



YB Technologies
Technologies for a Cleaner World

MBT™ Treatment of Soil and Solid Waste for Leachable PFAS...



MBT™ Technology for PFAS Sequestration in Soils and Solids

Chemical reagent treatment system for leachable PFAS

Reagent formulations available for soils, sediments, biosolids, water treatment/other solids and solid wastes (insitu or exsitu applications)

Reduces PFAS leachability USEPA Test Methods:

- Method 1311 (TCLP – synthetic)
- Method 1312 (SPLP – acid rain)
- “Modified” Method 1312 (Substituted extraction fluids)
DI Water; PFAS impacted groundwater; D Landfill Leachate containing PFAS)

Broad-spectrum PFAS telomere response for low ng/Kg (ppt) concentrations

MBT sequestration reactions with PFAS continue over time



MBT™ Sequesters PFAS in Soils and Solids

Benefits:

Molecular Bonding/Binding Treatment:

- MBT sequesters and fixates PFAS in soil, sediments and solids
 - MBT mitigates PFAS from release/spill site soil to groundwater
 - MBT reduces PFAS leachability from soils/solid (variety of USEPA extraction test methods)
- Treatment end product suitable for onsite management or off-site D landfill
- MBT reagents do not chemically alter PFAS compounds, i.e. no by product intermediaries.
- Conventional soil blending equipment

MBT PFAS Leachability Viability Results:

Eastern MI Soil

MBT Treatment Results of PFAS Telomeres in Flint Michigan Soil

Soil Provider: Job Site Services, Inc., Bay City, MI

PFAS in USEPA Method 1311 TCLP Extract - MS Semi-volatiles (EPA 537M BY ID)

Treatment Regime: Matrix:				Untreated Soil	MBT-1 Soil	MBT-2 Soil	MBT-3 Soil	MBT-4 Soil
PFAS Telomere	Acronym	Fluorinated C Atoms	Units					
Perfluorohexanoic acid	PFHXA	C ₆	ug/l	0.00415 J	<0.0040	<0.0040	<0.0040	<0.0040
Perfluoroheptanoic acid	PFHpA	C ₇	ug/l	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Perfluorooctanoic acid	PFOA	C ₈	ug/l	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Perfluorononanoic acid	PFNA	C ₉	ug/l	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Perfluorodecanoic acid	PFDA	C ₁₀	ug/l	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Perfluoroundecanoic acid	PFUnA	C ₁₁	ug/l	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Perfluorododecanoic acid	PFDOA	C ₁₂	ug/l	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Perfluorotridecanoic acid	PFTriA	C ₁₃	ug/l	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Perfluorotetradecanoic acid	PFTeA	C ₁₄	ug/l	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Perfluorobutanesulfonic acid	PFBA	C ₄	ug/l	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Perfluorohexanesulfonic acid	PFHxS	C ₆	ug/l	0.0143	<0.0040	<0.0040	<0.0040	<0.0040
Perfluorooctanesulfonic acid	PFOS	C ₈	ug/l	0.105	<0.0040	<0.0040	<0.0040	0.0167

MBT processing applied in four (4) different regimens: MBT-1, 2, 3, and 4

MBT is the patent-pending treatment technology owned by HMR Solutions, Inc. of Brooklyn, NY for leachable heavy metals, PFAS, and other constituents in soil, sediments, and other solid waste.

Analyses by SGS, Orlando FL



MBT™ PFAS Leachability Viability Results:



Western Michigan Site Soil – USEPA Method 1311
(TCLP – Synthetic Landfill Leachate)

PFAS Leachability: Method 1311 (TCLP)						
	UNTREATED Soil		MBT TREATED Soil			
	Totals in Soil (avg.)	Totals in TCLP Extract	T-1 Soil Extract	T-2 Soil Extract	T-3 Soil Extract	T-4 Soil Extract
<u>Telomere</u>	<u>(ng/Kg)</u>	<u>(ng/L)</u>	<u>(ng/L)</u>	<u>(ng/L)</u>	<u>(ng/L)</u>	<u>(ng/L)</u>
PFBA	264	50,000	49,000	50,000	<50	<50
PFOA	536	4,400	1,800	1,000	<10	<10
PFDA	1,175	<50	<50	<50	<50	<50
PFD _o A	394	<50	<50	<50	<50	<50
PFT _e A	1270	<50	<50	<50	<50	<50
PFOS	29,600	1,700	1,500	630	<10	<10
PFNS	346	<50	<50	<50	<50	<50
PFDS	765	<50	<50	<50	<10	<10
PFOSA	6265	<50	20	<50	<50	<50
EtFOSSA	4,055	62	<50	<50	<50	<50



MBT™ PFAS Leachability Viability Results:

Western Michigan Site Soil – USEPA Modified Method 1312
(Actual Site Groundwater Extraction Fluid)

PFAS Leachability: (MODIFIED) Method 1312 (Site Groundwater Extraction Fluid)					
	UNTREATED Soil and Groundwater			MBT TREATED Soil	
	Totals in Soil (avg.) (ng/Kg)	Totals in Groundwater Extract (ng/L)	Totals in Soil Extract (ng/L)	T-2 Soil Extract (ng/L)	T-4 Soil Extract (ng/L)
<u>Telomere</u>					
PFBA	264	640	620	144	144
PFOA	536	100,000	94,000	220	89
PFNA	<0.26	86	70	<10	<10
PFDA	1,175	96	57	<50	<50
PFDoA	394	<50	<50	<50	<50
PFTeA	1270	<50	<50	<50	<50
PFOS	29,600	390,000	190,000	230	121
PFNS	346	<50	<50	<50	<50
PFDS	765	<10	<10	<10	<10
PFOSA	6,265	63	120	<10	<10
EtFOSSA	4,055	<50	140	<50	<50

MBT™ PFAS Leachability Viability Results:



Western Michigan Site Soil – USEPA Modified Method 1312
(Actual Subtitle D Landfill Leachate Extraction Fluid)

PFAS Leachability: (Modified) Method 1312 with Subtitle D Landfill Leachate Extraction Fluid							
		UNTREATED Soil and Subtitle D Landfill Leachate			MBT TREATED Soil		
		Totals in Soil (avg.)	Totals in Landfill Leachate	Totals in Soil Extract	T-2 Soil Extract	T-3 Soil Extract	T-4 Soil Extract
<u>Telomere</u>	<u>Chemical Name</u>	<u>(ng/Kg)</u>	<u>(ng/L)</u>	<u>(ng/L)</u>	<u>(ng/L)</u>	<u>(ng/L)</u>	<u>(ng/L)</u>
PFBA	Perfluorobutanoic Acid	264	1,900	1,800	1,500	1,500	1,300
PFOA	Perfluorooctanoic Acid	536	680	490	200	170	110
PFDA	Perfluorodecanoic Acid	1,175	230	57	<50	<50	<50
PFDoA	Perfluorododenoic Acid	394	<50	<50	<50	<50	<50
PFTeA	Perfluortetradecanoic Acid	1270	<50	28	<50	<50	<50
PFOS	Perfluorooctanesulfonic Acid	29,600	450	<10	52	38	33
PFNS	Perfluorononanesulfonic Acid	346	<50	<50	<50	<50	<50
PFDS	Perfluorodecanesulfonic Acid	765	<10	<10	<10	<10	<10
PFOSA	Perfluorooctanesulfonamide	6265	<10	28	<10	<10	<10
EtFOSSA	N-Ethylperfluorooctane	4,055	<10	<50	<50	<50	<50

RESULTS



MBT™ – Pilot

Confidential Site Source, MI
MBT Processed Material

YBT - STUDY

MBT™ – Pilot: Leachable PFAS in Solids

Confidential Site Source, Michigan (8/2025)

- No characterization data available
- PFAS indicated by Engineer to be @ ~800,000 ng/Kg
- MBT treatment regimes designed for 1,000,000 ng/Kg
- **BLIND** Batch treatment
- MBT reagents and water for Mixing
- MBT-1 and MBT-2 reagent systems applied to differentiate between organic and mineral based materials
- Absorptive Waste Mass – expansive in mixer and sample containers
- All treatments observed and sampled by Fishbeck (Grand Rapids, MI)
- Sample Duplicate Splits
- **NO OPTIMIZATION PERFORMED PRIOR TO PILOT**



MBT™ PILOT: CONFIDENTIAL MI SITE (Untreated Control)

- Actual Total PFAS:
- >15,000,000 ng/Kg
- Treatment design for ~ 1,000,000 ng/Kg)

PFAS Telomeres	Chemical Name	C Atoms	UNTREATED: CONTROL			
			Yost Brothers (ALS)		FTCH (Fibertec/Trace)	
			TOTALS (dry wt) ng/Kg (dry-wt)	TCLP ng/L	TOTALS (dry wt) ng/Kg (dry-wt)	TCLP ng/L
PFBA	Perfluorobutanoic Acid	C4	<150	<49	140	18
PFPeA	Perfluoropentanoic Acid	C5	170	<49	160	13
PFHxA	Perfluorohexanoic Acid	C6	350	<49	340	21
PFHpA	Perfluoroheptanoic Acid	C7	490	<49	430	20
PFOA	Perfluorooctanoic Acid	C8	9,400	340	12,000	350
PFNA	Perfluorononanoic Acid	C9	270	30	1,100	11
PFDA	Perfluorodecanoic Acid	C10	23,000	190	1,400	<10
PFUnA	Perfluoroundecanoic Acid	C11	2,200,000	3,800	2,800,000	<10
PFDoA	Perfluorododenoic Acid	C12	12,000	<49	<30	<10
PFTriA	Perfluorotridecanoic Acid	C13	990,000	130	1,200,000	<20
PFTeA	Perfluortetradecanoic Acid	C14	<150	<49	<120	<20
PFBS	Perfluorobutanesulfonic Acid	C4	79	<9.8	70	<10
PFPeS	Perfluoropentanesulfonic Acid	C5	1,109	<9.8	130	11
PFHxS	Perfluorohexanesulfonic Acid	C6	1,900	100	2,200	110
PFHpS	Perfluoroheptanesulfonic Acid	C7	7,500	210	8,900	160
PFOS	Perfluorooctanesulfonic Acid	C8	6,800,000	80,000	10,000,000	32,000
PFNS	Perfluorononanesulfonic Acid	C9	32,000	81	57,000	25
PFDS	Perfluorodecanesulfonic Acid	C10	45,000	23	61,000	<10
FtSA 4:2	Fluorotelomer Sulfonic Acid 4:2	C6	<150	<49	<30	<10
FtSA 6:2	Fluorotelomer Sulfonic Acid 6:2	C8	<150	<49	<30	<10
FtSA 8:2	Fluorotelomer Sulfonic Acid 8:2	C10	<150	<49	<30	<10
PFOSA	Perfluorooctanesulfonamide	C8	140,000	160	180,000	39
N-EtFOSSA	N-Ethylperfluorooctanesulfonic amidoacetic Acid	C12	5,300,000	5,300	3,300,000	200
N-MeFOSAA	N-Methylperfluorooctanesulfonic amidoacetic Acid	C11	2,200	<49	2,900	<10
F-53BMin	11Cl-Pf3OUds	C10	<29	<9.8	NR	NR
ADONA	4,8-Doxa-3H-perfluorononanoic Acid	C8	<29	<9.8	NR	NR
F-53BMaj	9Cl-PF3ONS	C8	<29	<9.8	NR	NR
---	Hexafluoropropylene	C3	<150	<49	NR	NR
Summation of PFOA :			6,809,400	80,340	10,012,000	32,350
Summation of PFAS Telomere Totals:			15,565,468	90,364	17,627,770	32,978





MBT™ Pilot (Treated TCLP Data):

Confidential Site Source

MBT – Treatment #1

TCLP Extraction Date = End of MBT Treatment Reactions

		TREATED: MBT-1				
		08282020 - 1100				
		FTCH: Fibertec/Trace		YB: ALS		
		9/9/2020	10/21/2020	9/11/2020	10/5/2020	
		TCLP		TCLP		
<u>PFAS Telomers</u>	<u>Chemical Name</u>	<u>C Atoms</u>	<u>ng/L</u>	<u>ng/L</u>	<u>ng/L</u>	<u>ng/L</u>
PFBA	Perfluorobutanoic Acid	C4	14	12	<50	<50
PFOA	Perfluorooctanoic Acid	C8	35	21	12	<10
PFUnA	Perfluoroundecanoic Acid	C11	<10	<10	2,800	<50
PFTriA	Perfluorotridecanoic Acid	C13	<20	<20	160	<50
PFHpS	Perfluoroheptanesulfonic Acid	C7	15	<10	<50	<50
PFOS	Perfluorooctanesulfonic Acid	C8	22,000	4,400	9,700	900
PFNS	Perfluorononanesulfonic Acid	C9	110	13	53	<50
PFDS	Perfluorodecanesulfonic Acid	C10	<20	<20	24	<10
PFOSA	Perfluorooctanesulfonamide	C8	130	85	92	12
N-EtFOSSA	N-Ethyl perfluorooctane sulfonamido acetic acid	C12	2,500	860	3,700	360
N-MeFOSAA	N-Methylperfluorooctane sulfonamidoacetic acid	C11	<10	<10	<50	<50
Summation of PFOA and PFOS:			22,035	4,421	9,712	900
Summation of PFAS Telomere Totals):			24,804	5,391	16,602	1,272

RESULTS

MBT™ Independent Evaluation:

“Based on a review of the testing data, Fishbeck has concluded that the MBT™ treatment protocol is effective in stabilizing and sequestering PFAS in impacted soils.”

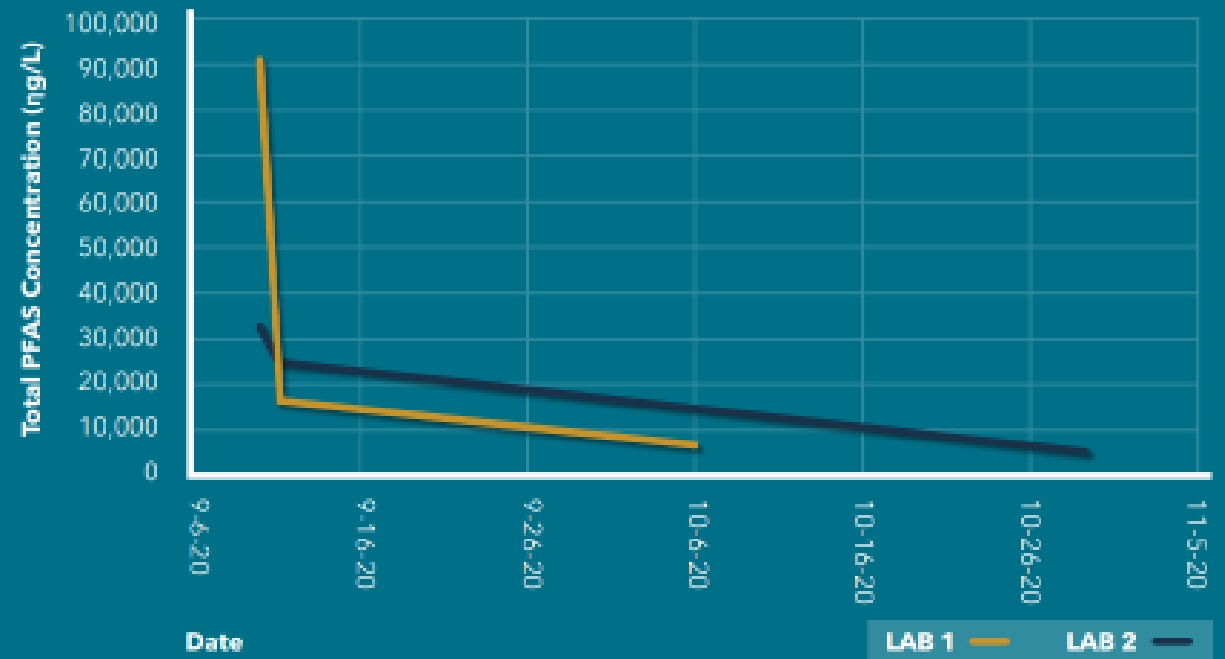
-Fishbeck, Grand Rapids, MI

December 15, 2020

Fishbeck provided an independent engineering assessment of MBT treatment protocol. Field testing was performed at Job Site Services, Inc. Facility in MI.

Testing performed by independent laboratories where data indicated an overall decrease in detected total PFAS compounds of 84%. Same testing occurred 1.5 months after treatment, and testing indicated MBT binding activity improved over time.

MBT Treatment – TCLP Extraction



MBT™ treatment technology are patent/patents pending in the US and abroad



YBT's PFAS Technology Solutions

MBT™ Treatment Technology

To sequester leachable PFAS in soil and solids for onsite management or non-hazardous RCRA landfill disposal

Advanced Neutralization (AN™)

For precipitation, coagulation, and separation of solids followed by GAC from PFAS removal

AMEOX® Technology

To destroy PFAS in spent/exhausted GAC media

Technologies are patented/patent(s)-pending in the US and abroad



MBT™ Technology Application Potential for RCRA Subtitle D Landfills

- Internment of highly leachable PFAS soil/solid waste under profiling protocols
- Daily cover “treatment” sublayer for non-treated leachable PFAS over burden soil placement
- Manufactured treatment aid for other PFAS-impacted material
- Mitigation of pre-existing leachable PFAS in cell fluids PRIOR to leachate collection
- Management tool for a site’s PFAS impacted solids (e.g., biosolids)



MBT™ Application Options (In-situ or Ex-situ)





THANK YOU

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