UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

September 2, 2011
Mr. James R. Erickson, P.G.
Vice President, Principal Hydrogeologist
Tetra Tech GEO
363 Centennial Parkway, Suite 210
Louisville, CO 80027

Dear Mr. Erickson:

Thank you for the May 24, 2011, submittal entitled "Former Process Area In-Situ Geochemical Stabilization Remediation Demonstration Project Work Plan for Hawthorn Group Deposits, Former Koppers, Inc. Site, Gainesville, Florida." Our comments on this submittal are as follows:

1. All dense nonaqueous phase liquids (DNAPL) impacted zones encountered in the boring DNAPL identification phase in the Upper Hawthorn should be treated. While it may be Beazer East's intent to do so, it is unclear in the Work Plan that the intention of the demonstration is to treat all DNAPL. For treatment purposes, it is unimportant the specific type of DNAPL that is identified but that it all be treated. Observation of whether DNAPL flows freely from a core (category 4) vs. forming droplets when sprayed with water (category 3) may provide some relative indicator of mobility. However, it will not be possible to tell whether the DNAPL is above or below residual saturation under in-situ conditions based on this test. It is not possible to make a definitive visual determination of its state of saturation quantitatively. Quantitative data should be collected regarding DNAPL mass in the cores to help determine the mobile/residual nature of the DNAPL. For instance, some portion of the universe of soil cores collected should be analyzed with EPA Standard Reference Test Method 8260 or 8310.

2. The injection of ISGS reagent will likely displace groundwater. This may result in a temporary decrease in groundwater contaminant concentrations in and around the source areas due to flushing.
   a. Please update the Work Plan to address the fate of the contaminated groundwater that will be displaced from the Former Process Area.
   b. Please update the Work Plan to include the use of a conservative tracer within the injected ISGS fluid to identify the quantity of recovered injected ISGS fluids in each sample. That should make it possible to correct the creosote COC concentrations for dilution by the injected ISGS fluid.

3. One concern with Phase III of the Work Plan is that, after the ISGS field-scale demonstration is completed and current Work Plan is implemented, there will be insufficient data to determine the degree to which the demonstration project has decreased contaminant mass flux from the treated area. At a minimum, the Work Plan should include the following:
   - UHG DNAPL Producing Wells
   - UHG Dissolved Flux wells
   - Post Treatment Cores
   - Specific performance criteria by which success will be evaluated

   All of the performance evaluation wells should be installed before injection of the ISGS solution begins so limited but important baseline information can be collected. The Work Plan should contain milestones with specific performance criteria. Failure to meet these criteria at any point should trigger re-evaluation.

4. We request that the following information be provided for the manganese dioxide minerals that are expected to be formed through the ISGS process:

   - Balanced stoichiometric reactions showing the specific minerals formed through the ISGS process;

   - Applicable Gibbs free energy or other calculations showing that the formation of these minerals is geochemically and thermodynamically favored under the conditions expected and concentrations of reagents to be applied at the Koppers site;

   - An Eh-pH diagram for the anticipated minerals (RemOx, EC precipitates);

   - Field data that show the variability in the types of manganese dioxide minerals formed through injection of RemOx EC using injection methods similar to those proposed for the Koppers site. In particular, data that show the relative quantity of silica-modified manganese dioxide solids versus non-silica modified manganese dioxide solids would be helpful;

   - A discussion of factors that may interfere with formation of the desired minerals and which of these factors are expected to interfere with desired mineral formation at the Koppers site. These factors may include variations in Eh, ORP, pH, TDS, aquifer minerals or geochemistry, competing reactions, changes in oxidant or silicate concentration as a function of distance from the injection point, or other factors. Any information about the bioavailability of the manganese in the minerals formed or testing done to assess its ability to act as an electron acceptor in the presence of naphthalene or other organic substrates.

5. The Work Plan should include a schedule that specifies milestones for evaluating performance of the ISGS remedial alternative. Milestones should be decision points that determine whether the ISGS injection is achieving specified performance goals. If ISGS fails to meet performance goals at any milestone then corrective action will be required. This corrective action may include adjustment of the ISGS approach or switching to in-situ stabilization/solidification. Milestones and the criteria for milestone evaluation are included in Table 1. Milestones should be set at the following points in time at a minimum:

a. Source Area Characterization (prior to treatment) – to characterize the DNAPL architecture, i.e., the spatial distribution of the creosote, treatment zone hydrogeology and establish baseline mass flux values;
b. After Pre-Demonstration Pilot Test – to assess ISGS delivery and permeability reduction at the pilot-test scale;
c. Immediately Post-treatment (i.e., after full-scale "demonstration") – to assess ISGS delivery and permeability reduction at the full-scale;
d. Short-term (12-18 months post-injection) – to demonstrate reduction in DNAPL recovery, dissolved flux and permeability reduction;
e. Mid-term (36 months post-injection) – continue demonstration of reduction in DNAPL recovery, dissolved flux and permeability reduction; and
f. Long-term – on-going monitoring to assess mass flux reduction & long term stability of encapsulation and permeability reduction (periodically thereafter – minimally at the required 5-year review).

6. The Phase II Pre-Demonstration ISGS Injection testing which precedes the "field-scale demonstration project" is a critical milestone in the Work Plan. Delivery and distribution of the ISGS reagent must be demonstrated at this stage for ISGS to be viable for full-scale demonstration. We recommend that performance assessment of these pilot tests occurs three months after their completion. Evaluation of the pilot test performance will be the only opportunity available to evaluate performance of the ISGS system before moving to the "field-scale demonstration project". Therefore, it is critical that the Work Plan be revised to reflect the importance of the Phase II pilot tests.

7. Section 3.1.1.1 proposes using field reconnaissance and review of historical maps and air photos to identify subsurface structure in the former Process Area. EPA believes that there are additional approaches to identify subsurface structures. For example, buried iron pipes might be detected with a magnetometer, and other simple surface geophysical instruments might prove useful in detecting subsurface anomalies that might be indicative of buried structures.

8. In Section 3.1.3, the Work Plan proposes to test short term and long-term ISGS reagent exposure on three samples of "DNAPL-rich" earth material and three samples of "DNAPL-poor" earth material (total of 12 samples tested). EPA recommends having

five samples per batch of material tested, for a total of 20 samples. This additional testing would result in a more robust data set from which to draw conclusions and would also be consistent with the proposed five samples to be tested for soil oxidant demand (Step 1, Section 3.1.3).

9. In Appendix A Section 2.1, the text states "Grain-size analysis of the upper HG deposits indicate the use of 20/30 mesh silica sand filter pack with 0.020-inch opening (20-slot) screen." This statement is made with regard to the construction of the proposed new DNAPL recovery wells. In Section 2.0 of Appendix B, a different screen slot size and filter pack gradation is proposed for new monitoring wells. In Section 2 of Appendix C, yet another screen slot size and filter pack gradation is proposed for the temporary injection points. Regardless of well function, it would appear that the appropriate screen slot size and filter pack would be based on the grain size distribution of the surrounding aquifer material. Please provide a rationale for proposing different screen opening size and filter pack size for the different wells in Appendix B and again in Appendix C.

10. EPA notes that in the proposed soil core permeability testing (Appendix D, Task 2), injection will likely be on soil cores oriented vertically. Under such conditions, intrinsic hydraulic conductivity in the "z" direction (Kv) is likely to be an order of magnitude or so lower than the hydraulic conductivity in the x/y directions (Kh). It is unclear how the laboratory hydraulic conductivity testing will provide a valid picture of the response of the aquifer materials to treatment with the ISGS solutions in this situation. Please provide clarification addressing this issue.

11. With regard to Appendix D, Task 2, some explanation is needed regarding the statement "At GeoTrans discretion, or if site soils are found to plug, a range of coarser geologic media (e.g., medium to coarse sands) may be used to conduct the tests." This statement appears to indicate that in order to evaluate the change in hydraulic conductivity imparted by the ISGS treatment, geologic materials that are coarser grained than native sediments would be used to determine permeability reductions and the results extrapolated to less permeable Site sediments. EPA does not support this approach because of the complexities in the hydraulic conductivity-grain size relationship created by differential grain shapes and packing of fines in a sediment versus grain shape and packing of sand sized particles, and microscale soil textural variations. Please provide clarification as to how the use of coarser geologic media not collected from the Site would provide accurate information related to Site-specific hydraulic conductivity.

12. On Page 1, Section 1.0 of the Work Plan, the text indicates the expectation that manganese dioxide precipitates will form as a result of reactions between the permanganate and NAPL. According to the surficial aquifer pilot study report, precipitates were dominated by alumino-silica oxyhydroxides. Manganese (Mn) precipitates were rare. Please provide GeoTrans reasoning for the belief that the pilot test in the Upper Hawthorn will produce Mn precipitates and not the more stable alumino-silica oxyhydroxides.

13. On Page 23, Section 3.3. of the Work Plan, the text notes that success will in part be measured by reductions in DNAPL mobility. Given that information suggests that the NAPL currently has limited mobility (with low recovery rates in extraction wells), measurable reduction in NAPL mobility is, at best, a minimal standard of success. The true measure of success will be demonstrating long-term effectiveness, as supported by evidence of formation of stable precipitates and no rebound in contaminant concentrations. At present, the Work Plan contains no provision for characterizing the composition of the precipitates (in contrast to the approach taken during the previous pilot). If any uncertainty exists about which precipitates will form (potentially unstable MnO_2 or stable alumino-silica oxyhydroxides), the Work Plan should be updated to establish precipitate composition as an effectiveness measure.

14. On Page 24, Section 3.3.1. of the Work Plan, the slug test task discussion appears to suggest that there may be a result of no measurable reduction in permeability. If there is a concern that slug tests in wells with 10-ft screens will not be able to measure permeability reductions in the 1-2 ft treated zones, then the solution is to install monitoring wells with short (2 feet) screens.

15. Section 1.0, p. 1 and Associated ISBS Pilot Study Report (2009), p. 7, third paragraph and Appendix B, Sections 1.0 and 5.0: The conclusions reached in Appendix B from the characterization of precipitates from the sediment from Pilot Study using the ISGS treatment at the Gainesville site and summarized on p. 7 of the Pilot Study Report and p. 1 of the Work Plan are that the precipitates formed are "crystalline aluminum silicate hydroxide typically containing a range of elements at trace levels, including Mg, P, S, Cl, K and Ca. Occasionally, Ti, Mn and Fe were also detected at trace levels in the coating. Aluminum silicate oxyhydroxides are not expected to be affected by changes in the redox potential of the aquifer in the same manner as Fe and Mn oxyhydroxides, and, therefore, are not likely to undergo reductive dissolution if the redox conditions become anoxic over time". In Appendix B are the following descriptions of the additives beyond sodium permanganate that were added in the pilot study ("Either a 4.5% RemOx® EC Stabilization Reagent (RemOx) (Carus Chemical Company) containing sodium permanganate, calcium silicate and sodium choride (in the DIP area) or a 10% sodium permanganate mixed with an ISBS catalyst solution containing calcium chloride, ferrous carbonate and sodium silicate (in the TIP area) was injected into the aquifer" p. 2, Appendix B).The following are not clear:

A. As aluminum was not one of the materials in the additives, it is not clear if the formation of the aluminum silicate oxyhydroxides precipipates described in the characterization are partiallly due to the presence of aluminum in the pilot study specific sediment materials. Therefore, it is not clear that the apparently stable aluminum silicate oxyhydroxides are particular to the pilot test sediment or can be extended to sediments in different areas of the site where aluminum may not be available. Please comment as to the specificity of the aluminum silicate oxyhydroxide precipitates and the extension of the results in the pilot study (including the apparent stability of these precipitates) to other areas of the site, including the Former Process Area.

B. Please describe the reasoning behind the statement that the aluminum silicate oxyhydroxides are stable (will not undergo reductive dissolution if the redox conditions become anoxic over time).

16. It would be useful to characterize the precipitates to correlate the long-term stability of the precipitates with the type of precipitates (and specifically characterize the stability of the aluminum silicate oxyhydroxides), if these precipitates form in the treatment of the former Process Area.

We look forward to working with you on implementation of this Work Plan. If we may be of assistance, please contact me at (404) 562-9120 or via Internet e-mail at miller.scott@epa.gov.

Sincerely,

Scott Miller
Remedial Project Manager
Superfund Remedial Branch
Section C

TABLE 1

Koppers- Proposed ISGS Milestones and Performance Criteria

Milestone	Performance Goal	Demonstration Method	Success indicators	Failure indicators	Notes/Comments
Source Area Characterization (*before Pre-Demonstration Pilot test)*	**Baseline** - Determine aquifer baseline pre-treatment conditions in Surficial, Upper Hawthorn, and Lower Hawthorn aquifer units	1) SA, UHG & LHG cores; 2) UHG & LHG dissolved groundwater analytical data; 3) UHG DNAPL Flow into wells; 4) Slug/ pumping tests	NA	NA	Baseline data to which post-treatment data will be compared. Requires UHG & LHG cores, and installation of DNAPL producing wells in UHG (&LHG if applicable), & dissolved phase wells in UHG & LHG. See notes[1, 2, 3].
	DNAPL Distribution -Determine DNAPL distribution and architecture vertically and horizontally in Surficial and Upper Hawthorn	Same	NA	NA	Same
Pre Demonstration Pilot Test (*Success must be demonstrated before initiating full-scale demonstration test)*	**ISGS Delivery** - Consistent, controlled delivery and distribution of ISGS injectate throughout designated treatment area; i.e. good "sweep" of ISGS injectate.	1) Field observations demonstrating control 2) Cores show ISGS injectate contacted all the DNAPL zones with good sweep and no significant by-passing of DNAPL zones. 3) Conservative tracer in ISGS injectate 4) GW monitoring (see Notes[1,2,3])	1) No liquefaction, maintain control of injection pressures 2) Injectate contacts all DNAPL zones identified in cores. Cores show 80% coverage of precipitate encrustation in the DNAPL zones 3) Conservative tracer and purple ISGS show good sweep/ROI in MWs/recovery trenches 4) Compliance with UIC ZOD laterally and vertically	1) Liquefaction of soil; loss of injection pressure control or insufficient injection rate, 2) Injectate failed to contact all DNAPL zones identified in cores and/or less than 80% encrustation of DNAPL. By-passing by injectate. 3) Uneven distribution of tracer 4) UIC exceedances, 5) Groundwater analytical data indicating ISGS failure	Use previously installed monitoring wells to assess distribution and treatment success. Inspection of cores supported by thin section analysis/ documentation. 1) without adequate DNAPL/injectate contact the remedial alternative can not succeed and 2) decision to proceed to full-scale demonstration of ISGS or switching to ISS/S - will be determined at this milestone.
	Permeability Reduction - Reduction in permeability and encapsulation of DNAPL to minimize DNAPL mobility	Pre and post treatment slug test/pump test in treatment zone	Reduction in hydraulic conductivity	minimal change in hydraulic conductivity	Slug /pump test to confirm significant reductions in both horizontal and vertical hydraulic conductivity and specific yield sufficient to curtail contaminant flux
		Pre and post pilot test water level measurements in MWs/piezometers in source and perimeter area	Significant change in hydraulic gradients throughout the UHG, velocity due to reduced permeability in source area	No change in hydraulic gradients or velocity	MWs/piezometers to be installed in both surficial, UHG and LHG (see note 2)

TABLE 1

Koppers- Proposed ISGS Milestones and Performance Criteria

Milestone	Performance Goal	Demonstration Method	Success indicators	Failure indicators	Notes/Comments
Immediate Post-Demonstration ISGS Reagent Injections ***(3 months after final demonstration project injection)***	**ISGS Delivery** - Consistent, controlled delivery and distribution of ISGS injectate throughout designated treatment area; i.e. good "sweep" of ISGS injectate.	1) Field observations demonstrating control 2) <u>Cores: Minimum of 30 cores through entire treated interval 3 months after injection.</u> 3) Conservative tracer in ISGS injectate 4) GW monitoring	1) Little liquefaction, 2) Cores show precipitate encrustations where DNAPL is present, 3) Contact of MnO2 injectate with 80% or more of DNAPL in Immediate Post-Treatment cores. 4) Compliance with UIC ZOD laterally and vertically 5) Bromide and purple ISGS show good sweep/ROI in MWs and recovery trenches	1) uneven distribution of injectate in cores, 2) Insufficient contact between injectate and contaminants (contact of MnO2 injectate with less than 80% of DNAPL in Immediate Post-Treatment cores) 4) Uneven distribution of tracer	This is a critical decision point that will be largely based on how well the injectate was delivered to the DNAPL. Installation of appropriate monitoring points is required to assess distribution and treatment success (see notes[1,2]). Inspection of cores supported by thin section analysis/ documentation.
	Permeability Reduction - Reduction in permeability and encapsulation of DNAPL to minimize DNAPL mobility	Pre and post treatment slug test/pump test in treatment zone	Reduction in hydraulic conductivity	No change in hydraulic conductivity	Slug /pump test to confirm significant reductions in both horizontal and vertical hydraulic conductivity and specific yield sufficient to curtail contaminant flux
		Pre and post pilot test water level measurements in MWs/piezometers in	Significant change in hydraulic gradients throughout the UHG, velocity due to reduced	No change in hydraulic gradients or velocity	MWs/piezometers to be installed in both surficial, UHG and LHG (see note 2)
	DNAPL Recovery - Decline in rate of DNAPL recovery	Continue method of DNAPL monitoring used during pre-test characterization.	Early and significant decline in rate of DNAPL flow to wells.	Increase in flow of DNAPL to wells or little change in DNAPL flow rate.	Early and significant decline in rate of DNAPL flow to wells is expected.
	LHG water quality	Sampling LHG monitoring wells.	NA	Significant negative change in water quality, ISGS solution, or ISGS tracers in LHG wells.	No change of water quality in LHG is expected at this early stage of remedial actions.
Short-term perf criteria *(1st 12-18 months after final demonstration project injection)*	**Permeability Reduction** - Reduction in permeability and encapsulation of DNAPL to minimize DNAPL mobility	Pre and post demostration test water level measurements in MWs/piezometers in source and perimeter area	Change in potentiometric surface, velocity due to reduced permeability in source area	No change in potentiometric surface or velocity	MWs/piezometers to be installed in both surficial, UHG and LHG
	DNAPL Recovery - Decline in rate of DNAPL recovery	Continue monitoring DNAPL recovery in UHG wells & compare with pre-test data.	Continued decline in rate of DNAPL flow to wells.	1) No material reduction in DNAPL recovery , 2) Appearance of DNAPL in previously unaffected MWs	Continued decline in DNAPL flow is expected.

TABLE 1

Koppers- Proposed ISGS Milestones and Performance Criteria

Milestone	Performance Goal	Demonstration Method	Success indicators	Failure indicators	Notes/Comments
	Dissolved COC Flux - Significant reduction in contaminant flux both vertically and laterally	Pre-test and Quarterly post-treatment groundwater sampling with trend analysis	Pronounced and lasting reduction in dissolved GW contam concentrations and mass flux indicating isolation of source, laterally and vertically	1) No significant reduction in GW contam conc and mass flux, laterally and vertically, 2) Vertical contaminant migration w/ increased GW concentrations in deeper MWs, 3) GW contamination observed in nearby Floridan Aquifer MWs	Attainment of goal demonstrated by sampling of MWs and use of PFM (flux meters).
	Compliance with UIC	Pre-test and post treatment groundwater monitoring	1) No unpermitted migration of ISGS components beyond ZOD laterally or vertically, 2) No ISGS solution observed beyond ZOD, laterally or vertically.		Work plan must include contingency plan to address uncontrolled migration of ISGS injectate or contaminant plume migration
Mid-term perf criteria *(begins after short term performance criteria are met and extends for 3 years)*	**Permeability Reduction** - Continued reduced permeability/encapsulation of DNAPL	Measurement of groundwater water levels and hydraulic conductivity	1) continued potentiometric responses that reflect reduced hydraulic conductivity, 2) Continued reduced GW flow into trenches and perimeter wells	Groundwater flux into trenches/wells returns to pre-treatment levels	
	DNAPL Recovery - Cessation of lateral/vertical DNAPL migration	Monitoring of DNAPL recovery in surficial (once the surficial ISGS pilot is completed), UHG, LHG	Deeper MWs continue to show decline in contaminant concentrations	1) Increased contaminant concentrations downgradient, 2) Newly observed contamination in deeper MWs or Floridan aquifer MWs	
	Dissolved COC Flux -Continued reduction in mass flux, both laterally and vertically.	Quarterly GW monitoring including recovery trenches/wells	1) GW monitoring shows continued reduction in COC concentrations, 2) No inferred DNAPL concentrations , 3) No observed contamination in nearby Floridan aquifer wells.	1) Rebound of contaminants in GW, 2) Reappearance of inferred or observed DNAPL, 3) GW contamination observed in nearby Floridan Aquifer MWs.	

TABLE 1

Koppers- Proposed ISGS Milestones and Performance Criteria

Milestone	Performance Goal	Demonstration Method	Success indicators	Failure indicators	Notes/Comments
	Compliance with UIC	Post treatment groundwater monitoring	1) No unpermitted migration of ISGS components beyond ZOD laterally or vertically, 2) No ISGS solution observed beyond ZOD, laterally or vertically.		Contingency plans are implemented to address uncontrolled ISGS or contaminant plume migration.
Long-term perf criteria *(begins after short term performance criteria are met and extends for duration of pilot and O&M of final remedy if ISGS is selected)*	**Permeability Reduction** - Reduced permeability/encapsulation of DNAPL is maintained	Measurement of groundwater water levels and hydraulic conductivity	1) Continued potentiometric responses that reflect reduced hydraulic conductivity, 2) Continued reduced GW flow into trenches and perimeter wells	Groundwater flux into trenches/wells returns to pre-treatment levels	
	DNAPL Recovery - Cessation of lateral/vertical DNAPL migration is maintained	Monitoring of DNAPL recovery in surficial, UHG, LHG	Deeper MWs showing decline in contaminant concentrations is maintained. COC concentrations that indicate no nearby DNAPL in monitoring wells inside slurry wall are maintained.	1) Dissolved concentrations indicating DNAPL inside slurry wall where not previously observed, 2) Increasing concentrations outside slurry wall or beneath treated zone indicating nearby DNAPL.	
	Dissolved COC Flux - Maintained reduction in mass flux, both laterally and vertically.	GW monitoring including recovery trenches/wells	1) GW monitoring shows reduction in COC concentrations is maintained, 2) No inferred DNAPL concentrations , 3) No observed contamination in nearby Floridan aquifer wells.	1) Rebound of contaminants in GW, 2) Increased contaminant concentrations downgradient or outside the slurry wall, 3) Newly observed contamination in deeper MWs or Floridan aquifer MWs .	

TABLE 1

Koppers- Proposed ISGS Milestones and Performance Criteria

Milestone	Performance Goal	Demonstration Method	Success indicators	Failure indicators	Notes/Comments
	Compliance with UIC	Post treatment groundwater monitoring	1) No unpermitted migration of ISGS components beyond ZOD laterally or vertically, 2) No ISGS solution observed beyond ZOD, laterally or vertically.		Contingency plans are implemented to address uncontrolled ISGS or contaminant plume migration

[1] Adequate characterization of DNAPL and groundwater contaminant levels in surficial, UHG, LHG and FL aquifer including installation of new monitoring wells in both Process Area and South Lagoon will be conducted prior to pre-demonstration pilot test and will be included in pre-pilot baseline sampling.

[2] Purpose of the MWs is to support design of pre-demonstration pilot test, evaluation of effectiveness of ISGS and demonstrate compliance with UIC. Monitoring wells will be installed within source areas, ISGS pre-demonstration pilot treatment area, and at perimeter of source areas.

[3]Groundwater Monitoring - Parameters monitored to evaluate ISGS performance should include the following: field parameters (dissolved oxygen, oxidation reduction potential [ORP], pH, specific conductance, temperature, turbidity), total and dissolved metals (Fe and Mn in particular), nitrate/nitrite, sulfate, sulfide, TOC, carbon dioxide, and alkalinity. It is particularly important to establish the natural background concentration of manganese in all aquifer zones prior to initiating RemOx EC injections. The full list of organic COCs and arsenic should also be analyzed.