Ryan, Nancy D - DNR

From: Scott Tarmann <starmann@ramboll.com>
Sent: Wednesday, May 11, 2016 11:24 AM
To: Ryan, Nancy D - DNR
Cc: wscott@mzmilw.com; Jeanne Tarvin
Subject: Former Express Cleaners Site - Racine, WI
Attachments: REH Proposal Addendum_Express Cleaners.pdf

Dear Nancy:

Per the request of Bill Scott, please find the attached June 8, 2015 Proposal Addendum that was prepared to address questions regarding the structural integrity of blended soil after treatment and Ramboll Environ's project summaries on similar projects where we successfully utilized zero-valent iron. In preparation for our meeting on May 26th, we plan on bringing handouts and/or presentation materials in support of our proposed approach and cost estimate presented in our May 29, 2015 proposal.

Please let us know if you have any questions or require any additional information.

Yours sincerely,
Scott Tarmann, PE

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ENVIRONMENT & HEALTH

Additional Information Requested
Former Express Dry Cleaner Site
June 8, 2015

Ramboll Environ US Corporation (Ramboll Environ) has provided this addendum to respond to two requests. The first request was to provide more information on the structural integrity of the blended soil after treatment and the second request was to provide project summaries on similar projects where we successfully utilized Zero- Valent Iron (ZVI). The following paragraphs provide our response to these two requests.

Structural Integrity of Post Blended Soils

The blending process inherently loosens and reduces the structural stability of the soil, and as a result, the blended soil may require stabilization and/or specialized foundation design to facilitate site redevelopment on the blended soil. Fly ash, quicklime, or portland cement can be added after blending as a stabilizer to sufficiently strengthen the soil to allow for redevelopment.

Post-blending soil stabilization of the treated soils is not included in the Ramboll Environ proposal dated May 29, 2015, because of the absence of future building construction plans, location, layout, and foundation requirements needed for us to specify a soil stabilization method. Therefore, we assumed that alternate foundation considerations would be considered such as piles, floating slabs, piers, etc. for any portions of the building that would be constructed over the blended soil area. Furthermore, as the soil blending is limited to a maximum depth of 9 feet below grade, we proposed that the soil would be stabilized using simple compaction and/or roller equipment immediately after blending. We have the expertise on staff to assist with identifying and evaluating alternatives for providing soil stabilization based on review of specific site redevelopment plans. We would be willing to work with the building designer on potential options to consider any soil stabilization, building foundation, and potential site layout alternatives, if necessary.

Project Summaries

Ramboll Environ has successfully implemented *in-situ* enhanced reductive dechlorination technology using ZVI as well as soil blending to remediate sites impacted with chlorinated volatile organic compounds (CVOCs) on two key projects in Wisconsin. Full project summaries for these two key successful Wisconsin projects are provided. In addition, we have provided summaries of remedial projects completed in other states where ZVI has been used to achieve site closure.

Ramboll Environ has also remediated numerous other CVOC-impacted sites by applying *in-situ* enhanced reductive dechlorination technology using carbon amendment alone without the use of ZVI. The use of ZVI combines chemical and biological reduction that can function synergistically by creating a strongly reducing environment that thermodynamically promotes biological reductive dechlorination. It should also be noted that the proposed ZVI application approach, *in-situ* soil blending, allows for substantially greater ZVI dosing and superior ZVI contact with impacted soil and groundwater than the successful case studies presented below that solely relied on hydraulic injection. The proposed *in-situ* soil blending approach using ZVI is well-documented in the scientific literature as ranking among the most aggressive remedial technologies for effective treatment of CVOC-impacted soil and groundwater.

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Project Title: Chlorinated Solvent Remediation Using Zero-Valent Iron (ZVI)

Project Duration: 2012 to present, anticipated closure 2015

Project Location: Appleton, Wisconsin

Project Reference: Jeff Van Thiel, Great Northern Corporation, (920) 739-3671

Services: Since 2012, Ramboll Environ (formerly ENVIRON International Corporation [ENVIRON]) has provided investigative and remedial action services to Great Northern Container (GNC) focusing on developing a cost-effective strategy to quickly remediate CVOCs in a tight clay environment.

Project Description: A former spill containment manhole was uncovered during construction work. The former spill containment manhole was the secondary containment structure for a former hazardous waste storage area on the site. Investigation activities conducted by ENVIRON in 2012 around the manhole determined that the soil and groundwater were impacted with CVOCs. Under the oversight of ENVIRON, a combination soil source excavation and an *in-situ* enhanced reductive dechlorination remedial option was implemented at the low permeability (clay soil) site. The implemented remedial action at the site included hydraulic probe injection of ZVI and carbon substrate in May 2013. The on-site injection of carbon amendment and ZVI (commercially known as "Anaerobic BioChem Plus® [ABC+]) was conducted from April 30 through May 3, 2013. A total of 36 injection points (6 feet on center) were advanced using a direct push drill rig, targeting a zone from 20 feet below ground surface (bgs) to 3 feet bgs. This injection approach was designed to effectively disperse the amendment vertically through the soil column below the water table. A total of 2,200 pounds of ABC+ product was injected. No day lighting of injected fluids occurred as part of the injection event.

In August, 2013, approximately 700 gallons of accumulated water from the former spill containment manhole was extracted and disposed of off site. The former spill containment manhole and a total of 125.02 tons of soil were subsequently excavated and transported to a licensed landfill for disposal. Excavation of impacted soils was limited to soils above approximately 3 feet bgs, as injection of ZVI and carbon amendment into the groundwater was conducted prior to the excavation activities.

Detected concentrations (micrograms per liter [µg/L]) of chlorinated ethenes in groundwater samples obtained from the most heavily impacted monitoring well within the groundwater treatment zone at the site are summarized as follows:

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Sample Date	Tetrachloroethylene (PCE)	Trichloroethene (TCE)	cis-1,2-Dichloroethen (cDCE)	Vinyl Chloride (VC)	Ethene
September 2012	5,080	4,650	40,900	3,520	Not Analyzed
January 2013	1,900	3,160	53,500	5,800	291
May 2013	*ZVI/Carbon Substrate Injection Event*				
July 2013	<590	<536	50,500	9,790	333
October 2013	<118	<91	41,400	16,000	546
January 2014	<94	<73	21,500	26,300	3,230
April 2014	<125	<83	13,500	16,500	4,740
October 2014	<1.0	<0.66	39.2	104	544
April 2015	<5.0	<3.3	46.4	89.6	3,440

It is useful to note that pre-treatment CVOC concentrations were indicative of dense non-aqueous phase liquid (DNAPL), based on comparison of the detected concentrations with their respective aqueous solubility. As indicated above, dechlorination of cDCE occurred in late 2013 in response to the May 2013 injection event, resulting in temporary accumulation of VC in early 2014 followed by further dechlorination to harmless end product ethene. Despite the likely presence of DNAPL, the total molar concentrations of chlorinated ethenes decreased from 680,000 nanomoles per liter (nM/L) in January 2013, to 1,910 nM/L in April 2015. This represents a reduction of 99.7% of the pre-treatment chlorinated ethene concentrations.

Evaluation of molar fractions (molar concentrations of PCE, TCE, cDCE, VC, or ethene divided by the molar concentration of total ethenes) over time is another method used to determine if biodegradation has been stimulated. The pre-treatment January 2013 molar fractions were as follows: 2% PCE, 4% TCE, 80% cDCE, 13% VC, and 1% ethene. The April 2015 molar fractions were 0% PCE, 0% TCE, 0.4% cDCE, 1.1% VC, and 98.5% ethene. Without sequential dechlorination, the molar fractions of the targeted compounds would all remain relatively constant, even if all of the concentrations would decline (due to dilution, for example). This dechlorination has occurred through a single injection of ZVI and carbon amendment alone (without bioaugmentation using microbial culture). Based on the positive results of the 2 years of post-injection groundwater monitoring, Ramboll Environ is requesting closure of the site.

Project Title: Chlorinated Solvent Remediation Using Soil Blending/Chemical Oxidation

Project Duration: 2010 to present

Project Location: Fredonia, Wisconsin

Project Reference: Bruce Keyes, Foley & Lardner, (414) 297-5815

Services: Since 2010, the proposed project team (Scott Tarmann and Jeanne Tarvin) have provided investigative and remedial action services to Phillips Plastics Corporation focusing on developing a time critical strategy to quickly remediate CVOCs in a tight clay environment over a sand aquifer at a former industrial site that was recently demolished and proposed for redevelopment.

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Project Description: A former industrial site had elevated CVOC impacted soil and groundwater in a unique hydrogeologic setting that allowed the project team to select an innovative remedial approach that met the client's need to quickly remediate the site for redevelopment purposes. Once the building was demolished additional investigation confirmed a targeted "hot spot" of very high CVOC soils across most of the former building footprint. The first 15 feet of soil below ground surface (bgs) in the former building footprint area consisted of a low permeability clay which had significantly high CVOCs. The high CVOC concentrations precluded excavation and off-site disposal as the CVOC concentrations were well above hazardous waste and landfill ban concentrations and depth of the contamination (up to 15 feet) precluded economical excavation to those depths. This clay layer was underlain by a more permeable sand aquifer which had relatively lower CVOC concentrations but these concentrations were still above NR 140 WAC groundwater concentrations and required active remediation. The challenge was to find a delivery method for the chemical oxidant in the tight clays that would work in concert with groundwater remediation strategy. At the time, only one other soil blending project with chemical oxidation had been completed in Wisconsin according to WDNR.

The project was conducted in two phases. The first phase included temporarily staging the upper clay soil on-site in order to blend oxidants into the deeper sand soil from 15 to 30 feet bgs across the site. The second phase consisted of replacing the upper clay soil and blending in place with chemical oxidant in the upper 15 feet across the building footprint. The project was considered a sustainable alternative since soil was not transported or disposed of in a landfill but was instantaneously remediated on site. Post-blending confirmation soil sampling supported that all remedial objectives for soil cleanup were met. The site is currently in post remediation groundwater monitoring.

Project Title: Chlorinated Solvent Remediation Using Zero-Valent Iron

Project Duration: 2004 to 2012

Project Location: Kansas City, Missouri

Project Reference: Confidential Client

Services: In 2004, ENVIRON was invited by the client to provide a path forward regarding CVOC impact that had been identified on the subject property which had previously been operated as a dry cleaning facility. A small-scale source removal action had been previously conducted in 2002 and CVOCs were determined to have impacted the site and migrated to an adjacent residential area. ENVIRON designed and implemented a monitoring and remedial program and conducted plume modelling and trend analyses to successfully close the subject property through the Missouri

Department of Natural Resources (MDNR) voluntary clean-up program. Applicable investigation and remedial costs were reimbursed through the Dry Cleaning Environmental Response Trust Fund.

Project Description: Investigation determined that impact was confined to shallow unconsolidated silty clay underlain by limestone bedrock encountered at 15 to 19 feet bgs.

Shallow groundwater at the subject property is encountered at depths from approximately 7 to 13 feet bgs. ENVIRON utilized existing site investigation and remediation data complimented by focused investigation to design and implement *in-situ* chemical reduction of CVOCs utilizing EHC; a proprietary product composed of controlled-release carbon, ZVI particles, and nutrients.

The remedial action utilized hydraulic probe injection of EHC in July 2006. A total of 30 injection points on an approximate 25 foot grid pattern were advanced and injections were targeted to the saturated zone. A total of 1,500 pounds of EHC was injected. Post-injection monitoring determined significant reductions in the concentrations of CVOCs; however, limited rebound was observed in one area of the site and a focused injection of EHS targeting this area was conducted. The focused injection was conducted in December 2011 and consisted of the injection of 1,750 pounds in five injection points spaced on a 10 foot grid pattern.

The MDNR issued a no further action determination for the subject property with respect to CVOCs in July 2012.

Project Title: Remediation Using Zero-Valent Iron with a Permeable Reactive Barrier

Project Duration: 1994 to present

Project Location: Danville, Illinois

Project Reference: Confidential Client

Services: ENVIRON is providing investigation and remedial action services to a confidential client with regard to CVOCs. Work conducted has included the design, installation, and long-term performance monitoring of a permeable reactive barrier (PRB) incorporating ZVI to passively remediate impacted groundwater.

Project Description: For over a 25-year period, manufacturing operations at the subject property had utilized CVOCs for degreasing purposes. On-going investigation and remedial activities are being conducted through the Illinois Environmental Protection Agency voluntary cleanup program. During

investigation of the subject property, it was determined that the leading edge of a shallow groundwater plume impacted with CVOCs had travelled down-gradient beyond the subject property boundary into a limited and defined area. Shallow groundwater is encountered at approximately 2 to 3 feet bgs and occurs in a low permeability silty clay with relatively discontinuous sandy seams and layers. Underlying the shallow saturated zone is a very dense clay till encountered at approximately 15 to 20 feet bgs.

A PRB was designed to intersect and treat impacted groundwater before it migrated beyond the subject property boundary and was installed in 2004 under the supervision of ENVIRON. The PRB is approximately 225 feet long, 2 feet wide, and extends from 2 to 20 feet bgs and incorporates ZVI within a sand backfill. As designed, the barrier was subdivided into three sections with specific amounts of ZVI incorporated into the sand backfill to treat anticipated influent CVOC concentrations.

Long-term routine performance monitoring has been conducted of conditions up-gradient, within, and down-gradient of the PRB during its first 10 years of operation. The results of performance monitoring indicate the PRB has operated as designed and continues to treat influent impacted groundwater before it flows beyond the subject property boundary. Conditions down-gradient of the PRB have attenuated over time as treatment has progressed with overall CVOC concentrations diminishing from three to five orders of magnitude.

Former Mitchell's Formal Wear – Richmond, Virginia

ENVIRON assisted with site remediation activities at a dry-cleaning facility in Richmond, Virginia. Site remediation included *in-situ* chemical reduction (ISCR) using EHC (proprietary product supplied by Adventus consisted of a food-grade carbon source and zero valent iron) to remediate tetrachloroethene (PCE) impacts in soil and groundwater at the site. Remediation was performed within the Virginia Voluntary Clean-up Program and site closure was granted in 2009.