Table 12-2. SOLIDS TECHNOLOGIES – REMEDIATION TECHNOLOGIES AND METHODS COMPARISON TABLE

FI – FIELD IMPLEMENTED **LA – LIMITED APPLICATION** **D - DEVELOPING**

This table belongs with the ITRC PFAS Tech Reg Document. The ITRC intends to update this table periodically as new information is gathered. The user is encouraged to visit the ITRC PFAS web page (http://pfas-1.itrcweb.org) to access the current version of this file. Please see ITRC Disclaimer http://pfas-1.itrcweb.org/about-itrc/#disclaimer

The mechanism of treatment (separation vs transformation) is listed under each Remediation Group.

Remediation Group	Remediation Technology	What PFAS Demonstrated On? What Concentrations?	Strengths (Includes Co-Contaminants, Sustainability, Scalability)	Challenges/Limitations (Includes Co-Contaminants, Sustainability, Scalability)	Waste Management/Life Cycle	Future Data Needs	PFAS Demonstration Maturity (Lab, Field Pilot, Full-Scale, Commercialized	References
Sorption and Stabilization (Separation)	12.3.1 Stabilization (As an example, activated carbon blended with amorphous aluminum hydroxide, kaolin clay, and additives)	PFOS, PFOA, PFHxS, PFHxA, and 24 other PFAS analytes PFOS~1–376µg/L with 95–99% reduction in measurable PFOS concentration	Basic implementation technology (soil mixing, etc.) with proven independent studies since 2015. Used at full-scale.	Competition for binding sites by organic co-contaminants.		***Long-term stability not demonstrated.***	FI	(Birk 2015; Kempisty, Xing, and Racz 2018; Marquez et al. 2016; Stewart, Lawrence, and Kirk 2016; Stewart and McFarland 2017)
	12.5.1 Modified minerals (iron oxide, goethite, high iron sand, clay/organoclay)	PFOS, PFHxS, PFOA, PFHxA PFOS~0.12–8.0 ppm	Enhance sorption by modifying surface. Adsorption isotherms vary for various minerals.	Potential for desorption and leaching of PFOS off surface. Influenced by soil chemistry (pH, ions, and organic carbon content). Relatively low surface area. Amendment dosage is high (>7%). The soil moisture content needs to be 60% of soil water-holding capacity.	May need to manage the sorbed media, particularly if potential desorption and leaching of PFAS is a concern.	Potential for PFAS to leach from soil after treatment. Further study needed to identify the sorption mechanism(s) involved.	D	(Johnson et al. 2007; Zhao et al. 2014; Kambala and Naidu 2013)

Remediation Group	Remediation Technology	What PFAS Demonstrated On? What Concentrations?	Strengths (Includes Co-Contaminants, Sustainability, Scalability)	Challenges/Limitations (Includes Co-Contaminants, Sustainability, Scalability)	Waste Management/Life Cycle	Future Data Needs	PFAS Demonstration Maturity (Lab, Field Pilot, Full-Scale, Commercialized	References
Thermal Desorption (Separation)	12.5.2 Thermal desorption, in situ and ex situ capture	Demonstrated on many PFAS compounds PFOS ~21,000µg/Kg, >99% removal at 400°C	Can remove other volatile co-contaminants	Due to high heat demand, in situ treatment may not be cost-effective. May have potential to be applied as an in-situ technology.	Generates waste stream (air) that still needs to be managed.	Field demonstrations and assessment of volatilization of PFAS thermal conversion products, as well as hydrogen fluoride and production of hydrofluoric acid, need to be better understood.	D	(Grieco and Edwards 2019; Crownover et al. 2019; DiGuiseppi, Richter, and Riggle 2019)
12.3.3 Incineration (Thermal Destruction)	Off-site incineration	Soil, remediation waste–all concentrations	Has the potential to be a permanent solution	High energy, expensive. Uncertainty in required temperature and complete destruction and flu gas chemistry. Potential byproducts that could be generated.	Could potentially generate an air waste stream that needs to be managed.	Field demonstrated when used in conjunction with excavation. Assessment of volatilized PFAS thermal conversion products needs to be better understood.	FI	(Watanabe et al. 2016)
12.3.2 Excavation and Disposal	Landfill disposal	Applies to all PFAS	Proven technology	Possible contribution to PFAS in landfill leachate. Some landfills refuse to accept PFAS-contaminated soils/materials.	Could potentially act as a secondary source, so long-term liability and leachability should be considered.	Ability to ensure landfilled materials do not contribute to PFAS in landfill leachate	FI	(Lang et al. 2017)

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