Figure 9-1 In Situ Bioremediation of Carbon Tetrachloride CCL4 **Reductive Dehalogenation** Are conditions anaerobic? Yes No CCL4 degrades by replacement of chlorine atoms with hydrogen atoms Manipulate redox conditions in anaerobic conditions Are CCL4 degradation products present? CHCl3, CH2Cl2, CH3Cl, CH4 Yes No Yes Are dehalorespirers present? No Are competing electron ceptors present? i.e.NO₃, Fe III, Mn IV, SO₄, methane Yes Bioaugmentation Deplete competing electron acceptors Has electron donor been Yes No identified Microcosm Test to: establish appropriate redox conditions & modification, or Are potential inhibitors sent? i.e chloroform at high bioaugmentation, or No Yes A co-metabolite may have o depletion of competing be introduced to promote (200 - 300 ug/kg) electron acceptors degradation of high concentrations of CF to DCM Microcosm Test to: The rate of Confirm reactions and kinetics dechlorination from DCM -Have degradation rates been Yes No test reaction chemistry test various electron donors estimated from field data Methane - CO2 may be inadequate and another mechanism may Has stoichiometry been defined Yes No have to be established to take the degradation to completion Complete site conceptual model? Review regulatory requirements & Have permitting and approval resubmit treatability study application to authorized state or EPA Yes No requirements been identified Pilot field test Has underground injection Yes control inventory been submitted? No Is field stoichiometry adequately documented? No Is the problem biofouling, chemical imbalance, equipment malfunction or hydrologic controls? Can amendments be equately distributed & mixed? Does monitoring indicate a decrease in electron donor & appropriate mass balance www.itrcweb.org reaction rates. Yes No equations and among e-donor and degradation compounds? stoichiometry of the system Does performance testing demonstrate adequate reliability & sustainability? Yes No Have you identified and satisfied all aditional permitting Review regulatory Yes No requirements & resubmit cleanup application to authorized State or EPA requirement for full scale deployment? Scale-up, engineering design, amendment & operating, costs, electrical costs, nutrient costs

