

PFAS IN WASTE: THE FINAL DESTINATION OF FOREVER CHEMICALS?





PFAS and Waste

- Nearly 40 years ago, the EPA created a series of regulations that fell under the Resource Conservation and Recovery Act (RCRA) meant to track and regulate the cradle-to-grave waste management of hazardous materials.¹
- RCRA Program set up a framework for the proper management of hazardous waste from "cradle to grave," meaning from the time it is created through when it is transported, treated, and stored, and until it is disposed.
- Disposal referred to the grave, or the final destination. But is this still true for PFAS and Forever chemicals according to RCRA program?
- According to Stockholm Convention, wastes that contain persistent organic pollutants shall be processed for destruction, and irreversibly transformed so that their hazardous characteristics are no longer detectable, unless the contents of the pollutants in wastes are low enough.²



Categories of Waste

- There are many way to characterize waste, and no matter how we look at it, there is good chance of the existence of PFAS in one form or other in waste products.
 - “Domestic Waste”: Household-generated waste (Fast food containers/wrappers, microwave popcorn bags, pizza boxes, candy wrappers, personal care products such as shampoo, dental floss, and cosmetics (nail polish, eye makeup)
 - “Industrial Waste”: Waste resulting from the processes of manufacture and final product (AFFF foams, paints, varnishes and sealants, adhesives, aviation hydraulic fluids, cleaning products, paper manufacturing byproducts, water and grease-proofing, chrome plating waste, textile manufacturing waste, tannery waste, water proofing)

Categories of Waste

- “Non-hazardous Waste”: End up in the landfills, such as carpet, furniture and upholstery with stain-resistant coatings used on them, fabrics - outdoor clothing, boots, tents, non-stick cookware such coated pots/pans
- Waste from Water and Soil Remediation Processes: Highly contaminated waste water and/or ground water, biosolids, contaminated absorbent and resins used in remediation process, contaminated soil, sediment and sludge





Landfills: Final Destination

- Sanitary Landfills are pits with a protected bottom where trash is buried in layers, then compressed to make it more solid. The main purpose of a sanitary landfill is to ensure waste is safe by reducing the harm from accumulated waste and allowing safe decomposition.³
- Sanitary landfill contains:
 - A liner system layer
 - A drainage system
 - A gas collection system
 - The trash itself

Landfills: Final Destination

- PFAS in Sanitary Landfills
 - Consumer Products
 - Industrial Waste
 - Carpet and upholstery
 - Food waste
 - Biosolids
- At present, the only technologies that are sufficiently mature for the treatment of PFAS-contaminated soils are excavation with off-site disposal in a sanitary landfill or incineration, capping or covering and monitoring infiltration, and soil washing.⁴





Landfills: Final Destination

- Landfills are not only the final destination for PFAS-contaminated industrial waste, sewage sludge, waste from site remediation, and PFAS-bearing consumer products.
- Since 1990, federal or state regulations have required the installation of a composite liner, a layer of compacted soil, and a leachate collection system (40 CFR 258.40); however, sanitary landfills placed into service prior to 1990 may still be active.⁵
- PFAS may directly enter the environment from waste buried in unlined landfills prior to 1990 or if liners or leachate collection systems fail.
- Leachate collected from landfills is typically treated on site or transported to a nearby municipal WWTP.



Landfills: Leachate Data

In 2013, the total volume of leachate generated in the U.S. was estimated to be 61.1 million m³, with 79% of this volume coming from landfills in wet climates (>75 cm/yr precipitation) that contain 47% of U.S. solid waste. The mass of measured PFAS' from U.S. landfill leachate to wastewater treatment plants was estimated to be between 563 and 638 kg for 2013.⁶

A US Landfill Study conducted a study with 95 samples from 18 landfills:

- 70 PFAS measured, 19 PFAS detected in >50% of samples
- PFOS: 3 to 200 ppt
- PFOA: 100 to 1,000 ppt
- Total PFAS: 2,000 to 29,000 ppt
- Majority of leachates: 400 to 15,000 ppt



Landfills: Final Destination

- Hazardous Waste Landfills
- According to 40 CFR 260.10, a hazardous waste landfill is defined as a disposal facility, or part of a facility, where hazardous waste is placed in or on land and which is not a pile. It could be a land treatment facility, a surface impoundment, an underground injection well, a salt dome formation, a salt bed formation, an underground mine, a cave, or a corrective action management unit. Hazardous waste landfill contains:

- Double liner
- Double leachate collection and removal systems
- Leak detection system
- Run on, runoff, and wind dispersal controls
- Construction quality assurance program ⁷

Incinerators: Final Destination

NJ LANDFILL AGREES TO ACCEPT PFAS-CONTAMINATED SOIL FROM PENNSYLVANIA MILITARY BASE

JON HURDLE | JANUARY 28, 2019

Some New Jersey environmental groups want the planned dumping of material from former Willow Grove naval station to be halted



A local environmental group has agreed to accept a consignment of soil contaminated with toxic PFAS chemicals that are increasingly seen as a threat to public health and are being more tightly regulated by New Jersey and other states. Some environmentalists have expressed alarm at the decision and have called for the dumping to be halted.

The soil is from the former Naval Air Station at Willow Grove, Pennsylvania, where high levels of PFAS chemicals have



- Thermal Treatment and Incineration
- The incineration of excavated soils and granular activated carbon from treatment
- The Concawe (2016) report recommends incineration temperatures of between 1,000 and 1200°C for complete destruction of PFOS.⁸
- More than 3 million gallons of the foam and related waste have been retrieved from U.S. Navy, Marine Corps, National Guard, Army, and Air Force bases around the world. Now the question is what to do with them.⁹
- In January 2017, a waste disposal company hired by the Defense Department began incinerating more than 1 million gallons of the foam and AFFF-contaminated water that had been collected from Air Force bases around the country.⁹



Incinerators: Final Destination

- PCBs can be destroyed by commercial incineration in special plants achieving temperatures of 1,200°F (650° C) in the presence of oxygen. Attempts at incineration at low temperature unfortunately results in degradation compounds which are even more toxic than the commercially synthesized PCB compounds.¹⁰
- The incineration of PFAS requires temperatures in excess of 1,100°C (2000°F) and is, therefore, very expensive.⁸
- Incomplete incineration sends PFAS chemicals back out into the environment, where they have the potential to form new chemicals could unknown impact on environment and human health.

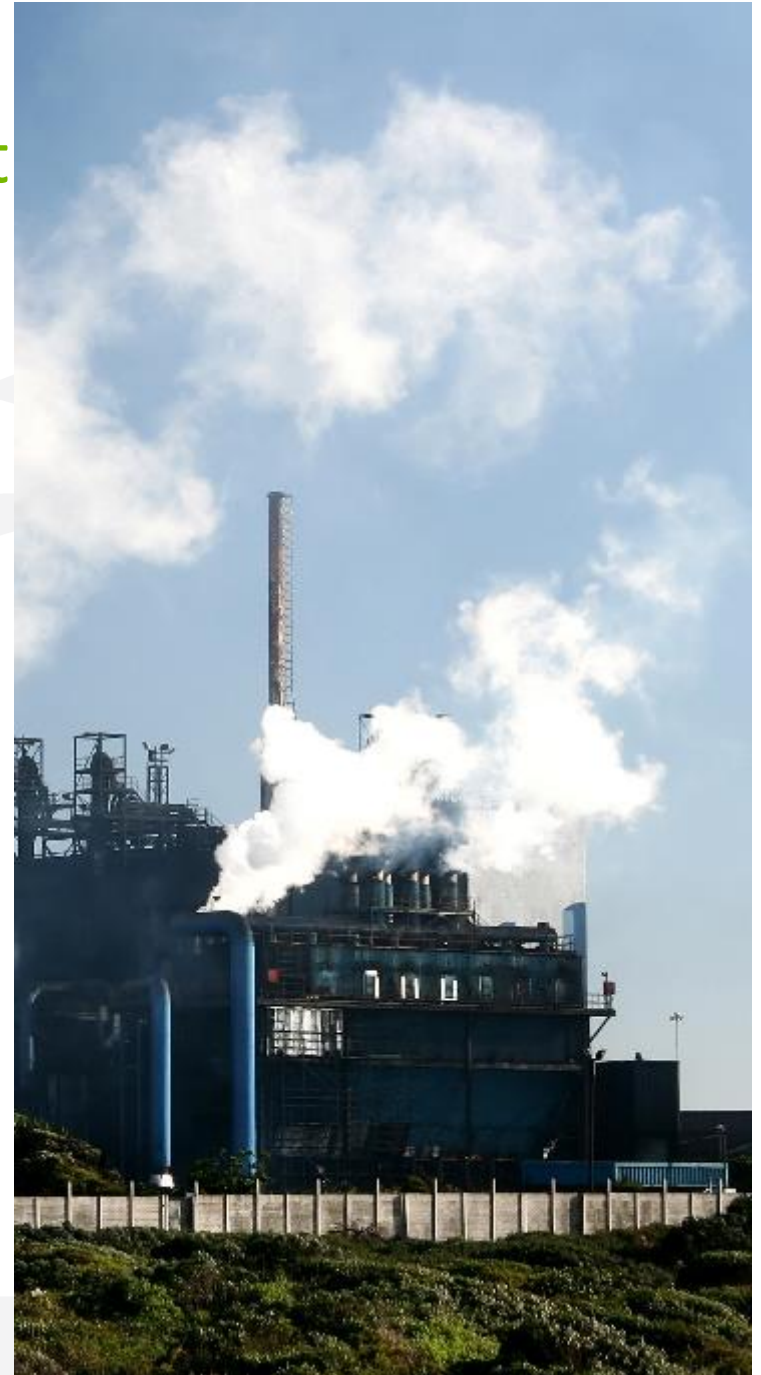


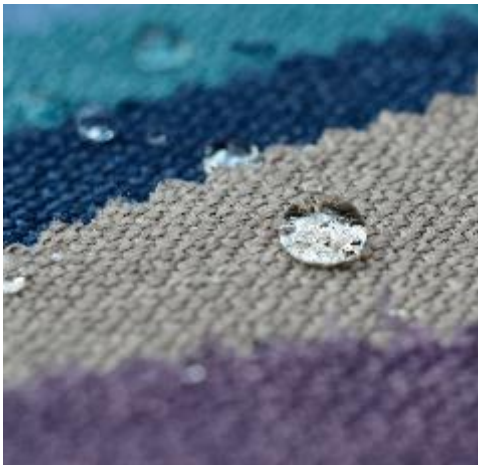
Incinerators: Final Destination/Grave

- MDEQ (2018) states that incinerators operating in Michigan function at temperatures between 590 and 980°C. As such, incomplete destruction and the formation of reaction byproducts is likely, and stack treatment to remove fluorinated chemicals would be required. ⁸
- While GAC has been shown to be effective for the removal of PFOS and PFOA in waters, there are no known studies demonstrating its use for stack gasses. Wet scrubbers are used at three Michigan incinerators. The use of this technology for stack gas treatment has the potential of transferring PFAS and byproducts to wastewater.
- PFAS Incineration Ban Act of 2019, introduced to the Congress earlier this year. ¹¹

PFAS in Air from Waste Treatment

- Once PFAS enter the air through stacks, they can be carried long distances by air currents or adsorb to particulate matter. ¹⁴
- Once in the atmosphere, PFAS has been observed to travel long-range before deposition onto land and water. This leads to concerns about contaminated food chains and accumulation in plants and animals, even in remote Arctic and Antarctic regions.
- Despite the U.S.-wide phaseout of longer-chain PFASs, atmospheric emissions of these compounds from offshore manufacturing need to be evaluated for their potential impact the United States.
- Trans-Pacific atmospheric transport from China leading to adverse impacts on air quality in California have previously been documented for other pollutants. ¹⁵





Case Study: PFAS & Carpet in CA

- Carpets and rugs have been shown to be potential significant sources of PFAS, and may cause widespread human and ecological exposures to this chemicals.
- In November of 2018, California's Office of Environmental Health Hazard Assessment (OEHHA) listed PFOA and PFOS as developmental toxicants under Proposition 65, requiring warnings if the public or workers are exposed to the substances.
- Carpets and rugs constitute nearly half of all floor coverings in U.S. homes and workplaces. A large percentage of the PFAS produced worldwide are used to treat carpets, rugs, and other home textiles to confer stain-, soil-, oil- or water-resistance.
- PFAS from carpets and rugs has been found in home and office air samples, and in the blood of residents and office workers. Compared to outdoor air, indoor air can have >1,000 times higher levels of fluorotelomer alcohols (FTOHs).¹⁶



Case Study 1: PFAS and Carpet in CA

- In 2016, 343 million pounds of post-consumer carpet were discarded in California.¹⁶
 - 257 million pounds (75%) were landfilled
 - 38 million pounds (11%) were recycled
 - 926,000 pounds (.27%) were reused
 - 21 million pounds (6.1%) were combusted for energy recovery
- PFAS from discarded carpets and rugs has reportedly been released into the atmosphere during carpet decomposition in landfills and through combustion, and become widely dispersed.
- They can leach into groundwater from unlined landfills or, contaminated leachates from lined landfills can be transferred to surface water via incomplete removal at WWTPs.

Case Study 2: PFAS and WWTP

- PFAS entering conventional wastewater treatment plants (WWTP) or produced from precursors during treatment can exit the plant in either the aqueous or sludge phase.
- Studies have shown that the discharge of waste water effluent is a significant source of PFAS in the environment. As a result WWTPs have come under scrutiny for discharging PFAS to the environment. The unique physio-chemical properties of PFAS compounds make them difficult to remove using conventional wastewater treatment technologies.¹³
- Multiple studies has reported PFOS and PFOA were still the main forms of PFAS in municipal wastewater treatment plant effluents five to ten years after the major phase-outs of C8-based PFAS' commenced.



Case Study 2: PFAS & WWTP

- Biosolids have been widely used on farms and other lands across North America for decades.
- Every US State and Canadian province allows biosolids use on soils. US EPA, USDA, and US FDA all support biosolids recycling.
- Currently, the United States Environmental Protection Agency (US EPA) regulates land application of biosolids based on pathogen, metal, and nutrient content under 40 CFR Part 503.11. However, PFAS in biosolids are not regulated.¹⁹
- PFOS and PFOA are known to be non-biodegradable.



Case Study 2: PFAS & WWTP

- The core concern being expressed by regulatory officials regarding biosolids applications to soils is about potential leaching of PFAS to groundwater.
- One well-publicized case occurred in Decatur, Alabama, where PFAS contaminated biosolids from a local municipal wastewater treatment facility that had received waste from local fluorochemical facilities were used as a soil amendment in local agricultural fields for as many as twelve years. Biosolids-borne PFAS were implicated in groundwater contamination.¹⁷
- In March of 2019, the state of Maine announced that it would temporarily halt the land application of sludge and begin testing after milk from a dairy farm in Arundel, Maine. The milk was found to be contaminated with PFAS that was hypothesized to have come from sludge the farmers had spread on their land as fertilizer.¹⁹





Regulation and Legal Update

- On June 27, 2019, the U.S. Senate passed legislation (the House has not yet voted) to regulate PFAS by requiring, inter alia:
 - The EPA to issue guidance on the destruction and disposal of PFAS within one year.
 - Changes needed in the RCRA regulations.
- In February 2017, a U.S. District Court denied motions to dismiss RCRA “imminent and substantial endangerment” claims relating to PFAS. See *Tennessee Riverkeeper, Inc. v. 3M Co.*, No. 5:16-cv-01029-AKK, 2017 WL 784991 (N.D. Ala. Feb. 10, 2017). This case involved the alleged continuing contamination of the Tennessee River and associated public drinking water supplies with PFAS that the plaintiff claims originated from a local manufacturing facility and two local landfills.
- RCRA 7002 orders have been filed to address PFAS contamination as “solid waste” that “may present an imminent and substantial endangerment”
 - Solid waste can be “any discarded material” “may present endangerment”
 - RCRA 7002 lawsuits have been filed in AL, NC, and MI

Final Thoughts and What Is Next

- PFAS Impacted Waste Characterization and Final destination
- PFAS in air : Emission regulation, monitoring and permits.
- **PFAS Forensics**
 - Custom projects – project needs clear definition, information on products and site, and an investigative plan.
 - Matching the fingerprints of a source or product (composition or degradation products) with the fingerprints at an area with PFAS concerns.
- Analysis of products and consumer goods (PFAS and TOP) vs field results to determine sources found in field.
- Future NPDES permits for WWTP wastewater discharge, stormwater and other industries for PFAS-related compounds.
- Groundwater standard consideration for PFAS by di
Due Diligent and Litigation
- Remember, Litigation continued many years after production and use of MTBE, PCBs and Asbestos, PFAS related litigation



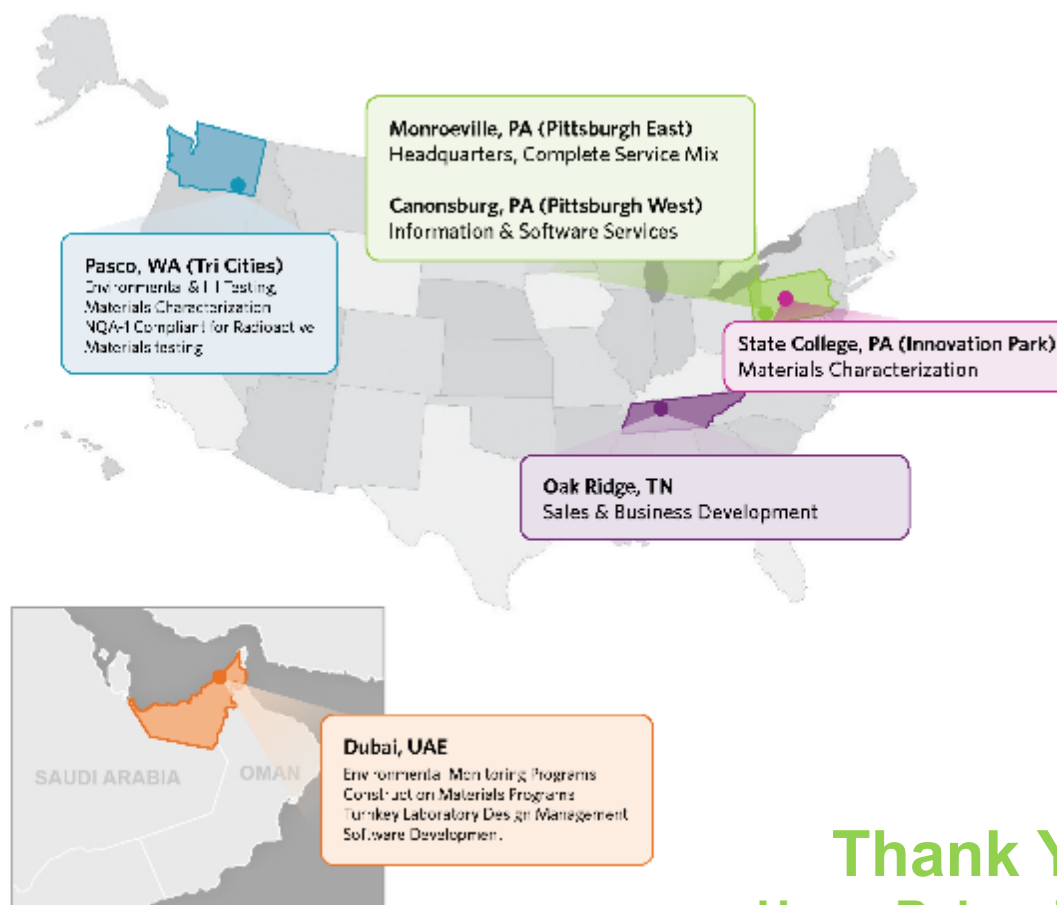
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RJ Lee Group Locations



Thank You
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