



TECH environmental

FOCUSED KNOWLEDGE. REAL SOLUTIONS.

**What if We Had to Treat All Air, Water,  
and Waste to Part per Trillion Levels?**

***NEBRA/NEWEA Spring Conference***

***Springfield, MA***

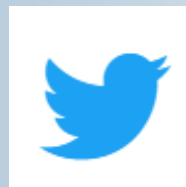
***Tim Jones, PMP***

***Mike Lannan, P.E.***

***October 18, 2019***

# **Breaking News Overnight**

- ***Patrick Mahomes' (the reigning NFL MVP) knee injury is now the #1 Trending Topic on Twitter...surpassing PFAS, the problem has now been solved, thank you for coming today!***



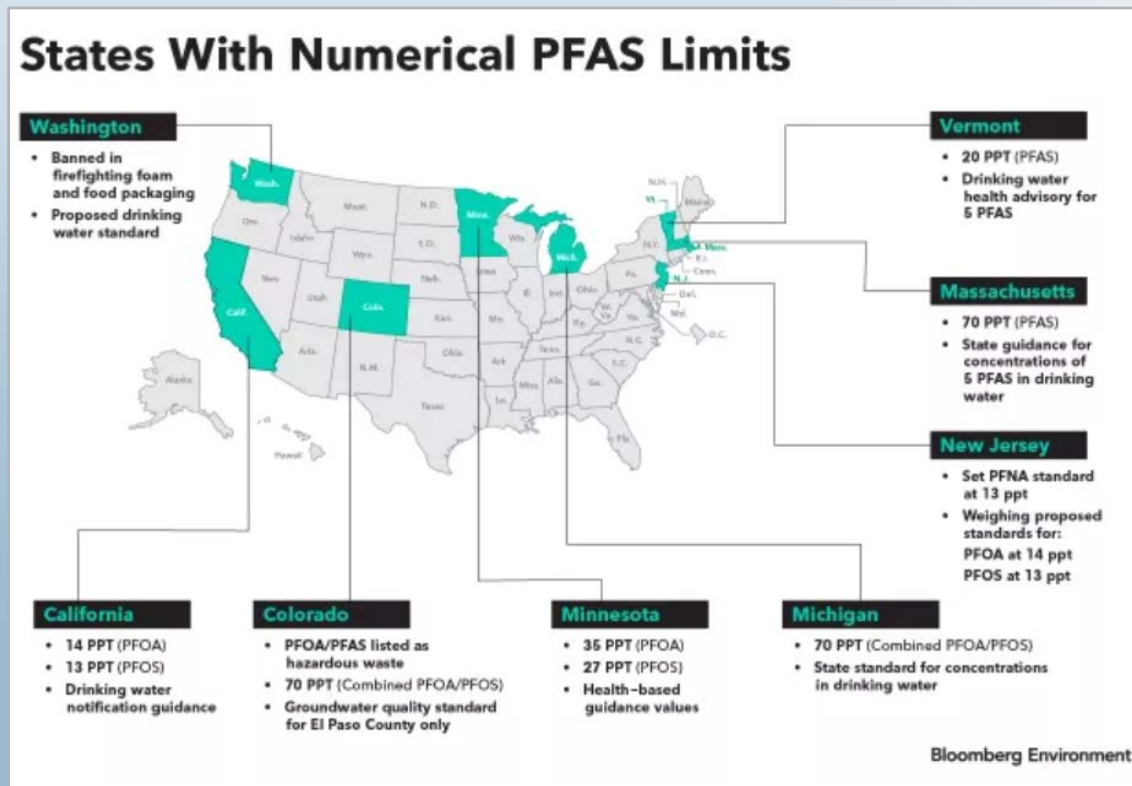
# **Presentation Outline**

- ***What IS NOT included in this talk....***
- ***What IS included in this talk...***
- ***Some Simple Observations***
- ***A Stunning Conclusion...if we do say so ourselves***



# Standards – Qualifications (BACT)

*States have adopted a patchwork of regulations and standards that present significant challenges to impacted industries.*



# NOT Included in this talk....

- **A Discussion of PFAS exposure, but....**
  - ◆ **Unfortunately one factor – the half-life that it remains in one’s blood stream – is significantly more for this compound as compared to most other compounds.**
  - ◆ **It is not that the allowable blood stream concentration is abnormally low for humans for PFAS, one is only allowed to add as much as can be processed to keep below the NOAEL (no-observed-adverse-effect-level).**

Other Drinking Water Guidelines for PFOS						
	Agency	Reference dose (ng/kg/day)	Receptor	Drinking water intake (L/kg/day)	Relative source contribution (%)	Drinking water guideline (ng/L)
Federal	EPA	20	Lactating woman	0.054	20	70
	ATSDR	2	Infant, birth to 1 yr	0.143	No RSC	14
States	VT	20	Bottle-fed infant	0.175	20	20
	MA	5	Lactating woman	0.054	20	20*
	MI	3	Breastfed infant	0.047	50	16*
	MN	3	Breastfed infant	0.047	50	15
	NH	3	Breastfed infant	0.047	50	15*
	NJ	2	Adult	0.029	20	13*
	NY	2	Infant	0.151	60	10*
International	Health Canada	60	Adult	0.021	20	600

\* Proposed / Draft

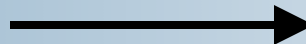
# **NOT Included in this talk....**

- ***A Discussion of the Extrapolation of PFAS exposure from Animals to Humans***
  - ◆ ***Unfortunately, the certainty of existence and exposure at the parts per trillion (ppt or ng/L) versus other exposures becomes less clear.***
  - ◆ ***However, this is standard practice for toxicology and one cannot shoot the messenger for these often called “crazy low numbers”.***



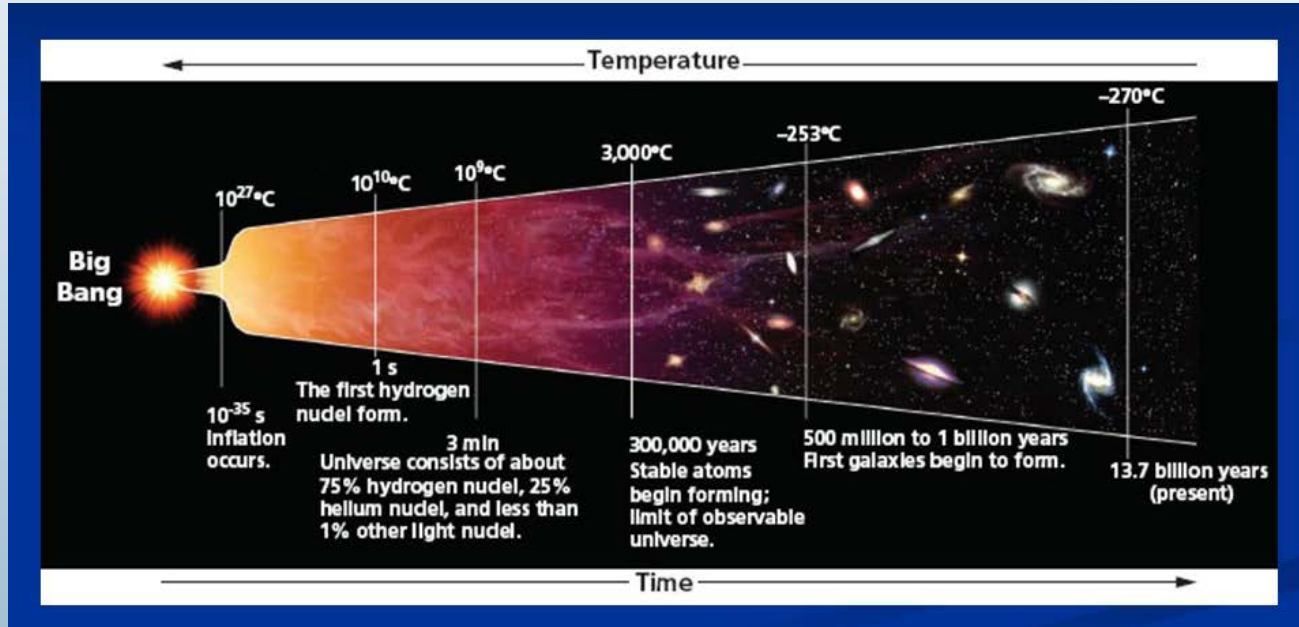
# **“Crazy” Perspective: What is a PPT?**

- **Area Comparison - one square foot of floor tile on a kitchen floor that is the same size as the State of Indiana**
  - ◆ **FYI...The state just happens to be 1.0153 trillion square feet**
- **Water Comparison - one drop of detergent in enough dishwater to fill a string of railroad tank cars ten miles long**



# “Crazy” Orders of Magnitude

- *History of the Universe → 14,000,000,000 years*



*And just for an order of magnitude comparison again...*

- *MA PFAS drinking water limit → 20 parts PFAS in 1,000,000,000,000 parts water*



# Where are We?

## History of the “Forever Chemical”

Table 2-1. Discovery and manufacturing history of select PFAS

PFAS <sup>1</sup>	Development Time Period							
	1930s	1940s	1950s	1960s	1970s	1980s	1990s	2000s
PTFE	Invented	Non-Stick Coatings			Waterproof Fabrics			
PFOS		Initial Production	Stain & Water Resistant Products	Firefighting foam				U.S. Reduction of PFOS, PFOA, PFNA (and other select PFAS <sup>2</sup> )
PFOA		Initial Production	Protective Coatings					
PFNA					Initial Production	Architectural Resins		
Fluoro-telomers					Initial Production	Firefighting Foams		Predominant form of firefighting foam
Dominant Process <sup>3</sup>		Electrochemical Fluorination (ECF)						Fluoro-telomerization (shorter chain ECF)
Pre-Invention of Chemistry /			Initial Chemical Synthesis / Production			Commercial Products Introduced and Used		
<b>Notes:</b> 1. This table includes fluoropolymers, PFAAs, and fluorotelomers. PTFE (polytetrafluoroethylene) is a fluoropolymer. PFOS, PFOA, and PFNA (perfluorononanoic acid) are PFAAs. 2. Refer to Section 3.4. 3. The dominant manufacturing process is shown in the table; note, however, that ECF and fluorotelomerization have both been, and continue to be, used for the production of select PFAS.								
Sources: Prevedouros et al. 2006; Concawe 2016; Chemours 2017; Gore-Tex 2017; US Naval Research Academy 2017								

*Reference:  
From the  
History and  
use of Per-  
and Poly-  
fluoroalkyl  
Substances  
(PFAS) –  
Interstate  
Technology  
Regulatory  
Council  
(ITRC)  
Washington,  
DC,  
November  
2017*

# Some Simple Observations

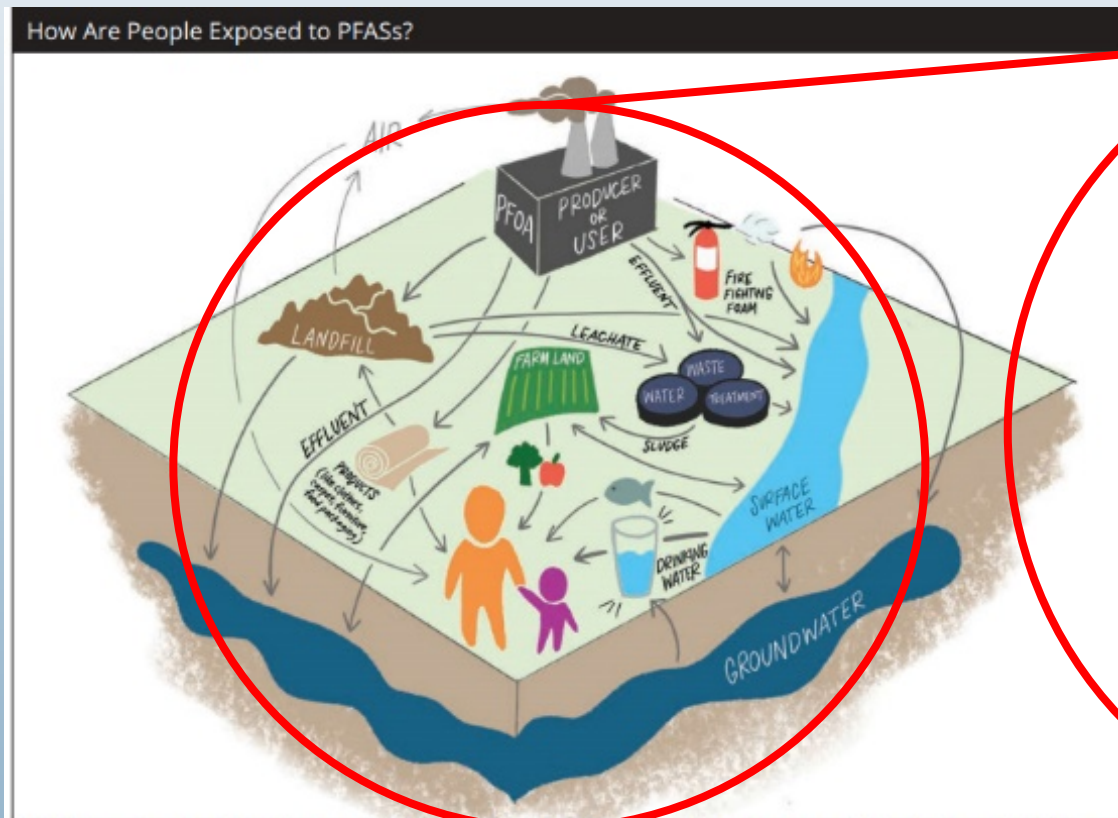
## Timeline Perspective

- *History of the Universe* → 14,000,000,000 years
- *History of the Sun* → 4,600,000,000 years
- *History of the Earth* → 4,500,000,000 years
- *Last Ice Age Began* → 2,600,000 years ago
- *Last Ice Age Ended* → 12,000 years ago
- *History of PFAS* → 90 years

*It is safe to say the jury is still out on the “forever” aspect of PFAS, some medical journals suggest 5 to 10 years for a human half-life.*

# Some Simple Observations

*While not “forever”, it is persistent, the chart below is a great illustration from [www.foodandwaterwatch.org](http://www.foodandwaterwatch.org)*

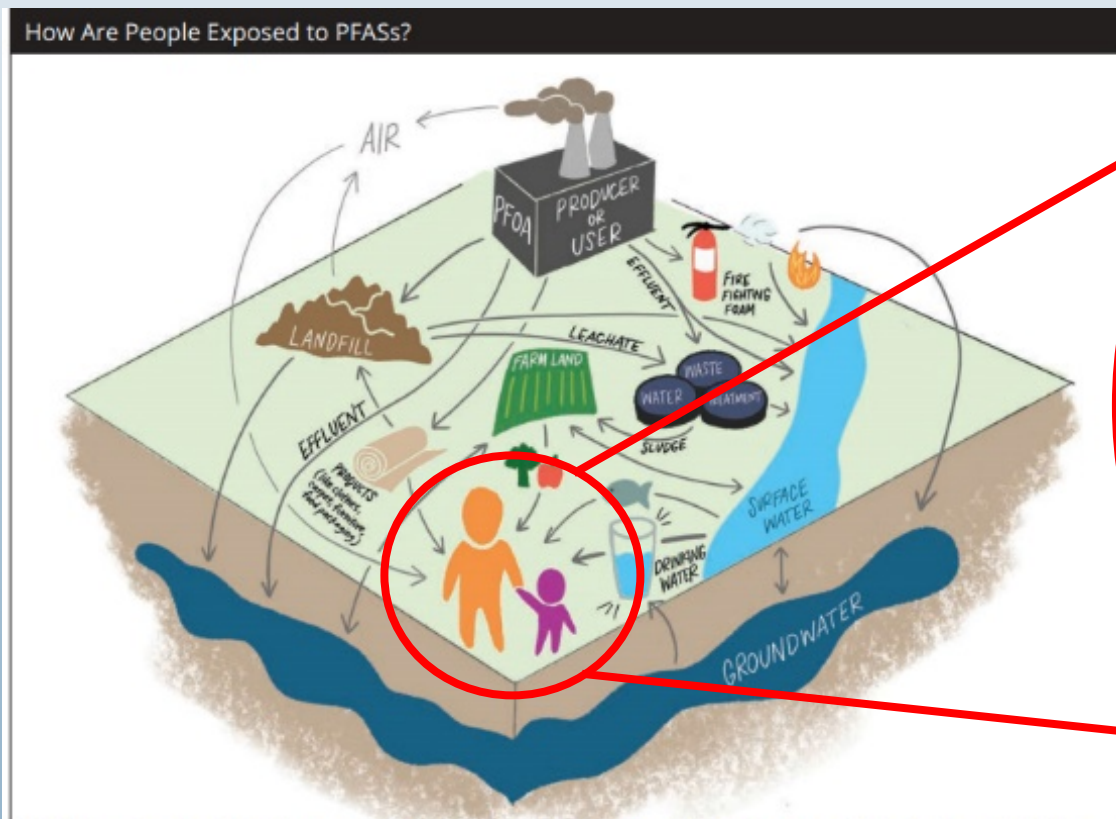


***Because PFAS is persistent the need to protect Drinking Water has been discussed everywhere in this Life-Cycle Circle.***

SOURCE: Image based on Ollaei, Fardin et al. "PFOS and PFC releases and associated pollution from a PFC production plant in Minnesota (USA)." *Environmental Science and Pollution Research*. Vol. 20, Iss. 4, April 2013 at figure 1 at 1979.

# Some Simple Observations

*While clearly everything in this illustration is connected to the exposure pathway, only four pathways have a direct connection to people.*



**Direct Exposure is from:**

- **Drinking Water**
- **Food**
- **Air; and**
- **Products.**

SOURCE: Image based on Oliaei, Fardin et al. "PFOS and PFC releases and associated pollution from a PFC production plant in Minnesota (USA)." *Environmental Science and Pollution Research*. Vol. 20, Iss. 4. April 2013 at figure 1 at 1979.

# **Some Simple Observations**

***PFAS is different than any other “pollutant of concern” that mankind has attempted to address for the following reasons:***

- ***It is not a single compound, but thousands of similar compounds.***
- ***These compounds, by design, are resistant to degradation.***
- ***They are a unique combination of water soluble and biologically stable.***
- ***They travel through our water cycle and our bodies and accumulate more than they degrade.***

# **Some Simple Observations**

***PFAS is different than any other “pollutant of concern” that mankind has attempted to address for the following reasons:***

- ***The allowable threshold is likely very low today, because these are unique halogen chemicals that have only been around for one or two generations.***
- ***The levels being considered safe are drastically reduced by the accumulation factor.***
- ***It is nearly impossible to sample for these compounds and draw conclusions about exposure because they are so widespread and free-flowing at very low levels.***

# Some Simple Observations

***PFAS is different than any other “pollutant of concern” that mankind has attempted to address for the following reasons:***

- ***As MassDEP so eloquently stated in NEBRA’s first formal meeting on this subject in their Boston Office: “This issue is like no other. Never before have we had a compound or group of compounds that affect every aspect of the environment that we protect: drinking water, wetlands, solid waste, hazardous waste, air quality, groundwater.”***
- ***It is everywhere. There is no “smoking gun” for treatment. **Where is the ‘BACT’ approach?*****

# Some Simple Observations

*PFAS is different, so maybe we need to treat it differently...*

- *Traditionally, if an elevated level of a pollutant of concern was identified, its location would be tracked down, and it would be targeted for pretreatment.*
- *With PFAS, every household is a contributor.*
- *While the ultimate “pretreatment” at every house is pollutant phase out, it is not going to happen for some time, so one must balance wastewater exposure with the benefits of wastewater treatment.*





# **Some Simple Observations**

***PFAS is different, so maybe we need to treat it differently...***

- ***Logically now, the burden of any PFAS treatment for every homeowner can only be at the treatment plant***
  - ◆ ***The question then is, what is the direct exposure pathway from wastewater treatment?***
    - ◆ ***Air – typically minimal exposure as long as there are no sludge combustion processes.***
    - ◆ ***Wastewater – no direct consumption of the wastewater, since it is typically treated and discharged to a receiving water.***
    - ◆ ***Biosolids – no direct exposure as sludges are not accessible to the general public.***

# **Some Simple Observations**

***PFAS in wastewater treatment is essentially a pass through. It enter in the influent and is either adsorbed on/into the biosolids or absorbed into the discharge water***

- ***Traditionally, for items that would simply pass through, one would attempt to calculate the capacity of the receiving water or fields if the biosolids are land applied.***
  - ◆ ***One of the closest examples today may be phosphorus...while a nutrient, it can cause a significant imbalance if “too much” is added before it can dissipate***
  - ◆ ***The real difference here however is that the capacity of the receiving water or fields.***

# **Some Simple Observations**

***What is the range of PFAS capacity of the surface or groundwater discharge or fields?***

- ***To answer this question one would consider:***
  - ◆ ***How much “room” there is between the background concentrations and the allowable limit.***
  - ◆ ***The rate at which the compound will be consumed or reacted.***
- ***Essentially the discharge limits are set to insure that in a reasonable period of time with dilution, consumption and reaction, any area of influence of a discharge in minimal.***

# **Some Simple Observations**

***Again, unfortunately, PFAS, is different:***

- ***There is PFAS already in many drinking water sources according at elevated levels.***
- ***The compounds are not readily consumed and they do not readily react.***
- ***Even if one reduces the concentration to low ppt levels, it will not insure that drinking water sources downstream will not still require treatment.***
- ***The lower the limits established, the more likely that this is the case.***

# **For Example...**

- ***With an MCL (max contamination level) of 50 ppt, it is likely that more than 50% of drinking water (at least 100 gallons per person) for roughly 330 million people will need to be treated, we will need to spend nearly \$30 Billion per year to treat all potable water consumed***
- ***Unfortunately, in removing PFAS a side stream is created. In the drinking water example, nearly 4 million pounds of carbon will be consumed, this will need to go somewhere. If it is landfilled, it will cost more than \$25 million per year in disposal costs.***

# **For Example...**

- ***Unfortunately, in landfilling this material, it will be exposed to weather until fully capped. Leachate will be produced prior to and after it is capped, typically over 10 to 30 years after placement. With 10 years, this could create up to 2.5 million gallons of leachate.***
- ***This leachate will require wastewater treatment. At \$0.20 per gallon that will cost about \$50,000 per year, plus the cost of PFAS removal again, since the leachate will clearly have PFAS concentrations above the 50 ppt.***

# ***For Example...***

- ***Although at this time, some of the PFAS will be sequestered in the landfill, since PFAS is very stable, it is possible that a majority of the original PFAS removed in the water treatment process will leach out in the rainfall added prior to capping over time.***
- ***So where are we now? We have reduce exposure through drinking water, but all this money will have been spent, millions of pounds of carbon will have consumed landfill space, and the PFAS will still exist.***
- ***Once again the burden will be on municipalities again to remove in their wastewater system.***

# **Some Simple Observations**

- ***One could suggest at this point, if PFAS is still close to the same quantities, and have similar carbon removal needs, and the effort and costs will occur all over again in the wastewater phase.***
- ***Unfortunately, once this cycle has been completed, it will again return to the wastewater treatment plant via leachate (do loop).***
- ***Since wastewater is not directly exposed to humans, what is the benefit of shifting PFAS from wastewater and biosoilds to carbon again and again?***



# **Some Simple Observations**

- ***The only two pathways to reduce PFAS, short of thermal destruction of anything and everything that comes into contact with “it” (and addressing the byproducts of that thermal destruction) is to:***
  - ◆ ***(1) Stop making “it”. Unfortunately, “it” is not one compound, but “them” thousands of compounds that we have come to rely on in society for our modern lives, or***
  - ◆ ***(2) Wait for generations and generations for all humans, animals, and most importantly bacteria to adapt to digest it more quickly.***
- ***Obviously, continuing to follow pathway (1) is preferred for more immediate health benefits.***

# **Some Simple Observations**

- ***Unfortunately this is going to take time, and it will NOT occur any faster simply by continuing to lower exposure thresholds in the ppt levels to be “more conservative”.***
- ***What should be done in the meantime:***
  - ◆ ***Continue to focus on addressing environmental “hot spots”***
  - ◆ ***Continue to focus on direct exposure pathways in the air we breath, the water we drink, and the food we eat***
- ***Think outside of the traditional “capture and treat” paradigm that does not work here.***

# **Think Outside the Box**

- ***If a Wastewater Treatment plant discharges to a river and there is already little PFAS capacity because background is already in the ppt level, does it make environmental sense to try to remove the wastewater PFAS, as any potable uses from the river downstream will require PFAS removal anyway?***
- ***Buy everyone in the country a Brita home and jug filter?***
  - ◆ ***127 M households X (\$30 home filter + \$40 jug filter) = \$8.9 B***

# **Think Outside the Box**

- ***Should we start segregating municipal water into direct potable (water that we drink or use for growing food) and indirect potable water (water treated to traditional water standards with no PFAS removal)?***
- ***Evaluate PFAS removal needs via a cost benefit analysis instead of an absolute limit basis (a BACT analysis in air quality, or a nutrient analysis for receiving waters)***

# **Stunning Conclusion**

***If one combines many different interpretations of the PFAS background concentration data:***

- ***At a threshold of 100 ppt well over **50%** of the receiving waters will have adequate capacity for ANY discharge ,so reducing the concentration via wastewater treatment could be beneficial to future uses of the water***
- ***At 20 ppt less than **25%** of the receiving waters will have adequate capacity for ANY discharge***
- ***At 5 ppt or lower less than **5%** of the receiving waters will have adequate capacity for ANY discharge***

***The more one pushes lower Drinking Water standards for PFAS, the LESS practical it is attempt to treat to these levels in wastewater – treatment volumes and costs TBD.***

***THANK YOU & Safe Travels!***

***Tim Jones –  
tjones@techenv.com***

***Mike Lannan –  
mlannan@techenv.com***