. There are significantly fewer employment opportunities and higher costs for heating fuel, vehicle fuel, and household basic necessities due to added on cost of shipping items to village.

Without incorporating these general profiles, the proposed problem formulations are not relevant to Tribal peoples, a susceptible subpopulation.

La Guardia, Hale, Harvey, Mainor, Ciparis (2012) studied in-situ accumulation of HBCD, PBDEs, and several alternative flame-retardants in the bivalve and gastropod. While they found that several alternative brominated flame-retardants (BFRs) were being detected in the environment, they noted that contaminant bioavailability is influenced by the organisms' ecology (i.e., route of uptake) and in situ environmental factors. We observed that the filter-feeding bivalve (Corbicula fluminea) and grazing gastropod (Elimia proxima), collected downstream from a textile manufacturing outfall. Maximum levels of total hexabromocyclododecane diastereomers (ΣHBCDs) and those of polybrominated diphenyl ethers (ΣPBDEs) were among the highest reported to date worldwide. While BDE-209 was once thought to be nonbioavailable and resistant to degradation, it was the dominant BFR present and likely debromination products were detected. Contributions of α- and β-HBCD were higher in tissues than sediments, consistent with γ-HBCD bioisomerization. Mollusk bioaccumulation factors were similar between HBCD and PBDEs with 4 to 6 bromines, but factors for TBB, TBPH, and BTBPE were lower. Despite
different feeding strategies, the bivalves and gastropods exhibited similar BFR water and sediment accumulation factors.\textsuperscript{68}

In consideration of BFRs effect on flora, for example, Wu, Huang & Zhang (2016) investigation of the accumulation and phytotoxicity of technical hexabromocyclododecane (HBCD) in maize, using young seedlings exposed to solutions of technical HBCD at different concentrations. The results demonstrate HBCD accumulation in both the roots and shoots of the plant, HBCD causing DNA damage, and variances between HBCD diastereoisomers.

The uptake kinetics showed that the HBCD concentration reached an apparent equilibrium within 96hr, and the accumulation was much higher in roots than in shoots. HBCD accumulation in maize had a positive linear correlation with the exposure concentration. The accumulation of different diastereoisomers followed the order $\gamma$-HBCD>$\beta$-HBCD>$\alpha$-HBCD. Compared with their proportions in the technical HBCD exposure solution, the diastereoisomer contribution increased for $\beta$-HBCD and decreased for $\gamma$-HBCD in both maize roots and shoots with exposure time, whereas the contribution of $\alpha$-HBCD increased in roots and decreased in shoots throughout the experimental period. These results suggest the diastereomer-specific accumulation and translocation of HBCD in maize. Inhibitory effects of HBCD on the early development of maize followed the order of germination rate$>$root biomass$>$root elongation$>$shoot biomass$>$shoot elongation. Hydroxyl radical (OH) and histone H2AX phosphorylation ($\gamma$-H2AX) were induced in maize by HBCD exposure, indicative of the generation of oxidative stress and DNA double-strand breaks in maize. An OH scavenger inhibited the expression of $\gamma$-H2AX foci in both maize roots and shoots, which suggests the involvement of OH generation in the HBCD-induced DNA damage. The results of this study will offer useful information for a more comprehensive assessment of the environmental behavior and toxicity of technical HBCD.\textsuperscript{69}

Several studies in the last few years have built on data analysis of BFRs in aquatic and terrestrial species. Sun et al. (2018) measured $\alpha$-, $\beta$-, and $\gamma$-HBCDs in three freshwater fish—mud carp, tilapia, and plecostomus—from rivers and an electronic waste (e-waste) recycling site in Pearl River Delta, South China.\textsuperscript{70}

HBCD concentrations were not significantly correlated with the gross domestic product or population data and recent HBCD sources were thought to include e-Waste recycling activities, harbor construction, and shipment. Commercial Irish foodstuffs were assessed by Garcia Lopez et al. (2018) for the occurrence of BFRs.\textsuperscript{71} Of 53 samples, eighty-one percent contained one or more PBDE congener, twenty-six percent with one or more HBCD stereoisomer, and the highest concentrations were found in fat and oily fish samples, and bromophenol residues were in twenty-six percent of samples, specifically in eggs and fish. In 2010, de Wit, Herzke & Vorkamp published their study of BFRs in the Arctic for seabirds and marine mammals.\textsuperscript{72} Hexabromocyclododecane (HBCD) is also ubiquitous in the Arctic, with the gamma-HBCD isomer predominating in air, the alpha-HBCD isomer predominating in biota and similar concentrations of
alpha-, beta- and gamma-HBCD found in marine sediments. PBDEs and HBCD spatial trends in seabirds and marine mammals are similar to those seen previously for polychlorinated biphenyls (PCBs). The tetra-hexaBDEs and alpha-HBCD also biomagnify in Arctic food webs. Findings of BTBPE, HxBBz, PEBE, PBT and TBECH in seabirds and/or marine mammals indicate that these compounds reach the Arctic, most probably by long range atmospheric transport and accumulate in higher trophic level organisms. Letcher et al. (2009) reported the bioaccumulation and bio transformation of brominated and chlorinated contaminants and their metabolites in ringed seals and polar bears tissues (adipose, liver and brain) of various classes and congeners of persistent chlorinated and brominated contaminants and metabolic by-products, including PCBs and BFRs including HBCD. We detected all except two in ringed seal blubber with high frequency. Detection for all indicated that these organohalogens bioaccumulate, and in some cases there was tissue-specific biomagnification. Curious results were reported by Hong et al. (2017) regarding the α- and β-HBCD diastereoisomers and variance in the generational effects. Exposure to α- and β-HBCD, and this resulted in significantly higher lethal toxicity in T. japonicas than with exposure to γ-HBCD (Hong et al., 2017). Both of the former showed a higher potential to induce oxidative stress, which may be a factor in the higher lethal toxicity observed with α- and β-HBCD exposure. It is of note that T. japonicus was found to be more sensitive to all three diastereoisomers in the F1 generation than in the F0 generation. The bioconcentration potential of HBCD diastereoisomers “was found to be higher in T. japonicus than has been reported for fish species.”

Expanding on experimental study results of HBCD exposure causing liver fatty acid (FA) changes, the evidence from Bernhard et al. (2016) of marine fatty acids aggravating the hepatotoxicity of α-HBCD in juvenile female mice is alarming. Oily fish and the fats of higher chain marine mammals are a majority of the diet for Arctic residents. They specifically note that these results highlights that the background diet is a critical variable in the risk assessment of persistent organic pollutants (POPs) of which include HBCD and other BFRs.

16.2 With Tribes as a representative population for greater environmental media exposure risk, any resultant action levels will not only protect tribes and the general population, but the ethnic, minority, and rural population groups that may be at higher risk due to their customary lifestyle and activities and/or traditional practices.

Fishing illustrates this point. Fishing is a universal practice for Alaska Tribes, potential exposure via ingestion of contaminated fish is higher due to higher consumption, as is potential exposure via inhalation through smoking fish, and other heat preparation methods particularly with poor indoor ventilation, via potential absorption when fishing and preparing a greater amount of fish, via non-dilution of contaminated fish with fish from another location due to unavailability of store-bought fish, via particular practices associated with fishing, which may include gathering greens and using untreated water near the fishing spot, etc. Also, the full Tribal population – from infant to elder, disabled, single parents with small
children and relative living outside the village – is exposed due to sharing of fish. This is a magnified representation of the Alaska population as a whole, particularly the rural population, which tend to fish for, and share and eat fish like salmon, at a much greater rate than their counterparts in the contiguous states. The same can be said for exposure to contaminated “game meats”, marine mammals, berries, water and other environment sources due to customary food resources and recreational activities. With Tribes as representative, the full Alaska population is protected.

17. **Destructive Sociocultural Consequences**

17.1 **The sociocultural consequences to Tribal communities of overexposure to chemicals are as significant, or more significant, compared to the consequences to other groups.**

17.1.1 The small population size, high-context, and group-oriented nature of Tribal populations translates to substantial impact on health and well-being when a Tribal member is negatively affected by chemical exposures. For example elders are a significant resource in their community and fill multiple roles:

17.1.2 Teachers of cultural values and mores for their community including other older adults that are younger than the elder in addition to children and teens. It is well documented that tribal people’s socio-cultural knowledge base is more internalized and is not adequately learned via verbal or written instructions. It must be acquired over a lifetime of experiencing the day-to-day contexts of being a tribal person and relating with elders that have fully acquired the knowledge in their time by being with generations past.

17.1.3 Sources of historical information shared with their community including other older adults that are younger than the elder in addition to children and teens.

17.1.4 Leaders whose experience provides stability and experience to the tribal council and in consultations with government agencies.

17.1.5 Caretakers for extended family members, providing unpaid childcare. A grandmother who develops cancer will not be able to care for her grandchildren, parents may miss work resulting in job or income loss, or children may miss a critical mentor role or be injured because they are left alone.

17.2 **Impacts to societal health and well-being contribute to disproportionate health and socioeconomic indicators.** E.g., exposure to a certain chemical affects childhood brain development, causing neuro-developmental delays, which are compounded as the child progresses through school and Tribal populations suffer from low high school and college graduation rates.
18. Environmental Justice

While NTTC recognizes that part of EPA’s risk assessment process is collecting existing data on the chemicals in question, asking tribes to fill this data gap is unreasonable. EPA must provide funding before starting the process (at least more than one year prior) to request tribes gather information. Specifically, sampling within tribal homes in high-risk areas would provide valuable data to further complete risk assessments accounting for high-risk, vulnerable tribal populations.

EPA must take into account widespread backyard open burning and open burning at both municipal and construction & demolition landfills. Tribal and other rural citizens are exposed to chemicals in commerce via this pathway, including HBCD. These types of burning are prevalent in underserved tribal communities on reservations in the U.S. and other rural lands, including nearly every community in the State of Alaska. These communities rarely have proper burn units nor appropriate safety protocols to prevent residents’ inhalation.

Again, regarding fish consumption and the rate referenced above, in relation to population scenarios, the tribal population scenario is the most appropriate to use for risk assessments by EPA, because their rules indicate that they are to protect the population of highest risk. As identified in the 2015 problem formulation for the HBCD cluster, EPA must use fish consumption rates for subsistence fishers in aggregate exposure for those who rely heavily on locally sourced fish.

It is imperative that EPA consider potential cumulative exposure—including multiple chemical exposure—in these risk assessments because it is an on-going void in implementing environmental justice policies. This is a significant problem that EPA is not considering cumulative exposure in the risk assessment process at this time. It is an environmental justice issue affecting tribes, who rely heavily on high volumes of fish and aquatic mammals for half or more of their diet. Additionally, a large percentage of American Indian and Alaska Native communities are at or below the poverty level. This translates to lower replacement cycles of furniture, toys, clothing etc. from those with higher toxicities to more recently manufactured items of lower toxicities. For example, although PCB is no longer manufactured, studies have detected it in Puget Sound tissue sample monitoring. EPA must also look at wastewater outside of only the Toxics Release Inventory, which does not account for small local government facilities like unlined but permitted landfills, unpermitted landfills, open dumps, and open dump and backyard burning. As the Council has previously discussed with EPA, the stovepiped processes of EPA fails in protecting tribes from exposures to chemical in commerce.

19. Other Susceptible or Highly Exposed Populations

Most states have developed fish consumption advisories to protect residents from toxins in fish species known to bioaccumulate contaminants. One particular challenge that has been expressed by state fish advisory programs is communicating fish advisory information to ethnic or immigrant populations who do not speak English and are difficult to reach via fish advisory communication methods targeted toward the broader public. Ethnic or immigrant populations are specifically at risk due to their predominantly urban fishing locations that of contaminants than species typically consumed by sport fisherman (due to benthic feeding habits or tolerance to live in polluted waters). EPA maintains a compendium of fish advisory technical information including contacts for state and Tribal fish consumption advisory programs managers at its website at https://www.epa.gov/fish-tech. In addition, EPA supports a fish advisory program manager listserv to promote sharing of fish.
consumption advisory technical information among state and Tribal fish advisory program managers and EPA. The EPA contact for this program is Sharon Frey (Frey.Sharon@epa.gov or 202-566-1480) and she should be contacted to assist with compiling existing consumption and exposure information for ethnic or immigrant subsistence fishers residing in urban areas.
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ENDNOTES

1. Toxic Substances Control Act of 2016. 15 USC 53. §§3 and 6
8. NTTC 2015
17. NTTC 2015
20. NTTC 2015.
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64 Yu G et al., 2016.


Affirmed by the Supreme Court, it is the law of the land that federal agencies must fulfill a legally-binding trust responsibility to protect tribal trust resources and must uphold U.S.-Tribal treaty agreements. The June 22, 2016 TSCA amendments mandate health-based assessments and the inclusion of sensitive and exposed subpopulations in identifying the health risk of chemicals to the American people.

Tribes have high exposure to the natural environment, dietary reliance on local wild foods, and unique customary and traditional practices that are not present in the United States general population. Consequently, they meet the definition of an exposed subpopulation under TSCA, and EPA must adequately and transparently evaluate these exposures. Yet, tribal-based risk is not addressed in the First Ten Chemical Problem Formulations, and it is not even mentioned, whether it be in the literature search or bibliography, the narrative, or conceptual model.

We, the undersigned employees, leaders, and members of federally-recognized tribes across the Country agree with the National Tribal Toxics Council that:

- A tribal-based chemical risk assessment must be performed under TSCA in order for EPA to meet the intent of Congress and the law of the land.
- That assessment must account for the many unique ways in which tribes may be exposed to the chemical.
- The use and disposal of legacy products with active service life must be considered, and
- Product disposal must be included as a condition of use.

Dated 08/15/2018 and 08/16/2018 and signed in person at the Tribal Lands Forum, Spokane WA

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<tr>
<td>Scott W. King</td>
<td>Water Quality Specialist</td>
<td>Kainab Band of Paiute Indian</td>
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<tr>
<td>Alfred Talley</td>
<td>Brownfields Coordinator</td>
<td>San Carlos Apache Tribe</td>
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<td>Kein Anderson</td>
<td>Brownfield Coordinator</td>
<td>Swinomish Indian Tribal Community</td>
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<td>Alex Cabille</td>
<td>Water Resources Mgr</td>
<td>Hualapai</td>
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<td>Russell N. Hepler</td>
<td>Vice Chairman</td>
<td>Cow-t-a-CTA Tribe</td>
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<td>Dianne C Birtz</td>
<td>member</td>
<td>Bad River Band of Lake Superior</td>
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<td>Amity Farr</td>
<td>Env. Specialist</td>
<td>Eight Northern Indian Pueblos Council</td>
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<td>Glenna Lee</td>
<td>Env. Sp</td>
<td>Navajo</td>
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<td>Kristin Kietl</td>
<td>Env. Sci</td>
<td>Central Council of Shingit'Ha &amp; Haida Tribes of AK</td>
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<td>Ann Wyatt</td>
<td>Env. Coordinator</td>
<td>Klawock Cooperative Association</td>
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<td>Antonio Morsette</td>
<td>Brownfield Coordinator</td>
<td>Chippewa Cree Tribe</td>
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<td>Glenn Tortalita</td>
<td>Env. Manager</td>
<td>Zia Pueblo</td>
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<td>Director</td>
<td>Institute for Tribal Environmental Professionals</td>
</tr>
<tr>
<td>Shari Vennu</td>
<td>Environmental Planner</td>
<td>Houltton Band of Maliseet Indians</td>
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<td>Ken Norton</td>
<td>Environmental Director</td>
<td>Hoopa Valley Tribe</td>
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<tr>
<td>Ernie Stevens III</td>
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<td>Oneida Nation (WI)</td>
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<td>Daniel Guzman</td>
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<td>Chris Price</td>
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<td>Qawalayqum Tribe</td>
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<td>TRP Manager</td>
<td>Sandee Sioux Nation</td>
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<td>Brittani Clairmont</td>
<td>Natural Resource Dep</td>
<td>Confederated Salish Kootenai Tribes (MT)</td>
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<tr>
<td>LILY BERNASIO</td>
<td>Senior Environmental Specialist</td>
<td>SRPMIC</td>
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<tr>
<td>Maggie Sanders</td>
<td>Exec. Secretary</td>
<td>Nisg̱a’a Tribal Council</td>
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<td>Amelia Marchand</td>
<td>TRP Manager</td>
<td>Colville Confederated Tribes</td>
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<td>William J. Barnes</td>
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♦ Product disposal must be included as a condition of use.

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<td>Deanna Johnson</td>
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<td>Little Traverse Bay Bands of Odawa</td>
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<td>Jacqueline Shirley</td>
<td>Tribal Member</td>
<td>Native Village of Hooper Bay</td>
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<td>Jacob &amp; Rothe</td>
<td>Env. Prep Asst. TAMU</td>
<td>Blue Lake Ranchers</td>
</tr>
<tr>
<td>Craig Price</td>
<td>Env. Coordinator</td>
<td>Osawamink Tribe</td>
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<td>Ga'valangin</td>
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<td>Allison M. Smart</td>
<td>Tribal Manager</td>
<td>Suukt St. Marie Tribe of Chippewa Indians</td>
</tr>
<tr>
<td>Lanny Siyuja</td>
<td>Hualapai Tribe</td>
<td><a href="mailto:Lsiyuja@hualapai-nsn.gov">Lsiyuja@hualapai-nsn.gov</a></td>
</tr>
<tr>
<td>Ryan Evans</td>
<td>Pesticide Specialist I</td>
<td>Confederated Salish &amp; Kootenai Tribes (CSKT)</td>
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<td>Fond du Lac Band of Lake Superior Chippewa</td>
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<td>Outreach Coordinator</td>
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<td>Nancy Schuld+</td>
<td>Water Projects Coordinator</td>
<td>Fond du Lac Band of L. Superior Chippewa</td>
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<td>Jane Rothkins</td>
<td>Air quality</td>
<td>Reorganized Band</td>
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<tr>
<td>Morgan Ashley</td>
<td>Environmental Tech.</td>
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<td>Natural Resources- GAP</td>
<td>Pueblo of Jemez, NM</td>
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