4 Chemical Isolation Design Data Needs

Table 4-1 summarizes the data that may be needed to support cap design, construction, and monitoring to meet the desired chemical isolation design criteria. Where noted in Table 4-1, detailed description of the key data needs specific to the CIL design is included in Appendix C. Although not all data are needed for every project or site, this checklist is a useful way to explicitly consider each possible data need during the respective stages of the project. These phases, presented in Table 4-1, are described in the following bullets:

- Design criteria: the key factors with respect to the site-specific CSM that would support the development of the chemical isolation design criteria.
- CIL modeling: the parameters recommended for informing or selecting model inputs for effective CIL design. Key modeling inputs are further described in Section 5.5.3.
- Construction: the key factors that would affect the placement of CIL and should be considered during the CIL design.
- Post-remediation monitoring: the key factors that should be considered during the development of the long-term monitoring plan for the CIL performance evaluation.

Table 4-1. Potential data needs for the chemical isolation design

Data Type	Description	CSM/ Design Criteria	CIL Modeling	Construction	Post-Remediation Monitoring
Chemical-Specific Properties					
Contaminant Type (e.g., Organics or Metals)	Site-specific contaminant(s) (i.e., COCs).	X	X		X
Contaminant Concentration in Porewater	Source of chemical to the cap (from beneath the cap). It is important to know whether concentrations represent total dissolved or freely dissolved contaminants. Additional details are provided in Appendix C.	X	X		X
Contaminant Distribution in Either Bulk Sediment or Porewater	Concentrations of one chemical relative to the other chemicals, either individually or as individuals that make up a total (e.g., homologs of total PCBs).	X	X		
Contaminant Mobility, Including Sorption Isotherms / Partition Coefficients	Understanding how mobile a chemical is and COC-specific K_{oc}, K_d, or K_f and 1/n. Additional details are provided in Appendix C.	X	X		
Sorption Kinetics	Rate of sorption/desorption.		X		
Chemical Degradation Rate	Rate of aerobic or anerobic decay.		X		
Chemical Molecular Diffusion Rate	Rate at which chemicals diffuse (i.e., transport across a concentration gradient).		X		

Contaminant Concentration in Surface Water	Concentration in surface water serves a few purposes: recontamination of cap, boundary condition for the cap model, and possibly the initial concentration of chemical concentration in pore space of the cap, if placed through water column.	X	X		X
Contaminant Bioavailability and Toxicity	Caps are designed to reduce contaminant bioavailability and toxicity. Freely dissolved concentration in porewater is an indicator of bioavailability and toxicity.	X	X		X
Geochemistry	Geochemistry is particularly important for the fate and transport of metals.	X	X		
Molecular Weight of Chemical	LMW organic contaminants are less hydrophobic and more mobile in the environment. HMW organic contaminants are strongly partitioned to organic carbon in sediments and are less mobile. Some model processes can be quantified based on empirical relationships to molecular weight (e.g., diffusion).		X		
Presence of NAPL	The presence of NAPL has two impacts on cap design: (1) it may inform the need for an NAPL sorption layer and (2) it may inform the dissolved-phase concentration in proximity to the NAPL (Raoult’s Law). Observations of NAPL migration should be noted during construction.	X	X	X	X
Data Type	**Description**	**CSM/ Design Criteria**	**CIL Modeling**	**Construction**	**Post-Remediation Monitoring**
Transport Properties					

Sediment Deposition	Rate and concentration of depositing particles and the rate of deposition inform the need for addition of material on top of cap. Concentration on depositing particles informs background concentration and concentration at surface of cap due to deposition (not transport through cap). Additional details are provided in Appendix C.	X	X		X
Rate of Erosion	Rate of loss of material from the surface of the cap. Additional details are provided in Appendix C.	X	X		X
Groundwater Seepage Rate	Rate of groundwater flow through a cap describing advection. Additional details are provided in Appendix C.	X	X		
Tidal Oscillations (Period and Range)	Groundwater seepage rates change with changes in the tide, including possible changes in flow direction. May inform decisions about hydrodynamic dispersivity. During construction, tidal cycles may be important to understand water depths during cap placement.	X	X	X	
Hydrodynamic Dispersivity	Measure for describing the mixing process. Often a factor of domain length. Dependent on groundwater flow/velocity and tidal oscillations.		X		
Tortuosity Correction	Describes the tortuous path of the chemical through the pore spaces (i.e., chemical does not move in a straight line).		X		
Surface Exchange / Mass-Transfer Coefficient	Rate of mass transferred across the cap (or sediment) surface interface.		X		
Bioturbation Rate and Profile	Depth of bioturbation and intensity of bioturbation with depth. Additional details are provided in Appendix C.	X	X		
Vertical Hydraulic Gradient	Change in hydraulic head over a distance. Along with hydraulic conductivity, it is used to calculate groundwater seepage rates.	X	X		

Sediment Hydraulic Conductivity	Hydraulic gradient and hydraulic conductivity can be used to calculate seepage rate. Less permeable sediments have lower hydraulic conductivity and lower seepage rates.	X	X		
Data Type	**Description**	**CSM/ Design Criteria**	**CIL Modeling**	**Construction**	**Post-Remediation Monitoring**
Physical and Geotechnical Properties					
Water Depth and Site Bathymetry	Informs constructability and cap monitoring.	X	X	X	X
Sediment-Bearing Capacity	Important for dry placement of cap.	X		X	
Sediment and Cap Material Grain Size Distribution	Geotechnical parameter that can impact cap design.	X		X	X
Consolidation	Geotechnical parameter that can impact cap design. Also adds to seepage rate based on the amount and timing of porewater expressed due to consolidation.		X	X	
Slope Stability	Important to evaluate slope displacement and for constructability of cap.	X		X	
Surface Water Velocity	Important for constructability of cap and to evaluate erosion potential. Can be used in calculation of surface exchange / mass-transfer coefficient.		X	X	
Armor / Filter Material Selection	For erosion protection.	X	X	X	X
Cap Material Types	To meet project criteria and cap design specification.	X	X	X	
Amendment Options	Primary CIL material.	X	X	X	
Porosity of Sediments and Cap Material	Pore space and pore velocity.		X		
TOC of Sediments and Cap Material	Contaminants partition strongly to organic carbon. Additional details are provided in Appendix C.		X	X	
DOC of Porewater in Sediments and Cap Material	Contaminant flux to surface water as truly dissolved or associated with DOC.		X		
Bulk Density of Sediments and Cap Material	Important design specification for constructability of cap.	X	X	X	

Temperature of Sediments	Important information for fate and transport of contaminants. May be used to inform locations of higher and lower seepage rates.	X	X		
Data Type	**Description**	**CSM/ Design Criteria**	**CIL Modeling**	**Construction**	**Post-Remediation Monitoring**
NAPL-Specific Properties					
NAPL Type and Extent, Including Potential Stratigraphic Correlation It Can Influence	NAPL type (LNAPL or DNAPL), NAPL presence (lateral and vertical extent), and contamination partitioning and migration.	X	X	X	
NAPL Migration	Evaluate whether NAPL in sediment can migrate at the NAPL body scale (ASTM E3282-21a; ASTM 2022). Immobile or stable NAPL are generally suitable for capping; however, migrating NAPL may be capped if the potential for upward migration and thickness of migrating NAPL is limited. Quantifying how much NAPL could move due to consolidation requires knowledge of the NAPL saturation, thickness of sediment being consolidated, and the decrease in pore space.	X			
Occurrence of NAPL Seeps	Surface surveys for visual observations of sheens.	X		X	X
Occurrence / Rate of Ebullition-Facilitated NAPL / Contaminant Flux	Design should consider NAPL released from sediment due to ebullition-facilitated transport, buoyancy, and erosion/scour.	X		X	X

Acronyms and Abbreviations:
COC = contaminant of concern
DNAPL = dense nonaqueous-phase liquid
DOC = dissolved organic carbon
HMW = high molecular weight
K_d = adsorption-desorption distribution coefficient
K_f = Freundlich's constant
K_{OC} = organic carbon-water partition coefficient
LMW = low molecular weight
LNAPL = light nonaqueous-phase liquid
NAPL = nonaqueous-phase liquid
PCB = polychlorinated biphenyl
TOC = total organic carbon