Table A-5.C. Technical implementation considerations for multi-phase extraction

Data requirements	Site-specific data for technology evaluation	Hydraulic conductivity, transmissivity	Hydraulic conductivity and transmissivity data help determine the appropriate groundwater extraction rate that may be sustained by the groundwater pump. These data may be obtained from slug tests, groundwater pumping tests, or predictive modeling. Relatively tight formations with low-conductivity/transmissivity soils may require the use of low-flow pneumatic pumps, as opposed to higher-flow submersible pumps.
		LNAPL conductivity, LNAPL transmissivity	LNAPL conductivity and transmissivity data help determine the appropriate LNAPL extraction rate that may be sustained. These data may be obtained from LNAPL baildown tests, pumping tests, or predictive modeling. Relatively tight formations or sites with low LNAPL transmissivity/LNAPL conductivity may require the use of low-flow pneumatic pumps, as opposed to higher-flow submersible pumps.
		LNAPL characteristics	Low-viscosity LNAPLs are more amenable to pumping than higher viscosity LNAPLs. Hence, lighter-end, low-viscosity LNAPL such as gasoline, kerosene, jet fuel, diesel and No. 2 fuel oil are more amenable to MPE than a No. 6 fuel oil or Bunker C.
		Soil permeability (to air, e.g., in unsaturated zone)	Permeability to air in the unsaturated zone directly affects the radius of treatment that can be developed around each well for a given vapor extraction rate. Lower-permeability soils require more wells per unit area.
		Safety precautions	Explosivity of LNAPL—potential need for bonding and grounding of metal equipment/containers and other associated safety requirements.
		Available power/utilities	System usually needs three-phase power.
	Bench-scale testing	N/A	
	Pilot-scale testing	Groundwater ROC	Establish groundwater ROI/ROC for different groundwater pumping rates. For continuous pumping systems, determine acceptable pumping rate that may be sustained for design groundwater drawdown.
		LNAPL ROC	Establish LNAPL ROI/ROC for different LNAPL pumping rates. For continuous pumping systems, determine acceptable pumping rate that may be sustained without creating unacceptable drawdown.
		Groundwater recovery rate, volume, and influent concentrations	Determine groundwater recovery rate, volume, and influent concentrations to assist with design of water handling, treatment, and discharge options.
		LNAPL recovery rate, volume, and chemical characteristics	Determine LNAPL recovery rate, volume, and chemical characteristics to assist with design of LNAPL storage, handling, treatment, and discharge options.
		Vacuum and flow	Blower sizing
		Vacuum ROI	Well spacing
		Vacuum influent concentration	Treatment system type and sizing
	Full-scale design	Number of extraction wells	Determine number of required MPE wells necessary to achieve adequate zone of LNAPL recovery consistent with LNAPL site objective(s).
		Conveyance piping	Determine locations, lengths, materials for all horizontal conveyance piping to/from MPE wells and recovery/treatment system. Assess pipe insulation and heat tracing needs for winter conditions, if applicable.
		Groundwater ROC	Establish groundwater ROI/ROC for different groundwater pumping rates. For continuous pumping systems, determine acceptable pumping rate that may be sustained without creating unacceptable drawdown.

		LNAPL ROC	Establish LNAPL ROI/ROC for different LNAPL pumping rates. For continuous pumping systems, determine acceptable pumping rate that may be sustained without creating unacceptable drawdown.
		LNAPL emulsification issues	Determine level of emulsification occurring, feasibility of LNAPL/water separation, required residence time for LNAPL/water separation. Emulsification may enhance biofouling.
	Performance metrics	Groundwater/LNAPL recovery rates and volumes	Basic system performance monitoring
		System uptime vs. downtime	
		Cumulative groundwater/LNAPL recovery	
		LNAPL recovery vs. groundwater recovery	LNAPL/water ratio
		LNAPL recovery cost metric	Cost per gallon of LNAPL recovered
Modeling tools/ applicable models		Projected future LNAPL recovery	Use of decline curve analysis, semi-log plots, etc. to predict future LNAPL recoveries and help determine when LNAPL recovery is approaching asymptotic.
Further information		FRTR. n.d. "Remedial Technology Screening and Reference Guide, Version 4.0, Dual Phase Extraction." www.frtr.gov/matrix2/section4/4-37.html	
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