RE: Project: 2022103702 Taylor Shellfish/Manzanita Geoduck SSDP, Additional public comment

Date: January 8, 2024

To: Sonja.Cady@co.thurston.wa

From: Betsy Norton

To the Hearing Examiner:

I would like to add these specific concerns related to sediments into the record for consideration with this application. I do not support approval of the permit.

Respectfully,

Betsy Norton

Sediment Concern 1: Existing Latent industrial pollutants

Puget Sound has a long history of pollution. The WA Department of Ecology established a toxic cleanup program to identify and manage sites and point-sources of this pollution. Budd Inlet, next to Henderson Inlet, is one of these sites, a historic dumping ground for primarily the wood products industry, it also suffers from municipal wastewater runoff that triggers toxic algae blooms. Budd Inlet is not open for any kind of shellfish harvest at any time of the year. The primary pollutants in Budd Inlet (as is common in south sound areas) are dioxins, furans, and PCB's – most of them Persistent Organic Pollutants "POP" (wood products) and lead and arsenic (Tacoma smelter). [i]

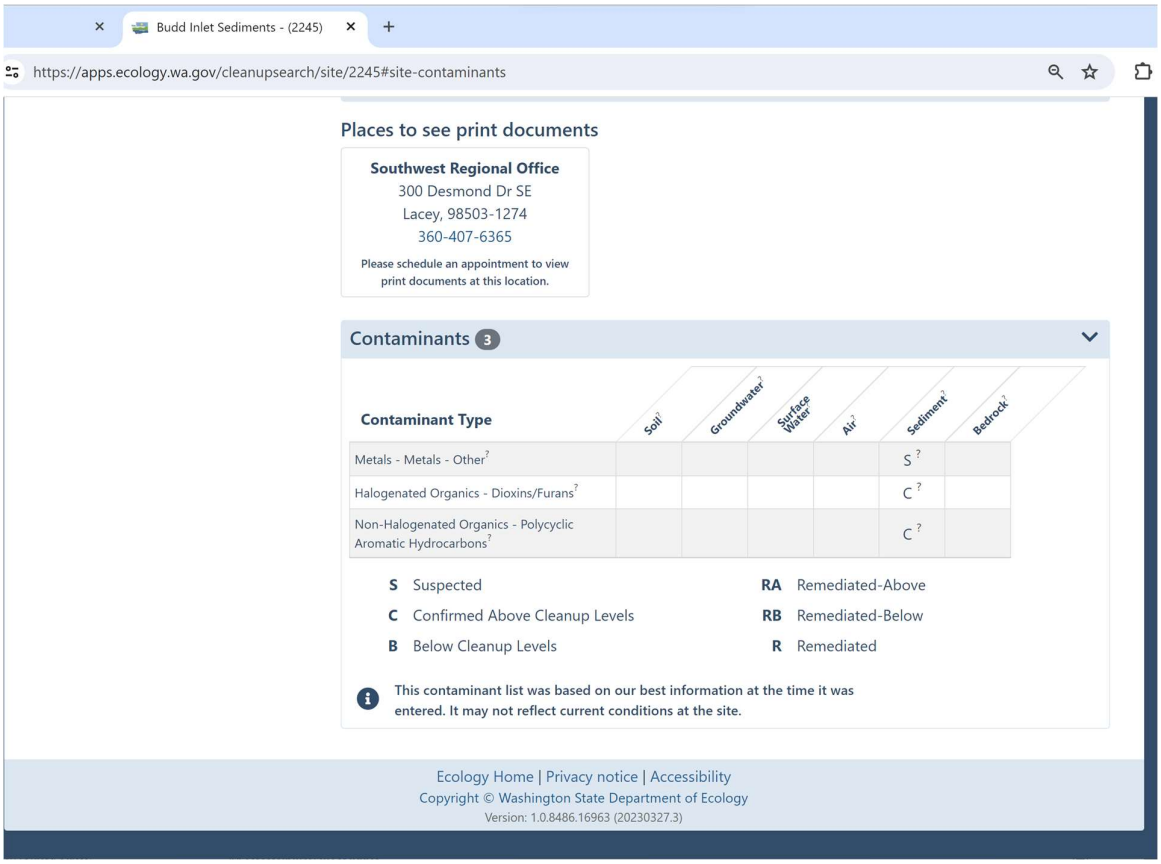
The POP's are mostly hydrophobic, so they can be adsorbed by sediments and stored away from the water line at the lower levels of sediments/substrate, until some kind of physical action occurs to resuspend those sediments back into the water column. Once resuspended, the chemicals can migrate onto other organic-based particles – like algae or micro/nano plastics. In the water column, these particles – with their hitchhiker POP toxins, are eaten by small invertebrates and fish, entering the food chain at a low level.

Because they are usually hydrophobic, the typical method for 'cleaning' the environment of toxic sediments so far has been primarily to bury them – either wait for nature/time to cover them up with additional layers of sand/gravel/silt, or, as has been done in Shelton Harbor, actively bury them under a foot of gravel. Neither of these methods actually removes them – the POP's can just become physically further removed from the water column, though this is not always the case, sometimes they just stay in the top layer of sediment.[ii] The result of this practice is that over time, these pollutants REMAIN in the substrate at various levels not far from the surface.

This is salient when discussing potential Geoduck growing and industrial farming practices, since the operations of planting the geoducks and their protective tubes at year 0, removal of those tubes in 2 years, and performing the hydraulic excavation of the geoducks when they are mature in years 4-7 all are likely to resuspend sediments containing some amount of POP's (PAH's, Dioxins and Furans), Arsenic and Lead. Depending on these concentrations in the sediment, there is potential for this activity to contaminate the waters of Henderson Inlet with a surge of dangerous endocrine-disrupting and carcinogenic chemicals that can enter the food chain, harming wildlife and people.

(I will defer to the WA DOH opinion on whether this creates a health concern for consumption of the geoducks by people.[iii])

The concern about EDC's impact in the marine environment is a long-standing concern of the WA Dept of Ecology. Their longitudinal study of chemical pollutants in Puget Sound notes: "Biological effects due to exposure to estrogenic and endocrine-disrupting chemicals had also been observed in Puget Sound fish (Johnson et al., 2008; Peck et al., 2011; daSilva et al., 2013). " They reference 4 separate citations on EDC's in their selective bibliography. [iv]



Budd Inlet ECY cleanup documents:

https://apps.ecology.wa.gov/cleanupsearch/site/2245

In their 2018 story map on Budd Inlet's Benthos, they calculated that 17% of the species variation between 2011 to 2018 could be explained by adding variables for changes to chemical contaminants in Budd Inlet, including as variables, including 2-Methylnapthalene, Acenaphthene, Dibenzo(a,h) anthracene, and Pyrene.[v]

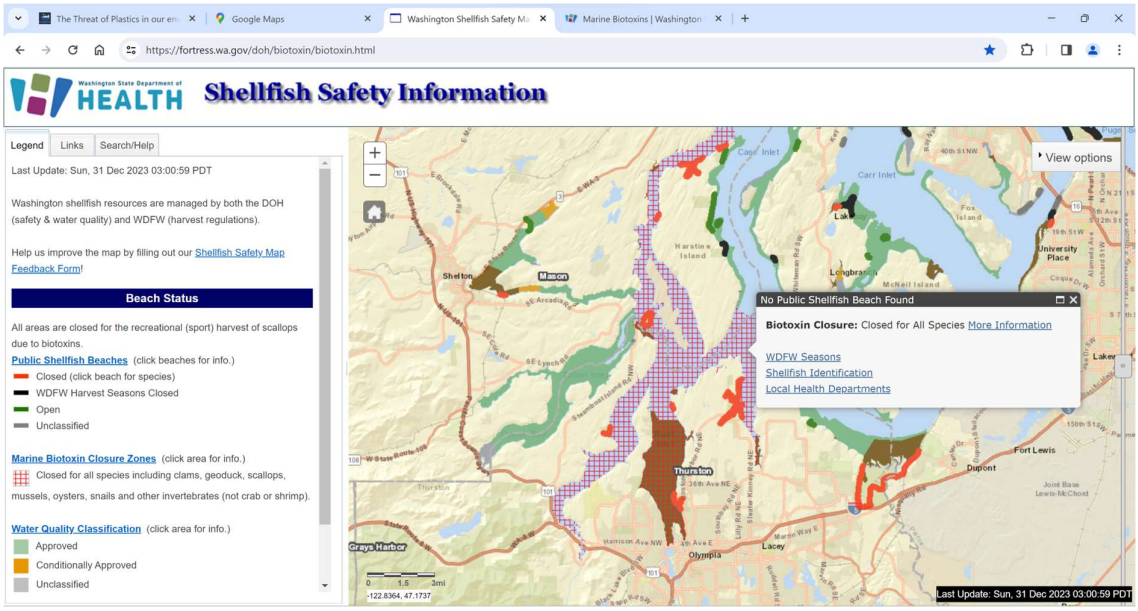
While this data is all from Budd inlet, ECY's sediments project also identified CPAH's in Henderson Inlet – the location was in the waters near Woodard Bay. They said these are probably from the old railroad trestle in Woodard Bay area, but also acknowledge that there's stormwater runoff from roads and residences around the inlet that could contribute some of these pollutants.

To summarize, the sediments in Henderson Inlet are likely to have some level of POP's, CPAH's, Arsenic and Lead already resident in them, and there's a danger that the excavation activities of the

Geoduck farm will resuspend these toxins when the sediments are disturbed, polluting the surrounding waters with pretty dangerous chemicals.

Sediment Concern 2: Biotoxins

Another aspect of sediment health is its role in managing nutrient loads and potential role in triggering algae Blooms (biotoxins). This is a relevant line of inquiry since Henderson Inlet is currently (Jan 2024) closed for shellfish harvest by the WA DOH due to HAB's:



The sediment is where organisms and chemical reactions manage the decomposition of organic matter/denitrification of bioavailable nitrogen that fuels algae growth. In addition, the sediment houses dormant 'cysts' of diatoms (algae) which, when released into the water column, grow, and reproduce[vi]. There is therefore a risk that geoduck operations, by disturbing and displacing the sediments that perform this ecosystem management of organics/nitrogen, and releasing and activating algae to grow, could provide conditions that foster algae blooms, possibly Toxic Algae blooms (HAB). .

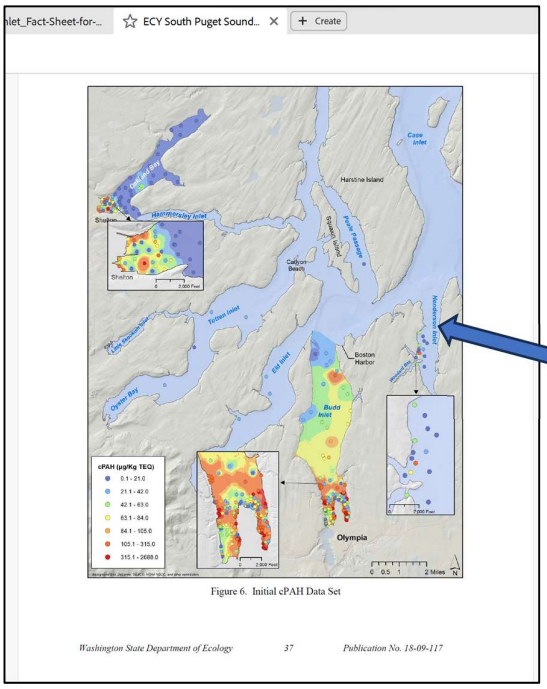


Figure 6. Initial cPAH Data Set

Washington State Department of Ecology 37 *Publication No. 18-09-117*

Approximate Geoduck farm proposed site

WA Dept of Ecology - South Puget Sound Regional Background
Final Data Evaluation and Summary Report, May 2018, Publication no. 18-09-117, p. 37

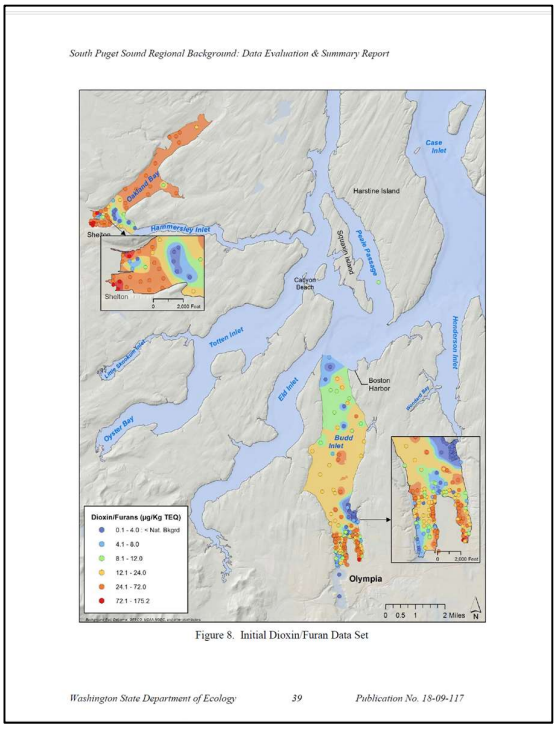

South Puget Sound Regional Background: Data Evaluation & Summary Report

Figure 8. Initial Dioxin/Furan Data Set

Washington State Department of Ecology 39 *Publication No. 18-09-117*

The text notes that: " Figure 8 shows the data set available for dioxins/furans in the South Puget Sound Area. *No dioxin/furan data were available for Totten Inlet, Eld Inlet, or Henderson Inlet*."[vii]

Sediment Concern 3: Benthic Habitat Loss

In addition to the chemicals and biological pollutants in the sediment, there are also a host of benthic organisms in the sediment. This is its own ecosystem, and these organisms (as referenced in the Forage Fish discussion) form the food near the bottom of the food chain for a lot of other wildlife. The geoduck operations will result in a net loss of habitat for these benthic organisms through excavation and disruption to plant the geoducks, displacement of benthic organisms by the geoducks themselves as they grow, creating burrows 3 feet deep into the sediment, and then a final destruction of the benthic habitat, sending of sediments and its organisms downstream during the "water wanding" excavation of the mature geoducks after 7 years.

Here are some estimated volumes of benthic habitat which will be lost:

Displaced soil activity	**soil removal per tube (inches)**	**soil removal per tube(feet)**	**Benthic Habitat displaced by gear/operations/geoducks**
Year 1: 6" diam, 12" depth - excavate to tube depth to place tubes/geoducks. Geoducks grow 1 foot depth	339.2928	0.1964 ft^3 soil disturbed / 1ft^2 soil	**30,791 ft^3**
Year 2: 6" diam, 24" depth - Geoducks grow to 2 foot depth, displacing soil and any resident benthic organisms as they grow.	678.5856	0.3927 ft^3 soil displaced / 1ft^2 soil	**61,582 ft^3**
Year 3-7 growth/Harvest: 6" diam, 36"depth - Geoducks inhabit this volume starting year 3, so would be pushing out any existing benthic organisms as they grow. When Geoduck company excavates 3 feet deep and wide enough to reach in, to harvest geoducks (see the video) the soil, the sediments will drift down shore in the water- See: https://youtu.be/w4Mt3H_ROCA	1017.8784	0.5891 ft^3 area of soil resuspended / 1ft^2 soil	**92,372 ft^3**

To summarize,

Permitting should not proceed without WA ECY or an independent 3rd party performing the following:

a) Sediment sampling at the project site, going down 3 ft from the surface of the substrate, to determine if existing pollutants (CPAH, Dioxin, Furan, Lead, Arsenic) are already resident at concerning concentrations and if so, take appropriate action to protect the ecosystem and human health. Use the Department of Ecology's Sediment Standards list for WAC 173-204 to assess toxicity of the sediments. (https://apps.ecology.wa.gov/publications/documents/1309055.pdf)

b) Analysis of the potential for a Geoduck Farm at this site to promote more/worse HAB's as a result of the displacement/removal of sediments and benthic organisms that help reduce nutrient loading, or potential to trigger HAB's from released dinoflagellate cysts imbedded in the sediments.

c) Consider the loss of benthic habitat, and whether the geoduck farm that removes existing ecosystem services and organisms from as much as 92000 cubic feet is or is not consistent with the No Net Loss of Habitat charge from the Shoreline Management Plan.

[i] Budd Inlet Sediments, Dept. Ecology Cleanup site 2245 – https://apps.ecology.wa.gov/cleanupsearch/site/2245

[ii] See e.g. Dept of Ecology studies of Budd Inlet/Oakland Bay dioxins and furans - only able at this date to find the 2011 study, but gives you an idea of the variation: https://apps.ecology.wa.gov/publications/summarypages/1403030.html\

[iii] Research indicates that different species ingest and retain POP's at different rates, so the question as to how much of a health concern this is should be vetted by WDOH. See e.g. Menéndez-Pedriza A, Jaumot J. Interaction of Environmental Pollutants with Microplastics: A Critical Review of Sorption Factors, Bioaccumulation and Ecotoxicological Effects. Toxics. 2020 Jun 2;8(2):40. doi: 10.3390/toxics8020040. PMID: 32498316; PMCID: PMC7355763. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7355763/

[iv] Pharmaceuticals, Personal Care Products, and Per- and Polyfluoroalkyl Substances in Puget Sound Sediments: 2010-2019 Data Summary, December 2021, p.11. https://apps.ecology.wa.gov/publications/documents/2103015.pdf

[v] Sediment Quality in Puget Sound/Budd Inlet Sediment Quality Results, "Putting it all together", September 11, 2023 (based on 2018 data) https://storymaps.arcgis.com/collections/aaec1a6656ff43e098d209c75ce00244?item=10

[vi] This dissertation at UW (2015) discusses the longevity of those cysts in the sediment and finds a correlation between the sedimentary cysts and the occurrence of Harmful Algae Blooms: https://digital.lib.washington.edu/researchworks/handle/1773/33226

[vii] This data is from Dept of Ecology, but the note from ECY appears to say that Henderson Inlet was just not fully sampled for these pollutants – not that ECY measured and found none. For this reason, sampling should be done before the farm goes in place. WA Dept of Ecology - South Puget Sound Regional Background

Final Data Evaluation and Summary Report, May 2018, Publication no. 18-09-117, p. 39

Geoduck gear – toxics and transmission

Supporting information for denial of permit request #2022103702, Taylor Shellfish/Manzanita Geoduck SSDP

January 9, 2024
Betsy Norton, Dr. Ron Smith

Greetings.

Ron Smith has written an excellent overview of the issues he sees with Taylor's use of plastic gear.

In this presentation, I want to share some of my special concerns from the research, on the mechanisms and cycles which cause us to be so concerned about the use of plastic gear in this geoduck project.

Please see our written submissions for the extended analysis and references.

Above picture is of a residential drainpipe adapter - Industrial grade PVC. If you can't read it, the label has a carcinogen warning.

Geoduck gear – toxics and transmission

- Overview
- Chemicals in Industrial Plastic gear are toxic
- The Plastic gear will degrade
- Degraded plastic leaches additives and adsorbs toxic chemicals
- Microplastics transmit these pollutants into the food chain
- Recommendation

The fact that plastics are adversely impacting the world's natural environment including the Salish Sea is not controversial. A 2022 study found 6608 research articles about microplastics (MPs) published since 2006. That science is expanding rapidly, reflecting the alarm of the scientific community about the biologic impacts that are unfolding.

In this context, old information is not the best available science, and as we have found with a host of other synthetic products, it's important to read the latest literature, get expert and disinterested opinion on it, before proceeding as you have in years gone by.

Climate change and the legacy of a century of pollution in Puget Sound are two very important facts of life here, and they need to be considered with any application for activity in Washington's public waters. It is not 1895 anymore.

Industrial Plastic gear is Persistent and toxic

PVC and HDPE plastic polymers are considered Persistent Pollutants. Their presence in the environment** is measured in "half-lifes".

The base polymers for PVC and PE are tightly bound and unlikely to disappear into the environment for hundreds of years (unless it's burned).

The geoduck farm proposes to use PVC tubes and (we are assuming) HDPE or LPDE netting. This use deliberately puts that plastic and its attendant chemical pollutants into the uncontrolled marine environment, where the existing ecosystem is impacted and where gear loss is inevitable.

**This does not mean the Plastic products (pipe,e.g.) remain intact products for that period: it breaks down into largely equivalent volume – in smaller and smaller pieces as time goes by.

https://www.wtae.com/article/train-derailment-east-palestine-ohio/42762517#

The Vinyl Chloride used to make PVC is toxic as well as the dioxins that are released when it's at high heat. The above photo shows the East Palestine, Ohio derailment and burning of VC …"destined for an OxyVinyls plant in Pedricktown, N.J., that makes plastic used in PVC flooring. " (https://www.nytimes.com/2023/04/17/climate/train-fire-palestine-plastics-pvc.html)

PVC and HDPE are considered **Persistent Pollutants**. Their presence in the environment is measured in half-lives.

The base polymer Vinyl Chloride used to make PVC (photo) is **toxic** as well as the dioxins that are released when it's at high heat. Once in a plastic product, however, the polymer is tightly bound and unlikely to migrate out into the environment for hundreds of years (unless it's burned). This is one reason why it's banned now for many applications in Europe: they have no way to get rid of the PVC plastic waste, and they'd like to avoid the risks associated with its manufacture.

All plastics include (PVC, PE, etc.) Additives, and some have coatings, and other chemicals left over from the manufacturing process, most of which are also toxic. The different with these additives, is that they are are NOT tightly bound to the long-lived plastic product, which allows these additives to leach into the environment.

The geoduck farm proposes to use PVC tubes and (we are assuming) HDPE or LPDE netting. This locates that plastic and all its additives into the uncontrolled marine environment.

Citation: picture from https://www.wtae.com/article/train-derailment-east-palestine-ohio/42762517#

PVC and HDPE will break down

All plastic eventually degrades via

a) Mechanical stress, causing scouring of the surface of the plastic and fragmentation into pieces

b) Oxidation breakdown – catalyzed by UV Rays or heat

c) Biodegradation – assimilation and mineralization by biological organisms

Mechanical stress and UV radiation are the primary causes of breakdown.

- increased degradation leads to breakage/loss / creation of microplastics

- Increased degradation increases the rate of leaching additives

Stored Geoduck gear in the open at Kennedy Creek Natural Area Preserve, 2023. PVC foreground shows breakage, HDPE mesh "sleeves" in piles at the back. All are in the open, exposed to UV light.

C - It is acknowledged by the County, the Corps of Engineers, and industry that plastic will be displaced from the intertidal planting site, prompting federal and local mitigation requirement for recovery. Unfortunately, there is no data for how much plastic is expected to be permanently lost to the environment, as Taylor does not report this, and there is NO monitoring program in place by Thurston County. Since PVC is denser than water and sinks, it is more difficult to recover when displaced by growing geoduck, requiring Scuba, usually only done once per year.

D - The Johnson Point Loop site is one of the most exposed sites geographically in the South Puget Sound, directly impacted by storms from the west over a fetch of 4.5 nautical miles and tangentially from northerly storms over an 11-mile stretch. 3 to 4-foot waves can impact the beach during a severe storm. There is great risk of loss of geoduck tubes at this site. [attach nautical maps].

Citations:

Wayman, Chloe, and Helge Niemann. "The Fate of Plastic in the Ocean Environment – a Minireview." *Environmental Science: Processes & Impacts* 23, no. 2 (2021): 198–212. https://doi.org/10.1039/D0EM00446D

Mechanism 1: PVC / HDPE gear degradation cycle

Gear degrades progressively

1- Surface deterioration on the primary plastics from mechanical stress on the gear (wave action, e.g.)

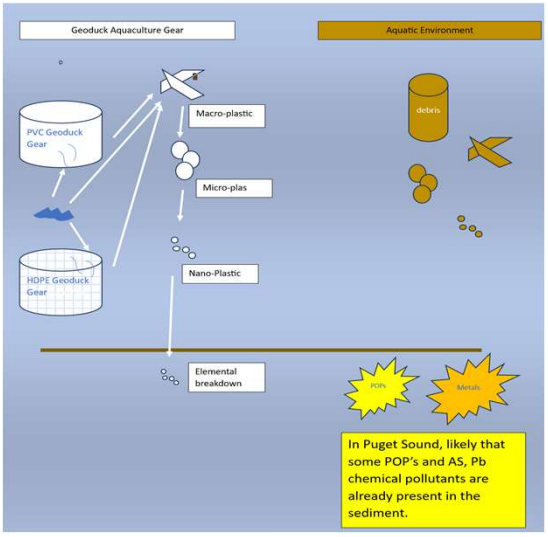
2 - Fragmentation into (secondary) Macro-plastic pieces (mechanical stress + UV radiation)

3 – Further degradation of Macro plastic pieces into Micro-plastics

4 – Degradation of Micro-plastics (if not ingested) into Nano-Plastics

5 – biological degradation – micro-organisms

Puget Sound already has an significant amount of plastic debris /microplastics present in the water column.



Plastic aquaculture gear in Henderson Inlet: PHI concerns.
January 9, 2024

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Plastics in Puget Sound/Salish Sea

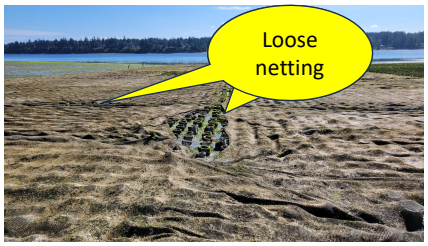
The Ikkatsu Project: Campbell, Kenneth J. "Message in a Plastic Bottle; Marine Debris in Puget Sound." (2016). https://cedar.wwu.edu/ssec/2016ssec/fate_and_effects_of_pollutants/7/

Maps based on sediment samples: https://cedar.wwu.edu/ssec/2022ssec/allsessions/238/

This research mentions geoduck pipes specifically:
Moore, Charles. "Rapidly increasing plastic pollution aquaculture threatens marine life." *Tul. Envtl. LJ* 27 (2013): 205. https://heinonline.org/hol-cgi-bin/get_pdf.cgi?handle=hein.journals/tulev27&section=15

Taylor does not fully acknowledge the degree and impact of plastic degradation on their gear

- While installed, their geoduck gear is exposed to sunlight regularly at low tide (UV breakdown).
- While stored outside, their geoduck gear is exposed to sunlight daily (UV Breakdown).
- Strong wave action can scour the pipe surface with sand/gravel in the substrate. (Mechanical breakdown)
- Gear is lost as tubes dislodge, break or become unstable.
  - Geoducks push PVC pipes up from their sediment footing as they grow, making them more unstable.
  - Strong wave action can dislodge tubes and loosen netting. Concurrent King Tides and storms,e.g., could be particularly damaging.
  - PVC is denser than water, it is likely to end up deeper in the Inlet/Sound - not on the shoreline.
  - Quarterly shoreline pickup and 1 year diving cleanup is very unlikely to recover most of the lost gear.
  - 1% loss of the 3.6 acre farm = 15,681 PVC tubes, or 103K cubic inches of plastic pollution in Puget Sound. Plus lost Mesh.



Citations:
Pictures from Dr. Ron Smith

Plastic Additives are toxic but not well regulated

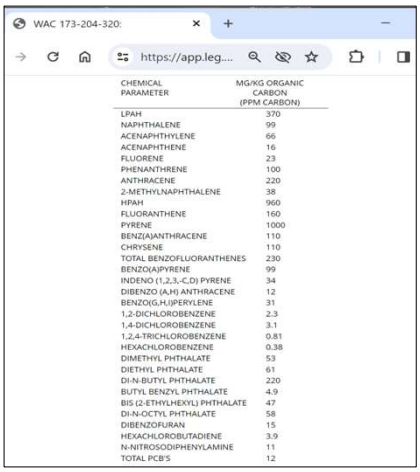
All plastics include Additives, which can and do leach into the Marine environment.

Common Additives in PVC and HDPE:
- Plasticizers, like Phthalates
- UV Stabilizers, like UV-328

Many likely additives are classified as:
- Endocrine Disruptors
- Carcinogens
- Persistent Organic Pollutants

These are harmful to human health - some at very low concentrations

Taylor doesn't list the materials in their gear. No regulations appear to require it.


WAC 173-204-320:

https://app.leg....

CHEMICAL PARAMETER	MG/KG ORGANIC CARBON (PPM CARBON)
LPAH	370
NAPHTHALENE	99
ACENAPHTHYLENE	66
ACENAPHTHENE	16
FLUORENE	23
PHENANTHRENE	100
ANTHRACENE	220
2-METHYLNAPHTHALENE	38
HPAH	960
FLUORANTHENE	160
PYRENE	1000
BENZ(A)ANTHRACENE	110
CHRYSENE	110
TOTAL BENZOFLUORANTHENES	230
BENZO(A)PYRENE	99
INDENO (1,2,3,-C,D) PYRENE	34
DIBENZO (A,H) ANTHRACENE	12
BENZO(G,H,I)PERYLENE	31
1,2-DICHLOROBENZENE	2.3
1,4-DICHLOROBENZENE	3.1
1,2,4-TRICHLOROBENZENE	0.81
HEXACHLOROBENZENE	0.38
DIMETHYL PHTHALATE	53
DIETHYL PHTHALATE	61
DI-N-BUTYL PHTHALATE	220
BUTYL BENZYL PHTHALATE	4.9
BIS (2-ETHYLHEXYL) PHTHALATE	47
DI-N-OCTYL PHTHALATE	58
DIBENZOFURAN	15
HEXACHLOROBUTADIENE	3.9
N-NITROSODIPHENYLAMINE	11
TOTAL PCB'S	12

Marine Sediment Standards, partial list from WAC 173-204-320.

Dredging and pier construction, e.g., must ensure their operations don't cause the sediment to exceed these standards.

Aquaculture gear leaching the same chemicals is not covered by this requirement.

Permitting authorities should require gear's chemical makeup information, leaching rates, loss rates and apply best available <u>science</u> (not "best industry practices") to assess this risk when making decisions.

1. All plastics include (PVC, PE, etc.) Additives, which are ALSO toxic, but are NOT tightly bound to the plastic gear, *so they can and do leach into the environment.*

2. Additives we'd expect to see in PVC and HDPE for marine environments, include
- Plasticizers, like Phthalates which make HDPE more flexible
- UV Stabilizers, like UV-328, which protect the plastic from sunlight

3. We do not know what chemical additives are in Taylor's gear, because Taylor <u>does not and is not required to</u>, list the materials (additives) in its plastic gear.

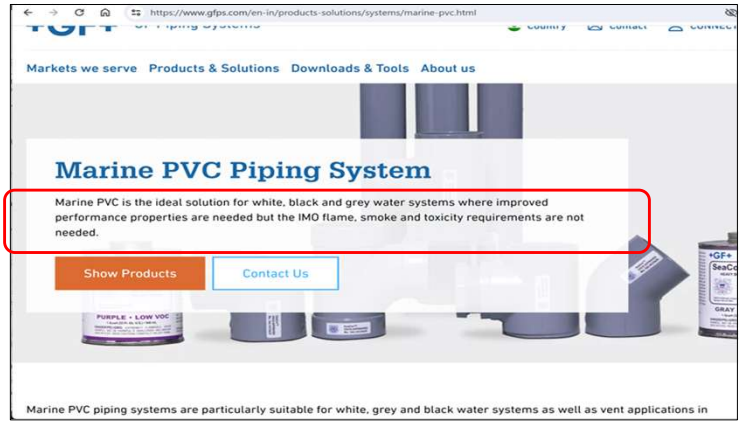
4. In addition, the sediment in which the geoducks are being grown does not have to be tested for these chemicals. In Puget Sound, which has a long history of industrial pollution, this seems like a big gap.

5. Permitting authorities should note this gap in regulation, and use their discretion to apply the latest available science and prevent further dispersal of these toxic chemicals.

Please see excellent overview of regulatory challenges here:
Samuel Hudgens, "The Microplastics Crisis: Exploring Pathways for Regulation and the Growing Concern for Human Health," Tulane Environmental Law Journal 36, no. 1-2 (Summer 2023): 205-222

See Appendix D for Details

“Marine Grade” = Industrial plastic without Fire Protection



Sample advertising from a piping distributor online. IMO standards relate to ensuring plastics do not emit “excessive” quantities of smoke and toxic products when subjected to high heat.

“Marine Grade” plastics is just a branding/product marketing term.

It is not a formal standard and has no relationship to environmental or health protections.

In spite of the fact that most of the additives are chemical toxins associated with environmental and/or human health concerns, Plastics are mostly unregulated. Only direct contact items like children’s toys and drinking water pipes are regulated by the EPA to protect human health.

Industrial grade plastics are largely unregulated for toxic chemicals.

“Marine grade” PVC appears to refer to a standard of strength and durability of the plastic under marine conditions. It does not mean the pipe is environmentally friendly for marine environments.

PVC in particular is very hazardous when burned, emitting dioxins and other hazardous compounds. Apparently, it’s expensive to create PVC which does not pose this hazard.

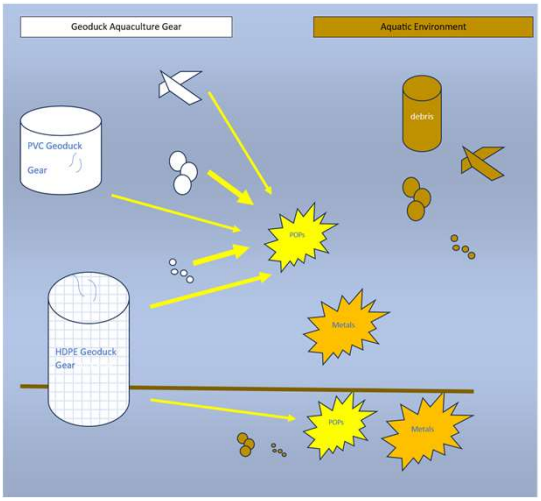
Mechanism 2: Plastic Additives Leach into the aquatic environment*

Gear leaches toxic additives,

Leaching takes place on the surface of the plastic pieces, so -surface scour, broken pieces, micro-plastics, nano-plastics -

progressively release relatively more of these toxic additives as the pieces get smaller/relative surface area increases.

**Most of these don't float in the water, this is just for illustration.*



Plastic aquaculture gear in Henderson Inlet: PHI concerns. January 9, 2024

See also Appendix: LDPE Leaching for example of research on leaching rates for UV-328

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Although plastics look inert they are not.

The Additives in them are not tightly bound to the plastic polymers: they are sort of loosely held among the structured, bound plastic polymers.

If the relatively weaker bonds that hold the additives "inside" the plastic structure are weakened, the additive chemicals can float out of the plastic structure and into the water.

Since the additives are hydrophobic, they will adsorb onto organic matter floating by, whether that be suspended sediment or macro/micro/nanoplastic debris.

Mechanism 3: Plastics adsorb(adhere) pollutants in their immediate vicinity

Micro-plastics and Nano-plastics in particular, will adsorb organic pollutants. Micro-plastics float in the water, but are also on or imbedded in the sediment.

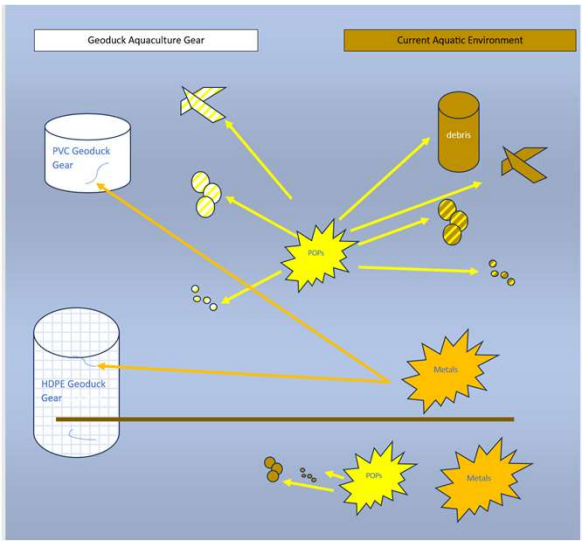
Sediments on the bottom or suspended in the water column will adsorb organic pollutants as well.

Organic Pollutants (POP's) include:

- Additives leached from the gear
- Historic pollutants in the local environment.

Budd Inlet has a long history and current constraints on some activities due to historic pollution (dioxins, furans, PCB's) in the sediment.

Recent research shows metals/metalloids (Arsenic and especially Lead) will oxidize and on the degraded plastic surfaces as well.



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In Henderson Inlet, plastic gear will come into contact both with microplastics that arrived from other sources, and historic pollutants inherent in the water and soil of the Henderson inlet.

A. Leached pollutants from the gear are adsorbed onto plastics/microplastics/nanoplastics *and sediments* that come into close proximity with the leaching object

B. Existing Environmental pollutants in the immediate area can be adsorbed or deposited on the plastic gear, and the microplastics created from it.

A. POP's, dioxins, furans are historical legacy of the timber industry here, and are so concentrated in Budd Inlet, right next door, that there is no shellfish harvested there. Ever.

B. Arsenic and Lead from the Asarco Plume are likely to be in higher concentrations than normal in the sediments. The metals can collect on the surfaces of plastics.

Any plastic gear which is lost from the site will carry with it all its remaining additives, and is likely to have higher concentrations of historic pollutants. As it degrades slowly deeper in Puget sound, it will continue to emit those chemicals.

Citations:

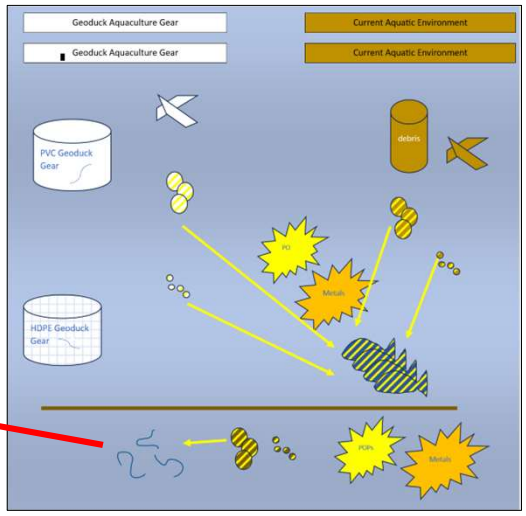
Menéndez-Pedriza A, Jaumot J. Interaction of Environmental Pollutants with Microplastics: A Critical Review of Sorption Factors, Bioaccumulation and Ecotoxicological Effects. Toxics. 2020 Jun 2;8(2):40. doi: 10.3390/toxics8020040. PMID: 32498316; PMCID: PMC7355763.

Mechanism 4: Microplastics and their pollutants get into the food chain

Micro and Nano-Plastics which have adsorbed the POP's from the plastics and the historic pollution, are ingested by fish, shellfish, sedimentary worms, other organisms, passing both the plastic particles and some % of those toxins, on up the food chain. How much this contributes to the total loading of these toxins in wildlife and humans is still being assessed, but given their toxicity, all known sources of exposure should be prevented.

https://www.youtube.com/watch?v=u9Zx10PsRAM

Western Sandpipers, Eating invertebrates From the sediment.



Plastic aquaculture gear in Henderson Inlet: PHI concerns. January 9, 2024

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Microplastics, their imbedded pollutants and adsorbed pollutants are ingested by marine life

Small predators, like the Western Sandpiper here, will predate on that marine life, ingesting the invertebrate and its microplastic/toxic load.

Different organisms have different rates of assimilation and bioaccumulation of these chemicals but few assimilate 0% of he adsorbed POP's and many retain some of the microplastics as well when eaten.

There is a lot of current research aimed at assessing the impact of the many vectors through which plastics and their toxins are assimilated in humans, but given their toxicity, all known sources of exposure should be prevented.

Wildlife and Human health is at risk.

Gallo, F., Fossi, C., Weber, R. et al. Marine litter plastics and microplastics and their toxic chemicals components: the need for urgent preventive measures. Environ Sci Eur 30, 13 (2018).

Kieran D. Cox, Human Consumption of Microplastics, 53 ENV'T SCI. & TECH. 7068, 7073, (2019). 214 #12; https://pubmed.ncbi.nlm.nih.gov/31184127/

Haodi Wu, Jing Hou, Xiangke Wang, A review of microplastic pollution in aquaculture: Sources, effects, removal strategies and prospects, Ecotoxicology and Environmental Safety, Volume 252, 2023, 114567, ISSN 0147-6513, https://doi.org/10.1016/j.ecoenv.2023.114567.

Tao Sun, Shuang Wang, Chenglong Ji, Fei Li, Huifeng Wu, Microplastics aggravate the bioaccumulation and toxicity of coexisting contaminants in aquatic organisms: A synergistic health hazard, Journal of Hazardous

Materials, Volume 424, Part B, 2022, 127533, ISSN 0304-3894, https://doi.org/10.1016/j.jhazmat.2021.127533.
(https://www.sciencedirect.com/science/article/pii/S0304389421025012)

Recommendation

The Thurston County Shoreline Master Plan (SMP) states:

- "**Protection of public health is recognized as a primary goal.** All applicants for development or use of shorelines shall be closely analyzed for their effect on the public health." (Section 2.H)

As the above information demonstrates,

- The plastic gear loss constitutes a significant source of plastic pollution. A 1% loss rate would result in the equivalent of 15,681 geoduck tubes of plastic debris added to Puget Sound, per rotation.
- The plastic gear degrades and leaches toxic chemicals, including Endocrine Disruptors and Carcinogens
- The plastic gear provides and uses plastic transmission mechanisms that send those toxic chemicals into the food chain and the environment
- The plastic gear for this aquaculture operation increases the risk to human health.

For these reasons, we respectfully recommend that the permit for the Geoduck Aquaculture Installation at Henderson Inlet should be denied.

The proposal to allow the geoduck farm in Henderson Inlet as currently configured, with plastic PVC and PE Mesh gear, should be rejected.

As the above slides demonstrate, the plastics all degrade in the marine environment, contributing to the dire problem of accumulating plastics in Puget Sound.

These plastics leach chemicals as they degrade and the toxic microplastic particles enter the food chain, with people at the top.

This plastic pollution adds to the increasing risks to the health of the wildlife and to human health. This installation does not meet the Thurston County SMP requirement that activities must protect public health.

Thank you for listening

Thank you for listening.
Please feel free to follow up with any questions.

Appendix A: Degradation rates of different plastics

- PVC is longest lasting, but is vulnerable to UV rays if no UV absorber is imbedded
- HDPE is not as long-lived as PVC, but forecast for its degradation is anywhere from 58-1200 years.

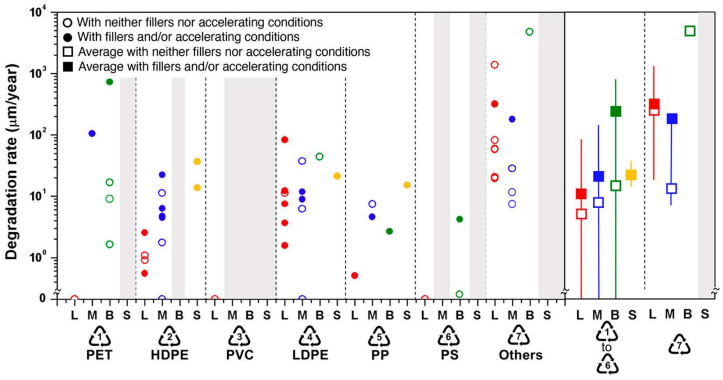


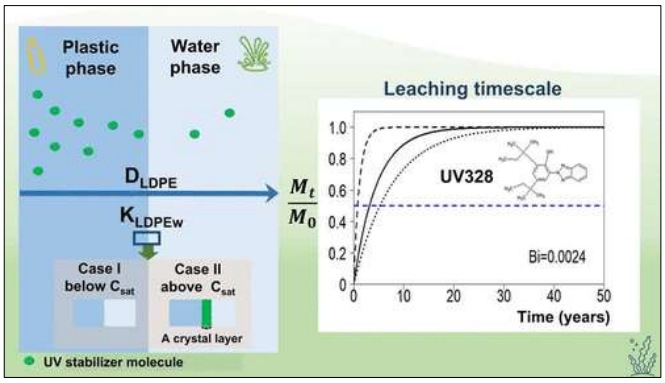
Figure 8. Specific surface degradation rates for various plastics, in µm year^{-1}. Vertical columns represent different environmental conditions (L, landfill/compost/soil; M, marine; B, biological; S, sunlight) and plastics types (represented by their resin identification codes). Plastics type 7, "others", corresponds to various nominally biodegradable plastics. The range and average value for plastics types 1–6 are shown on the right as lines and squares, respectively, as well as for biodegradable "others". Data points representing degradation rates that were unmeasurably slow are shown on the *x*-axis. Gray columns represent combinations for which no data were found.

Citations

Degradation Rates of Plastics in the Environment, Ali Chamas, Hyunjin Moon, Jiajia Zheng, Yang Qiu, Tarnuma Tabassum, Jun Hee Jang, Mahdi Abu-Omar, Susannah L. Scott*, and Sangwon Suh*, *ACS Sustainable Chem. Eng.* 2020, 8, 9, 3494–3511, Publication Date:February 3, 2020 , https://doi.org/10.1021/acssuschemeng.9b06635

Appendix B: LDPE leaching

"…additives, in nearly all cases, are not chemically bound to the plastic polymer."



<< Recent research showing LDPE leaching timeframes of the UV additive UV-328.

Months/Years timeframe means that any plastic gear loss will continue to pollute the marine waters for decades.

Although plastics look inert they are not.

The Additives in them are not tightly bound to the plastic polymers: they are sort of loosely held among the structured, bound plastic polymers.

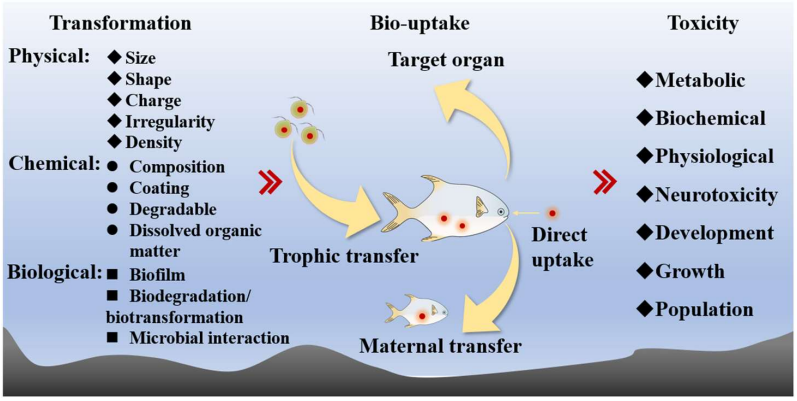
If the relatively weaker bonds that hold the additives "inside" the plastic structure are weakened, the additive chemicals can float out of the plastic structure and into the water.

Since the additives are hydrophobic, they will adsorb onto organic matter floating by, whether that be suspended sediment or microplastic debris.

Antioxidants are embedded in various polymer resins to delay the overall oxidative degradation of plastics if/when exposed to ultraviolet (UV) light [88,90,91]. The highly reactive free radicals that are generated by heat, radiation, and mechanical shear (often exacerbated by the presence of metallic impurities), cause the polymer to degrade (p. 186, ref 231) .
These include UV-238 which the Stockholm convention has just added to their banned POP list yet is commonly found in plastics advertised as "UV Resistant".

Citations:
John N. Hahladakis, Costas A. Velis, Roland Weber, Eleni Iacovidou, Phil Purnell, An overview of chemical additives present in plastics: Migration, release, fate and environmental impact during their use, disposal and recycling, Journal of Hazardous Materials, Volume 344, 2018, Pages 179-199, ISSN 0304-3894, https://doi.org/10.1016/j.jhazmat.2017.10.014.
(https://www.sciencedirect.com/science/article/pii/S030438941730763X)
Picture/LDPE research: Effect of Mass Fraction on Leaching Kinetics of Hydrophobic Ultraviolet Stabilizers in Low-Density Polyethylene. Anh T. Ngoc Do, Yeonjeong Ha, and Jung-Hwan Kwon*, nviron. Sci. Technol. 2023, 57, 50, 21428–21437, Publication Date:December 7, 2023 https://doi.org/10.1021/acs.est.3c06817, Copyright © 2023 American Chemical Society

Appendix C: Environmental toxicology of Microplastics



This article is highly recommended.

It summarizes the risks to human health of the microplastic food chain.

Citation:
Wang W-X. Environmental toxicology of marine microplastic pollution. *Cambridge Prisms: Plastics*. 2023;1:e10. doi:10.1017/plc.2023.9

https://www.cambridge.org/core/journals/cambridge-prisms-plastics/article/environmental-toxicology-of-marine-microplastic-pollution/86AD3CEBFD0DF82E73A0876511189A5C

This diagram summarizes the trophic (food chain) flow and lists the impacts these chemicals can have on any of the organisms in the food chain.

This article provides a good, accessible an much more complete summary of the concerns with generating microplastics and the impacts of their function as a vector of transmission chemicals up the food chain.

Citation:
Wang W-X. Environmental toxicology of marine microplastic pollution. *Cambridge Prisms: Plastics*. 2023;1:e10. doi:10.1017/plc.2023.9

https://www.cambridge.org/core/journals/cambridge-prisms-plastics/article/environmental-toxicology-of-marine-microplastic-pollution/86AD3CEBFD0DF82E73A0876511189A5C

Appendix D – Common additives and references

The lack of regulation of Industrial Plastics which Taylor uses, means that toxics like Phthalates which have been banned for drinking water pipes and children's toys are not regulated at all for industrial plastics. The literature seems to indicate that phthalates are still very commonly used industrial plastics as plasticizers. Any assertions that plastics "do not contain phthalates" should be carefully vetted.

UV 328 was put on the Stockholm Convention's POP list in 2023.

Please see the Hahladakis article for a long list of the most common additives to plastics and their risks.

Excerpts:

> "The various additives present in almost all plastic-derived materials can also contribute to marine pollution. Some plastics contain POPs as additives (e.g. hexabromocyclododecane (HBCDD or HBCD)and/or polybrominated diphenyl ether (PBDE)) at a concentration of 0.7–25% wt. "(p. 184, ref Hahladakis)
>
> "UV-328 is an ultraviolet stabilizer that protects polymers from degradation. It has been associated with adverse liver and kidney effects in animals. "

References:
Additive list: John N. Hahladakis, Costas A. Velis, Roland Weber, Eleni Iacovidou, Phil Purnell, An overview of chemical additives present in plastics: Migration, release, fate and environmental impact during their use, disposal and recycling, Journal of Hazardous Materials, Volume 344, 2018, Pages 179-199, ISSN 0304-3894, https://doi.org/10.1016/j.jhazmat.2017.10.014. (https://www.sciencedirect.com/science/article/pii/S030438941730763X)

National Lib of Medicine: https://pubchem.ncbi.nlm.nih.gov/compounds (chemical search)

WA Dept of Ecology Sediment standards: https://apps.ecology.wa.gov/publications/documents/1309055.pdf

UV-238: https://isotope.com/en-us/newsletters-the-standard-july-2023-dechlorane-plus-uv-328-and-methoxychlor-face-global-ban-under-stockholm-convention

Stockholm Convention POP list: https://www.pops.int/TheConvention/ThePOPs/AllPOPs/tabid/2509/Default.aspx