# Reduction of PFAS in Leachate from Closed MSW Landfills via Granulated Activated Carbon Filtration

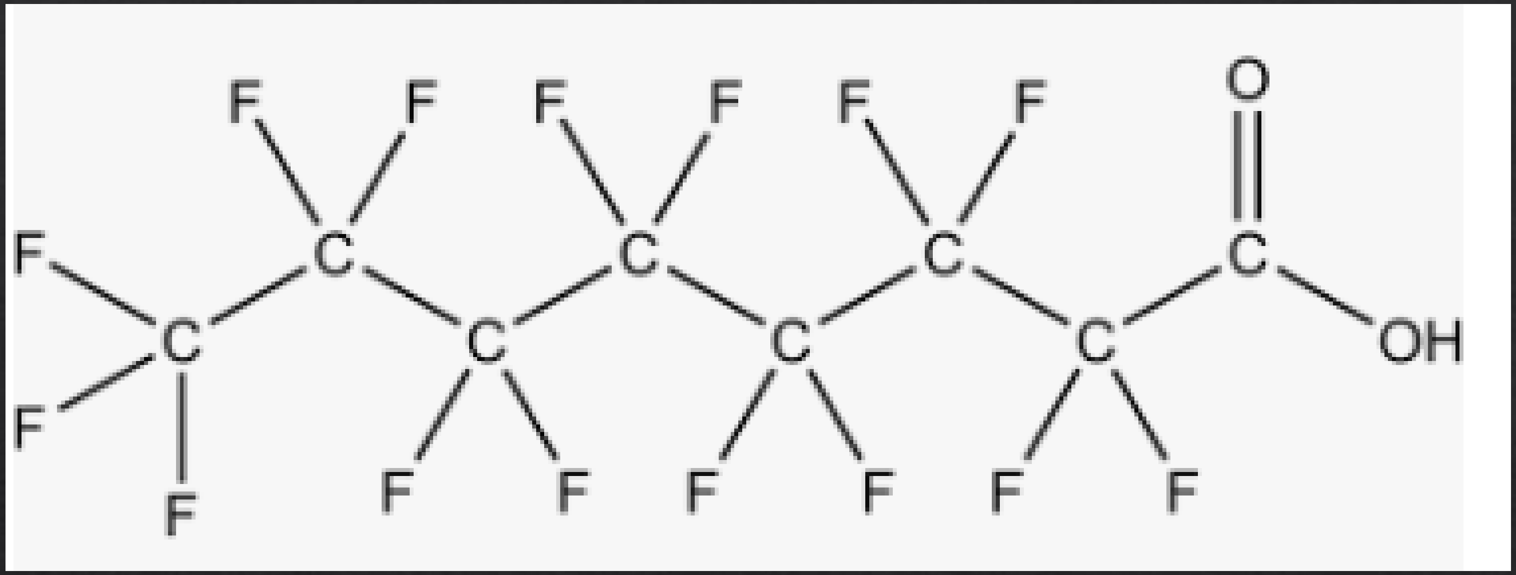
# Only PFAS standards in Wisconsin are for PFOA and PFOS in surface water

PFOA 95 ng/l; 20 ng/l in drinking water sources

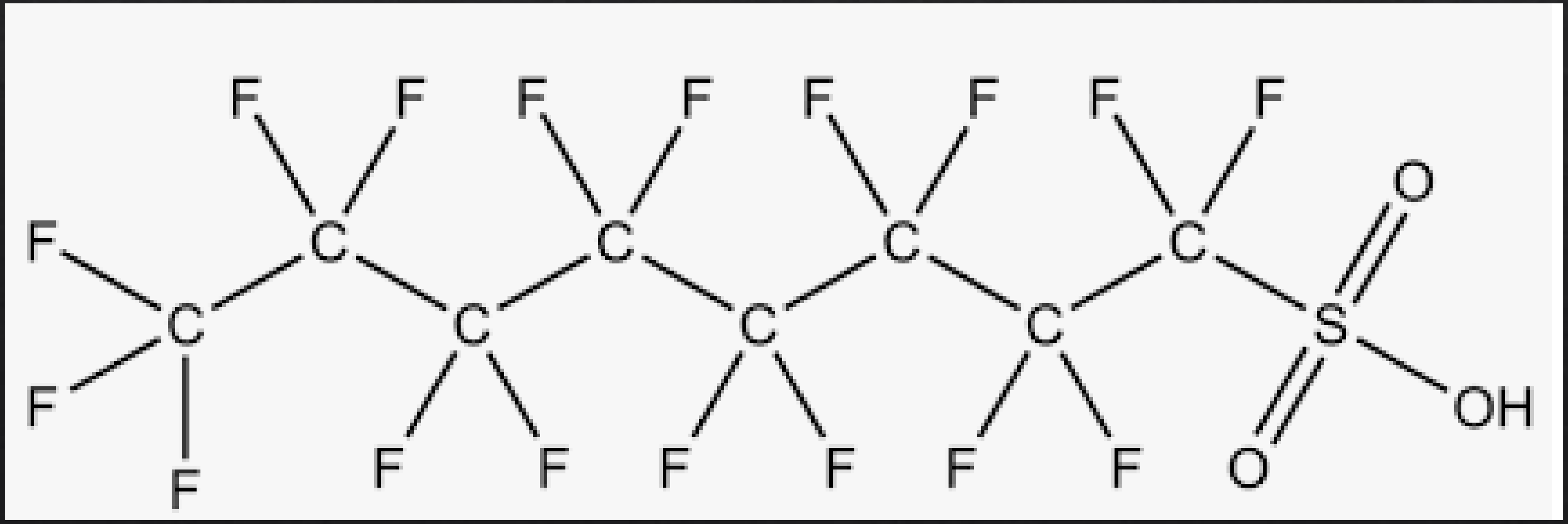
PFOS 8 ng/l

'End of pipe' standard with no allowance for mixing zone/dilution

# PFAS : Per/Poly Fluor alkyl Substances




PFOA




PFOS

# Wisconsin Interim Landspreading Strategy for PFOA + PFOS in Municipal/Industrial Biosolids

**< 20 µg/kg (ppb):** Land application is allowed per normal permitted procedures. If over 20 µg/kg, facilities are encouraged to consider a source investigation.

**50 ≤ x < 150 µg/kg (ppb):** Land application is allowed but restricted to a maximum application rate of 1.5 dry tons per acre. Permittees must also:

Immediately notify DNR staff; Investigate potential sources and develop a source reduction program; Provide PFAS analytical results to the landowner before application.; Track cumulative application rates at each site. Submit an alternative risk mitigation strategy if needed.

**≥ 150 µg/kg (ppb):** Land application is prohibited. Permittees must immediately notify the DNR and use alternative disposal methods, such as a lined landfill or incineration. The DNR will no longer approve new land application sites for these biosolids.

PFOS/PFOA have $K_{oc}$ values that are 2 to 4 orders of magnitude higher than nitrate or chlorides. Sulfur containing PFAS tend to have higher $K_{oc}$ values than non-sulfur containing PFAS.

PFAS are adsorbed by carbon/organics, such as biosolids and bioaccumulate in organisms. Sulfur containing PFAS tend to have a longer residence half life within organisms than their non-sulfur containing equivalent carbon species.

# Current State of Affairs

PFAS is always found in MSW landfill leachate.

Anecdotally, leachate from older, closed landfills tend to have higher PFAS concentrations.

WPDES permits now require testing for PFOS and PFOA in effluent and biosolids. A WWTF having to do a PFAS source investigation will automatically look at any landfill leachate they are accepting.

Over the past 3 years, a growing number of WWTFs are no longer accepting landfill leachate due to PFAS concerns.

# Leachate pre-treatment options: Separation (RO/Foam Frac) and Destruction

1. Reverse Osmosis and Foam Fractionation produce concentrate which will typically be returned to the landfill, but can't be returned if the landfill is closed.

2. Destruction technologies will greatly reduce PFAS in concentrate, but no technology can currently guarantee 100% removal or destruction.

3. These methods are currently not economically feasible for closed landfills due to costs (generally $1M - $10M+) AND are not required by regulation.

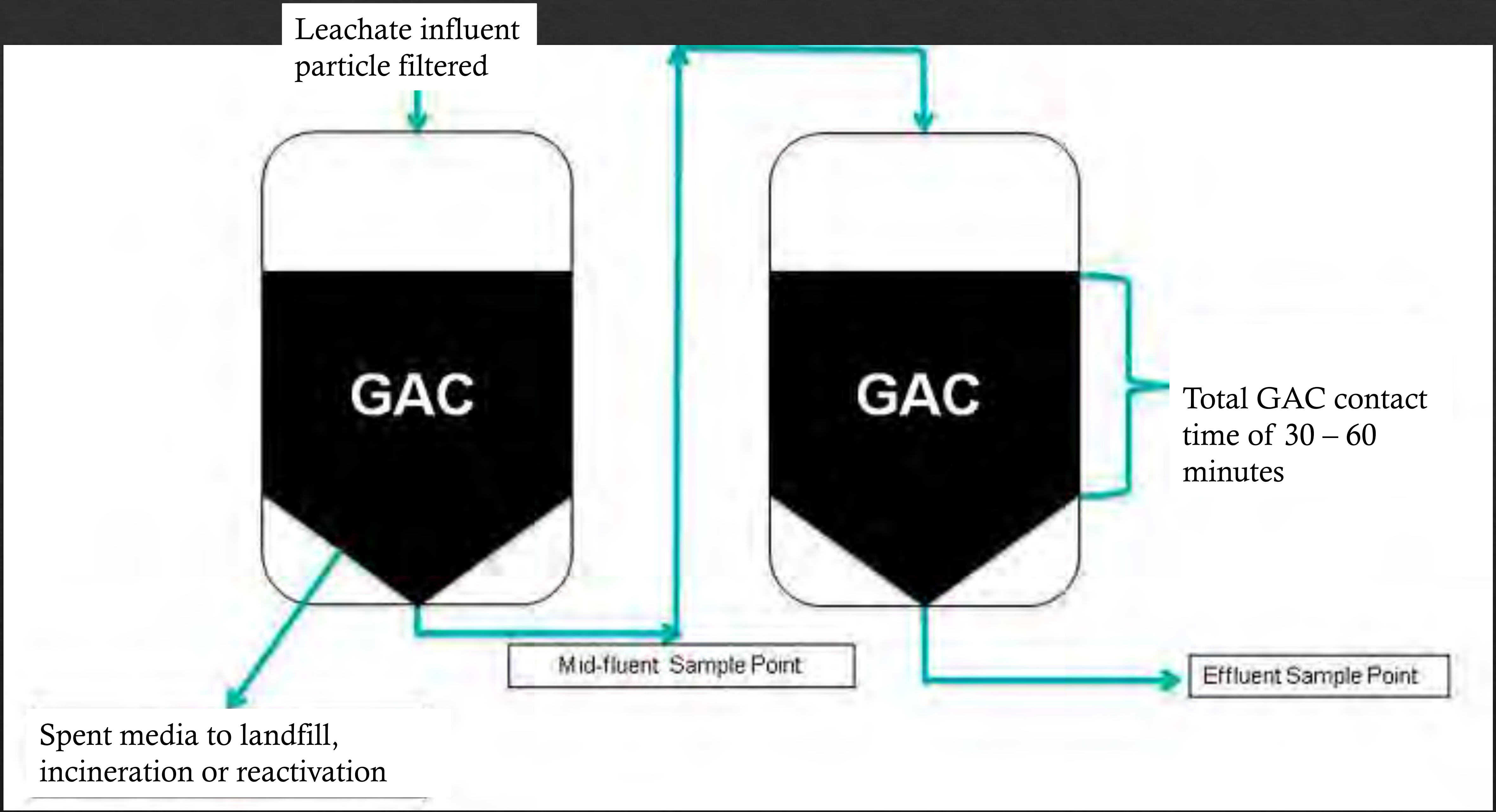
# Current best, proven treatment option for leachate pre-treatment is filtration

1. Granulated Activated Carbon (GAC); works best on longer carbon chains of 7 or greater and on sulfur containing PFAS

2. Anion Exchange; best for shorter carbon chains such as PFBA, PFBS

# Wisconsin DHS PFAS recommendations for drinking water (2024)

| Compounds | carbons | standard *ng/l* |
|---|---|---|
| PFOA/PFOS, FOSA | 8 | 4 |
| NetFOSA | 10 | 4 |
| NEtFOSAA, NetFFOSE | 12 | 4 |
| PFNA | 9 | 10 |
| PFHxS, GenX (HPFO-DA) | 6 | 10 |
| PFDA | 10 | 300 |
| PFKoA | 12 | 500 |
| DONA | 7 | 3,000 |
| PFUnA | 9 | 10,000 |
| PFBA | 3 | 10,000 |
| PFTeA | 5 | 10,000 |
| PFHxA | 6 | 150,000 |
| PFODA | 17 | 400,000 |
| PFBS | 3 | 2,000 |


Leachate influent particle filtered
GAC
GAC
Total GAC contact time of 30 – 60 minutes
Mid-fluent Sample Point
Effluent Sample Point
Spent media to landfill, incineration or reactivation

# GAC Filtration:

1. Effective for PFOA/PFOS

2. Relatively short media life due to competing ions such as iron and organics. Expect a media life of hundreds of Empty Bed Volumes (EBVs), compared a life of 10,000+ EBVs when GAC filtering well water

3. Disposal of spent media.  Not hazwaste, YET. Consider encapsulation if disposing in a Subtitle D facility

# Leachate Production/Treatment in Closed Landfills:

1. 43,000 gallons/month = 1 gpm

2. Size system for largest expected flow and desired residence time

## Sizing example:

1. 100,000 gallons/month max flow = 2.3 gpm

2. Minimum residence time of 30 minutes, assuming a 50% porosity would require a ~ 500 lb. GAC filter

3. Most of the year, residence time would be much greater

# Costs:

1. 100,000 gallons/month max flow, 2.3 gpm treatment system will cost between $75,000 and $350,000. Higher cost would be if new storage with containment is required for treated leachate.

2. Annual O&M costs will be between $30,000 and $60,000 with greatest costs being new GAC, labor and spent GAC disposal. For 500,000 gal/year site, this equals 6 – 12 ¢/gal for treatment not including transport and WWTF fees.

# Costs (continued):

3. Pre-treatment to remove iron and other competing elements/compounds will increase capital and O&M costs by ***at least*** a factor of 2.  Waste products will increase by at least 3 fold.

4. Any leachate pre-treatment costs are not included in current LTC calculations

# Summary:

1. Receiving WWTFs will, based on current regulation and local politics, determine if leachate pre-treatment is required

2. GAC filtration of landfill leachate is a proven, cost effective means to reduce PFOS/PFOA and other PFAS concentrations

3. GAC filtration will also decrease ammonia/um, metal and organics concentrations in leachate

4. Any regulatory requirements to pretreat landfill leachate will cause most, if not all, LTC equity funds, to be ‘underfunded’