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June 5, 2024 *via email delivery*

Todd Slater
Legacy Site Services, LLC
3553 West Chester Pike, #413
Newtown Square, PA 19073

Subject: *In Situ Stabilization Pre-Design Investigation Work Plan*
Arkema Facility, ECSI No. 398

Dear Mr. Slater:

The Oregon Department of Environmental Quality received and reviewed the May 17, 2024 *In Situ Stabilization Pre-Design Investigation Work Plan* (ISS PDI WP), prepared by Environmental Resources Management, Inc. (ERM) for Legacy Site Services LLC (LSS). The ISS PDI WP documents proposed actions to design and support the implementation of an interim remedial action measure (IRAM) to address the monochlorobenzene source area originating from the former acid plant area using ISS and/or in situ chemical oxidation (ISCO) technologies.

DEQ has the following comments on the ISS PDI WP.

General Comments

1) The ISS PDI WP must be stamped by an Oregon registered geologist or professional engineer in responsible charge of the work per Oregon Revised Statutes Chapter 672.

2) The ISS PDI WP does not present (or incorporates by reference) key information about the site characteristics, sampling collection procedures, and the scope and sequencing of treatability testing. Many of our specific comments below request specific additional information. In general, DEQ requests that LSS provide additional field sampling plan-level detail about sample collection, handling, and processing.

Specific Comments

1) **Section 1.1, Work Plan Objectives.** Revise the second objective of the IRAM 1 PDI to describe the desired outcomes of the ISS treatment more clearly. DEQ understands that the testing will evaluate changes in unconfined compressive strength (UCS), reductions in hydraulic conductivity, and changes in chemical leachability associated with different combinations and doses of reagents. The proposed testing does not appear to measure or quantify chlorobenzene mass destruction. Instead, DEQ believes LSS plans to infer chlorobenzene mass destruction indirectly based on leachability reduction in treatability testing samples treated with an oxidant.

2) **Section 1.3, Site Location and Setting.** Revise this section to include the following information:
   a) A more detailed description of the stratigraphy and hydrogeologic zones below the Acid Plant Area. The description should include soil types/grain sizes, saturated thicknesses, and hydraulic conductivities of each unit.

   b) A description of the currently understood nature and extent/conceptual site model of chlorobenzene dense non-aqueous phase liquid (DNAPL). The description should relate DNAPL observations associated with the stratigraphy and hydrogeologic zones below the Acid Plant Area. DEQ recognizes that one of the objectives of the PDI is to refine the understanding of DNAPL characteristics, and so the information presented in the ISS PDI WP is subject to revision.

   c) A conceptual cross section(s) illustrating the stratigraphy and hydrogeologic zones and generalized DNAPL nature and extent within the anticipated ISS treatment zone.

3) **Section 2.1, Identifying Boring Locations and Subsurface Clearance.** Clearly define the criteria for using an air-knife and vacuum truck to clear boring locations and to what depths locations will be cleared to before starting drilling activities.

4) **Section 2.2, Soil Sampling.** DEQ has the following comments:
   a) Provide a decision tree for additional boring attempts in the event refusal is encountered unrelated to the Basalt Zone.

   b) Provide clear definitions of DNAPL free product, ganglia, and blebs.

   c) Provide additional detail on step-down casing procedures to reduce contaminant migration between aquifers.

   d) LSS proposes collecting soil samples for chlorobenzene analysis “based on visual observations and PID readings.” Clarify the sampling strategy and the data use for these soil samples.

   e) Provide additional detail about how field personnel will conduct oil soluble dye testing.

   f) Treatability testing samples should be representative of site conditions, the DNAPL conceptual site model, and the anticipated ISS construction method to the extent possible. Provide a more detailed description of how soil will be selected and composited into samples for treatability testing to considering these factors. DEQ recommends that LSS collect separate treatability testing samples unique to the shallow zone (where DNAPL historically migrated through) and the shallow-intermediate silt and intermediate zones (where DNAPL may have pooled). These zones have different soil textures, hydraulic conductivities, and anticipated DNAPL characteristics.

   g) Describe soil sampling procedures in more detail and how they will be transported from the field to the laboratory.

h) DEQ recommends that the laboratory conduct the sample homogenization using relatively undisturbed samples collected from the field.

i) Estimate the soil volumes necessary to complete treatability testing. DEQ recommends archiving some additional homogenized soil sample volume for testing in the event of laboratory errors, grout mixing errors, unexpected cylinder cracking, or other incident, to avoid re-sampling.

j) This section references the "tank method" but does not discuss this method in further detail in Section 2.4. Clarify whether the "tank method" is proposed for treatability testing.

k) Describe the method for collecting composite soil samples for waste characterization.

5) **Section 2.4, IRAM 1 ISS/ISCO Bench-Scale Treatability Testing.** DEQ has the following comments:

a) This section identifies achieving a minimum UCS of 50 psi and achieving a reduction in hydraulic conductivity as goals of the treatability testing, but the testing regime to evaluate these parameters are not discussed (except in Tables 1 and 2). Revise the ISS PDI WP to include a narrative description of the proposed UCS and hydraulic conductivity testing, including test methods and frequencies.

b) DEQ does not necessarily agree that a two or three order-of-magnitude reduction in hydraulic conductivity is an adequate performance target. DEQ agrees that the ITRC Guidance for the *Development of Performance Specifications for Solidification/Stabilization*[1] discusses the need for ISS-treated soils to reduce hydraulic conductivity by orders of magnitude compared to the surrounding untreated soil. Section 3.2.2 of the ITRC guidance states, "In many cases, S/S treated materials with hydraulic conductivity values similar to silty clay (e.g., on the order of 10^{-7} cm/s) are desirable to reduce the potential for contaminant migration." DEQ has required ISS to achieve maximum hydraulic conductivities between 10^{-7} and 10^{-6} cm/s at other sites. Further, the ISS PDI WP does not establish a basis for characterizing the hydraulic conductivity of untreated soils, or what a two to three order of magnitude reduction would be. For context, the *GWET Wellfield Enhancement – Preliminary Design Investigation*[2] describes hydraulic conductivity estimates within individual hydrogeologic zones that range between one and four orders of magnitude. DEQ recommends further discussion of the target hydraulic conductivity reduction goals for the IRAM during the IRAM design. DEQ requests that LSS adopt a preliminary goal of reducing hydraulic conductivity to below 10^{-6} cm/s with the understanding that the design may consider alternative targets based on the treatability testing results. For example, LSS could evaluate whether an

[1] Interstate Technology and Regulatory Council (ITRC). 2011. Development of Performance Specifications for Solidification/Stabilization. July.
[2] ERM. 2021. GWET Wellfield Enhancement – Preliminary Design Investigation, Arkema Inc. Facility, Portland, Oregon. February 1.

alternative hydraulic conductivity target coupled with chlorobenzene mass destruction and COC leaching reduction can achieve overall RAOs.

c) In addition to UCS, hydraulic conductivity, leachability, and swell (volumetric expansion), DEQ requests LSS consider other tests that may relate to construction specifications or material workability (i.e., slump).

d) During each phase of testing, the laboratory should visually inspect treated soil cylinders for evidence of free liquids, sheens, supernatants/gels, and DNAPL, in addition to cracking or other evidence of physical degradation and record their observations.

6) **Section 2.4.2, Phase 2 Treatability Testing.** DEQ has the following comments:
a) Provide additional discussion of the factors that will be considered to select grout mix designs to advance into Phase 2 testing.

b) Grout curing is an exothermic reaction that may result in significant volatile organic compound (VOC) off-gassing. DEQ requests that LSS monitor VOC off-gassing from grout treated soils during the Phase 2 treatability testing. Monitoring of VOC off-gassing from grout-treated soils is simple to accomplish. One test cylinder of grout-treated soil can be placed inside a plastic bag and headspace air samples can be collected from a tube inserted into a small opening in the bag. Gas measurements can be collected using hand-held instruments (e.g., Draeger tubes, PID, etc.). Frequency on similar scopes of work typically collect measurements for these cylinders directly after preparation of the canister, after 24 hours, and again after 72 hours of curing time.

7) **Section 2.7, Quality Assurance and Quality Control.** Clarify whether LSS is proposing to conduct duplicates of any of the treatability tests.

8) **Table 1, Phase 1 In Situ Stabilization Test Conditions and Analyses.** DEQ requests addition testing of oxidation/reduction potential, total organic content, and dissolved organic content for baseline samples and ISCO-only samples.

9) **Table 2, Phase 2 In Situ Stabilization Test Conditions and Analyses.** DEQ requests addition testing of oxidation/reduction potential, total organic content, and dissolved organic content during the Phase 2 treatability testing.

10) **Figures 2, 3, & 5.** Indicate and label the location of the preliminary IRAM 1 Treatment Area.

EPA has reviewed the ISS PDI WP. EPA's comments are enclosed and should be considered. Please contact me at 503-860-3943 or by email at Katie.Daugherty@deq.oregon.gov if you have any questions.

Sincerely,

Katie DAUGHERTY

Katie Daugherty, R.G.
Project Manager
Cleanup Program
Northwest Region

Enclosure (EPA Comments)

ecc David Lacey, DEQ
Wes Thomas, DEQ
Laura Hanna, EPA
Brendan Robinson, ERM
Josh Hancock, ERM
Sarah Seekins, ERM

REGION 10
SEATTLE, WA 98101

June 5, 2024

MEMORANDUM

SUBJECT: Comments on the In Situ Stabilization Pre-Design Investigation Work Plan
Arkema Inc. Facility, Portland, Oregon
ECSI # 398
May 17, 2024

FROM: Laura Hanna, RG, Remedial Project Manager
Superfund and Emergency Management Division, EPA

TO: Katie Daugherty, RG, Project Manager
NWR Cleanup, Oregon Department of Environmental Quality

The following are the U.S. Environmental Protection Agency's (EPA's) comments on the document titled *In Situ Stabilization Pre-Design Investigation Work Plan* (ISS PDI Work Plan). The ISS PDI WP was prepared by Environmental Resources Management, Inc. (ERM) for Legacy Site Services LLC. The Former Arkema Inc. Facility (site) is located at 6400 NW Front Avenue in Portland, Oregon and listed as Environmental Cleanup Site Information (ECSI) #398. The site is located adjacent to the Willamette River upland of the River Mile 7 West (RM7W) remedial design project area within the Portland Harbor Superfund Site (PHSS). The ISS PDI Work Plan has been prepared to describe investigation sampling and activities at the site to inform the pre-design of Interim Remedial Action Measure (IRAM 1). EPA understands the goal of IRAM 1 is to address the monochlorobenzene source area using in situ stabilization/solidification (ISS) and/or in situ chemical oxidation (ISCO) technologies, and the treatment area of IRAM 1 focuses on dense nonaqueous-phase liquid (DNAPL) present in soil and groundwater.

EPA's comments are categorized as "Primary," which identify concerns that must be resolved to achieve the objective; "To Be Considered," which, if addressed or resolved, would reduce uncertainty, improve confidence in the document's conclusions, and/or best support the objectives; and "Matters of Style," which substantially or adversely affect the presentation of the technical information provided in the report.

Primary Comments

1. The work plan does not provide a means to investigate the bedrock surface (if consistent with the CSM). As a dense NAPL (density = 1.11 g/mL), chlorobenzene will accumulate within bedrock lows or on low permeability layers if present. Please indicate within the Work Plan how the bedrock surface will be investigated. For example, if one or more of the 20-30 borings indicate a bedrock (or low hydraulic conductivity [K] layer) low with DNAPL a procedure should be in place to map out the extent of the low area. Geophysical techniques could also be used as a guide to locate borings depending on the CSM.

2. The work plan should include a QAPP that addresses QA/QC requirements, includes standard operating procedures (SOPs) and additional information on the treatability testing procedures and processes. While not an exhaustive list, EPA recommends the following information should be provided in a revised ISS PDI Work Plan:

    a. Sample containers, preservatives, holding times, methods, reporting limits, and method detection limits.

    b. Details concerning sample selection from cores for actual testing and formulating mixtures; including an explanation on how the samples selected for analysis will be handled to prevent or minimize volatilization,

    c. Criteria for sample selection, lab processing, compositing, homogenization, subsampling, number of samples, etc.; General subsampling procedures should reference ASTM D6323 with a preference for riffle splitting,

    d. EPA recommends that detailed evaluations of leaching tests and associated leaching and overall performance criteria be included, including the modified SPLP procedure. Additional testing conditions/modifications typically incorporated into the testing may include those in ASTM C1308 and in "The Tank Test" (Environmental Agency EA NEN 7375:2004)

    e. EPA recommends if NAPL is identified by visual indicators (i.e., blebs; coated or saturated soil) a shake test should be administered. A shake test should be administered for each interval with visible NAPL. ASTM International E3281 – 21, Standard Guide for NAPL Mobility and Migration in Sediments – Screening Process to Categorize Samples for Laboratory NAPL Mobility Testing should be followed for NAPL identification and for performing a shake test.

    f. EPA recommends including the reference ASTM E3281-21a Section 10.4 when discussing the Sudan IV and Oil Red O dye.

3. <u>Section 2.2 Soil Sampling</u> – Add section to describe geologic units. The ISS PDI Work Plan mentions that each boring will be drilled and cased off when the different units are encountered (shallow intermediate silt, intermediate, and deep zones) but do not provide insight into how they will determine these units in the field. The geologic unit descriptions would provide context for field staff to know what unit they are in.

a. The UCS test method is listed as D2166 but ITRC (2011) lists D1633 as the preferred method. Explain the rationale for using D2166 over D1633. Additional consideration should be given for index testing of soil before amendment mixing including water content, Atterberg limits, sieve analysis, hydrometer analysis, specific gravity, total organic carbon, sulfate, chloride, bulk density. These are important parameters to consider in mix design (e.g., sulfate content can affect the performance of the cement; selection of cement type may depend on the amount of sulfate; chloride content can affect the performance of the bentonite). In addition, changes in temperature should be noted and any odor generation. The amount of swelling is important and hazardous waste characterization should be conducted if off-site disposal of the back flow from the swelling during ISS is necessary.

To Be Considered

1. EPA recommends inclusion of bentonite in the treatability testing to achieve hydraulic conductivity criteria and assist the in situ mixing. Note: Cement alone may not be an effective amendment in achieving a hydraulic conductivity performance criterion. An effective amendment in achieving a hydraulic conductivity criterion is bentonite. Bentonite is also more cost-effective (1-2 % reagent dose) compared to cement (5-15 % reagent dose) and also an important lubricant to enable adequate in situ mixing.

2. The Work Plan would benefit from a Data Quality Objectives (DQOs) section. DQOs should be written using the EPA guidance document "Guidance on Systematic Planning Using the Data Quality Objectives Process EPA QA/G-4, EPA/240/B-06/001 February 2006" or a more recent update of this guidance, if available.

3. Introduction – The use of ISCO for NAPL is possible, but challenging and generally requires high doses of oxidant (ITRC 2005). ISCO may effectively supplement ISS, but probably will not replace ISS. Please remove the "/or" from "and/or" in this sentence.

4. Section 2.2 Soil Sampling, 2nd bullet – There should be an additional category for samples with no evidence of DNAPL, but a positive PID reading.

References

EPA. 2006. *Guidance on Systematic Planning Using the Data Quality Objectives Process EPA QA/G-4*. EPA/240/B-06/001 February.

Interstate Technology Regulatory Council (ITRC). 2005. Technical and Regulatory Guidance for In Situ Chemical Oxidation of Contaminated Soil and Groundwater.

Interstate Technology and Research Council (ITRC). 2011. *Development of Performance Specifications for Solidification/Stabilization. S/S-1. Washington, D.C.: Interstate Technology & Regulatory Council, Solidification/Stabilization Team*. July.

EPA, 2011. Environmental Cleanup Best Management Practices: Effective Use of the Project Life Cycle Conceptual Site Model. EPA 542-F-11-011. July 2011.

cc: David Lacey, DEQ
Wes Thomas, DEQ
Katie Young, CDM Smith
Scott Coffey, CDM Smith