Remediation Technology	Application	Pros and Cons	Relative Cost	Effectiveness
Environmental Dredging	In situ river bottom sediments	Permanent removal of PCBs Less long-term maintenance Short-term increases in fish tissue contamination	Low Enclosed clamshell: $20,000/month or $15/cy (dredge only) (from Hudson FS) Cutterhead: $650,000 (from 2003 project) Price is dependent on land filling fees (see below)	Depends on type of equipment, size, and operating conditions Enclosed clamshell: range of 30-660 cy/hr Cutterhead: range of 33-3270 cy/hr
Landfilling	Ex situ for soil and sediments	PCBs can volatize and escape through surrounding air channels or leach and contaminate groundwater Dredging and soil excavation required beforehand	High Excavating and landfilling one acre of soil contaminated with lead to a depth of 50 cm: $400,000—$1,700,000 (Khan et al 2004)	Can be effective at containing PCBs; not effective at remediating PCBs
Soil Washing BioGenesis[sm]	Ex situ soil or sediment	No other treatment method required Includes the ability to recover metals and clean a wide range of contaminants from coarse soils	Low Competitive at commercial scale (500,00 cy/year)- $50-$59/cy. Avg. cost $170/ton (EPA 2000)	Average removal rate of 92% on silt, 89% on clay
Bioremediation BioPath Solutions	In situ soil, ex situ soil and sediment (dredged)	No other treatment method required Requires a minimum volume of about 500 yd^3 of soil/sediment BioPath can develop specific "bioblends" for site-specific contaminants	Less expensive than offsite disposal, cost effective for 500+ cubic yards but not for less	Achievement of a site's mandated cleanup goals is guaranteed. Toxaphene at a site in GA decreased from 3500 ppm to non-detect within 24 weeks. BioPath has developed 8+ formulations with proven efficacy in reducing PCBs. 2-4 treatment cycles will reach almost 100% reduction.

Remediation Technology	Application	Pros and Cons	Relative Cost	Effectiveness
Carbonaceous Materials Activated Carbon Biochar	In situ Activated carbon: sediment and water Biochar: soil and sediment	Mixing activated carbon into sediments does not cause resuspension of PCBs into the water column Biochar can reduce bio- and phyto-availability in soil and improve soil quality	Low Virgin carbon cost approx. \$3/pound, but regenerated carbon is cheaper	Sediment exposed to activated carbon retained a capacity to reduce aqueous PCB concentrations by approx. 90% after 18 months. A pilot study saw a decrease in the transfer of PCB from sediments into aquatic media by up to 73% in 5 years. Adding 2.8% of biochar to soil contaminated with 136 and 3.1 ug/g PCBs reduced PCB root concentration by 77% and 58% respectively. Biochar can reduce PCB bioavailability up to 89% (Gomes et al).
Electroremediation	In situ and ex situ soil and sediment	A more environmentally sustainable method than those requiring combustion or those relying mainly on non-renewable resources	Approx. \$78/cubic meter of contaminated soil (Gomes et al 2015)	Electrolytic biostimulation can removed approx. 62% of weathered Aroclor from sediments within 88 days. A study using electrodialytic remediation with iron nanoparticles saw an 83% PCB removal rate.
Phytoremediation	In situ or ex situ upland, shallow, and shoreline soil and sediments	Minimal environmental disturbance, maintenance, and secondary waste Aesthetically pleasing High public acceptance Possible deleterious effects on wildlife that consume vegetation	Low to moderate Low for large sites with low concentrations of PCBs. One acre of soil w/ lead contamination to 50cm would be approx. \$60,000-\$100,000 (Khan et al 2004)	Variable A study conducted in 2009 found that PCBs decreased by 60% after 60 weeks of treatment.

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UV Treatments UV-Oxidation UV Decontamination	In situ and ex situ UV-Oxidation: sediment and water UV Decontamination: soil and sediment	Relatively few resources required Mobile UV Decontamination: currently designed to handle smaller contaminations	UV-oxidation: $10 to $50 per 1,000 gallons of water Mobile UV Decontamination: low (Khan et al 2004); University of Calgary's technology will be approx. $350-500 per ton.	UV–Decontamination: A 2013 study using UV and visible light technologies saw PCBs degraded by as much as 94%.
Capping	In situ soil and river bottoms	Does not remove contaminants from environment Efficiency decreases over time	Moderate to high (Gomes et al 2013)	Effective at containing PCBs; not effective at remediating PCBs
In Situ Sediment Ozonation (ISO)	In situ soil and sediment	Ozonation reactors are readily available Can be manufactured at modest cost Ease of use- Ozonation as a treatment technique is common	Can be as low as $50/cy using pressure-assisted ozonation $75-$150/cy using integrated chemical/biological treatment	The integrated chemical-biological system achieved extensive removal over weeks. The new pressure-assisted process can achieve complete contaminant removal within an hour.
ZVI Dechlorination nZVI	In situ and ex situ soil, sediment, and liquids depending upon type of ZVI	To achieve the minimum PCB destruction efficiency, high temperatures (300º C) must be used Short reactive life span; unstable and prone to oxidation Great dechlorinator when palladized; can reduce Aroclors to congeners susceptible to aerobic degradation	Not yet available	In situ nZVI injection and the abiotic reductive dechlorination process produced an 87% reduction of PCB 1242 in a field study of a monitoring well. Researchers using nZVI have successfully dechlorinated PCB-contaminated soils to a 95% destruction efficiency.

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Solvent Extraction Green PCB Removal Sediment System (GPRSS)	In situ sediments	Treated solvent and other components can be reused System components can be scaled up or down depending on application	Not yet available	Average removal of 75% of PCBs by mass
Solvent Extraction Activated Metal Treatment System	In situ for paint, caulk, concrete, brick, and wooden surfaces	Allows for extraction of PCBs without removal of structures	Not yet available	Treatability test indicated PCBs in concrete materials decreased as much as 78% in 2 weeks
Incineration	Ex situ soil, sediments, and liquids	Adverse human health and environmental impacts from off gassing High removal efficiency Limited by the concentrations/types of metals present	High Varies from $695/cubic yard to $1,171/cubic yard depending on volume of waste. Up to $2,300/ton for a fixed PCB incinerator	Effective at very high heat; Temperatures up to 1200º C are required to achieve 99.99% removal efficiencies
Solidifcation/ Stabilization (S/S)	Ex situ or in situ soil and sediments	Extreme temps and precipitation can adversely affect the in situ S/S process	Ranges from $80 per cubic meter for shallow applications to $330 per cubic meter for deeper (Khan et al 2004)	Variable
Thermal Desorption	Ex situ and in situ volatile materials: larger particle soil, sediment, sludge, filter cakes	Versatile; can be implemented on or off site Not suitable for fine particle soil; more difficult and costly to use on wet soil	Highly variable: $50-$330/metric ton. Of this, $20-$35 goes to direct operating costs (Khan et al 2004)	High Passaic River basin project: PCBs reduced to 0.16 ppm

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Landfarming	Ex situ for soil, sediment, sludge	Amendments can be added to speed degradation of contaminants Need to control soil conditions to optimize degradation rate Runoff collection facilities must be contrasted and monitored May not be effective for high constituent concentrations of >50,000 ppm	Moderate	Variable
Moving-Bed Biofilm Reactor	In situ effluent	Sequential anaerobic-aerobic conditions, which are more suitable for organic biodegradation	Not yet available	A laboratory-stimulation resulted in an 83-84% PCB removal efficiency for PCB77
Membrane Bioreactor	In situ effluent	Able to also remove 99% of BPAs and similar compounds Used as a n enhanced secondary treatment method	Not yet available	>90% removal with activated sludge or membrane filtration
Natural Media Filtration (NMF)	In situ stormwater effluent	Can also be used to remove other hydrophobic compounds May promote adsorption of dissolved PCBs and capture of particle-bound PCBs Cost-effective and low maintenance	Less than traditional sand filtration followed by granular activated carbon	Varies depending on natural medium used for filtration A pilot test demonstrated an average PCB removal rate of 88% NMFs constructed by Roux Associates have sustained PCB removal to levels well below 100 ppt
Black Walnut Shell Filtration STiR	In situ effluent	Not all inorganics are removed	Approx. $7.50 / day or $2,733 / year Approx. $200,000 capital cost and an additional estimated $6,900 annual operating cost	STiR traps about 100% of trapped particulates

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StormwaterRx Aquip® Purus™	In situ stormwater	Adaptable: 2 products available in different performance levels Aquip®: does not use chemicals or backwash, operates unattended, 24/7, and is a gravity flow-through system Purus™: flow is matched to upstream treatment rates	Unavailable	Removes PCBs to non-detectable concentrations Purus™: No Aroclors were detected above the Method Detection Limit in treated effluent in a 2013 case study.
Chitosan-Enhanced Sand Filtration	In situ stormwater	Not feasible to treat all stormwater runoff from every event	Low to moderate	Predicted to achieve 73% total PCB load reduction annually (approx. 96% in dry weather and 68% in wet weather)