Colonie FUSRAP Site Two Year Monitored Natural Attenuation Study of Groundwater - 14441

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The U.S. Army Corps of Engineers (USACE) and Shaw Environmental, Inc. (a CB&I Company) conducted a Comprehensive Environmental Response, Compensation and Liability Act Groundwater Record of Decision (ROD) action at the Colonie Formerly Utilized Sites Remedial Action Program (FUSRAP) Site between 2010 and 2013. The Colonie FUSRAP Site is located at 1130 Central Avenue (New York State Route 5) in the Town of Colonie, Albany County, New York. The Colonie Site consists of 11.2 acres in Colonie, New York (population: approximately 81,591). The Site is bounded by a heavily wooded lot on the west (7 Railroad Ave), CSX (formerly Conrail) rail tracks on the southwest and south, active commercial properties on the east and northeast, New York State Route 5 on the north, and a Niagara Mohawk (NiMo) electrical substation on the northwest. The surrounding area consists of mixed use residential and commercial properties.

The Groundwater ROD employs monitored natural attenuation (MNA) to address the volatile organic compound (VOC)-contaminated groundwater while also monitoring radiological parameters in the overburden aquifer. This action, combined with land use controls, will limit potential future onsite residential exposure to contamination through vapor intrusion during the remediation period.

USACE and Shaw Environmental, Inc. performed a two-year, eight-quarter study to evaluate the efficacy of MNA. During that time, both field measurements and analytical data was obtained to demonstrate that naturally occurring *in situ* biodegradation processes are active. MNA was confirmed to be a viable remedy during the demonstration period; therefore, monitoring will continue until compliance with the cleanup levels have been achieved for all onsite monitoring wells included in the monitoring program.

Overall, the study supported that MNA was occurring, albeit at a slower than expected pace due to site specific geologic conditions. While ROD-stipulated target cleanup goals for groundwater have not yet been achieved for all contaminants of concern (COC), the presence and distribution of COCs continue to be localized. This paper will discuss the findings of a multi-year groundwater monitoring study and its conclusions and recommendations.

SITE BACKGROUND

Industrial operations on the Site began in approximately 1923 when the Embossing Company purchased a portion of the present Colonie FUSRAP site to construct a facility to manufacture wood products and toys. In 1927, Magnus Metal Company, Inc. (MMC) converted the facility to a brass foundry for manufacturing railroad components. In 1937, National Lead Industries (NL)

purchased the facility and continued the brass foundry operations initiated by MMC. After World War II, site operations included casting aluminum parts and frames for aircraft. In 1958, the nuclear division of NL began producing items such as armor piercing shells manufactured from uranium and thorium under a license issued by the Atomic Energy Commission (AEC). NL discontinued its brass foundry operation in 1960.

From 1958 through 1984, NL carried out a number of processes using radioactive materials, primarily depleted uranium but also thorium and enriched uranium. Other processes conducted at the plant included an electroplating operation for plating uranium with nickel and cadmium. Chemicals used in the plating operation included nickel sulfamate, sodium cyanide, ferric chloride, nitric acid, silicate phosphate, iridite (chromium brightener), cadmium metal, nickel metal, boric acid, and tetrachloroethene (PCE). How or where most of these materials were disposed is unknown; very few disposal records have been located.

New York State officials closed NL in 1984, at which time Congress authorized the DOE to remediate the property. DOE completed remedial efforts from 1984 to 1988 at 53 of the 56 Vicinity Parcels (VP). In 1997, the USACE assumed control of the site and responsibility for the cleanup of the main Site and remaining three VPs. FUSRAP soil removal activities including large scale excavation, on-site treatment and off-site disposal of soils, were completed in September 2007. Upon completion of the removal action, 103,401 cubic meters (135,244 cubic yards) of soil had been excavated.

Remedial action decisions for the Site groundwater were addressed in the *Colonie FUSRAP Site Record of Decision, Colonie Site Groundwater* (USACE, 2010b), signed in April 2010. The selected remedy for groundwater was Monitored Natural Attenuation (MNA) with Land Use Controls (LUCs).

SITE DESCRIPTION

The Site consists of 11.2 acres in Colonie, New York (approximate population: 81,591). The Site is bounded by a heavily wooded lot on the west (7 Railroad Ave), CSX (formerly Conrail) rail tracks on the southwest and south, active commercial properties on the east and northeast, New York State Route 5 (Central Avenue) on the north, and a NiMo electrical substation on the northwest. The surrounding area consists of residential and commercial properties. Maximum topographic relief across the Site is about 4.51 meters (15 feet), with a high point of approximately 71.62 meters (235 ft) above mean sea level (MSL). The land slopes gently from the northwest to the south-southeast.

An unnamed tributary of Patroon Creek (a portion of which is an underground culvert) crosses the Site from the west to the south and east, ultimately discharging into Patroon Creek south of the Site. The unnamed tributary drains an area of approximately 1.21 square kilometers (300 acres) in the Town of Colonie. During the early 1900s, a dam was constructed on the tributary to form Patroon Lake.

Patroon Creek is a perennial stream that drains an area of approximately 0.052 square kilometers (13 square miles) in Colonie and Albany (13 square miles should equal 33.7 square km). The drainage basin is mostly urban with commercial and residential properties. The creek is approximately 0.028 square kilometers (7 miles) long (7 miles long should equal 11.3 km long), from its headwaters to its discharge into the Hudson River.

The geological units at the Colonie site include two notable water-bearing zones named the Upper Silt (also referred to as the Upper Groundwater Zone) and the Lower Silt (Lower Groundwater Zone). The Upper Silt Unit is comprised of lake silt and sand and the Lower Silt Unit consists predominantly of silt with some clay. These two water-bearing zones are typically separated by an easily-identified clay layer known as the Upper Clay Unit that consists of a varied sequence of clay and silt that is 3.65 m to 4.57 m (12 to 15 ft) in thickness at the Site.

The Upper Groundwater Zone at the Colonie site is generally encountered at a depth of less than 3.08 m (10 ft) below ground surface (bgs). The saturated thickness of this zone ranges from over 6.16 m (20 ft) in the north portion of the Site to less than 4.57 m (15 ft) in the south near the property line. The thickness of the Lower Groundwater Zone ranges from 3.08 to 4.57 m (10 to 15 ft). Groundwater flow across the Colonie site is generally to the southeast in both groundwater zones.

GW RECORD OF DECISION REMEDY

Major components of the selected remedy approved by the regulator (the New York State Department of Environmental Conservation, or NYSDEC) include the following:

- A two-to-five year enhanced data collection period, known as Long-Term Monitoring (LTM), to assess the rate of natural attenuation processes was to be established. At the end of the data collection period, the progress of MNA would be assessed and the estimated timeframe to achieve target cleanup goal concentrations would be re-evaluated. Subsequent long-term monitoring would be implemented until compliance with the target cleanup goals has been achieved. The timeframe for compliance was estimated at 15 years.

- Temporary land use controls would be utilized to limit potential future onsite residential exposure to groundwater contaminants until target cleanup goals were achieved. In addition, groundwater pumping restrictions would be put in place to ensure that the groundwater is not used for potable or irrigation purposes.

- The remedial action would be considered complete and monitoring would be discontinued when it was determined that compliance had been achieved, based on data from onsite monitoring wells included in the monitoring program.

The two-year enhanced data collection period consisted of sampling 15 upper groundwater zone monitoring wells and seven lower groundwater zone monitoring wells. Locations of the selected monitoring wells are presented on Figure 2. Monitoring wells were selected based on the following parameters:

1. Wells in areas with the highest observed historic concentrations of COCs;
2. Wells on the leading edge of the contaminated groundwater;
3. Wells down-gradient of the contaminated groundwater; and
4. Wells up-gradient of the contaminated groundwater.

Monitoring frequency was quarterly in the upper zone wells for Volatile Organic Compounds (VOCs) and MNA geochemical assessment indicators and semi-annually for VOCs in the lower zone for the first two years. For informational purposes, select wells were also monitored for lead and select radiological parameters.

The Remedial Action Objective (RAO)-based target cleanup goal concentrations for the COCs as defined in the ROD are as follows:

- PCE 5.5 µg/L;
- Trichloroethylene (TCE) 18 µg/L;
- Cis-1,2-Dichloroethylene (cis-1,2-DCE) 1,800 µg/L;
- Vinyl Chloride (VC) 1.4 µg/L.

The ultimate goal of the monitoring program is to generate a robust data set to document the primary and secondary lines of evidence requested by U.S. Environmental Protection Agency guidance (i.e., decreasing concentration trends of primary contaminants and groundwater geochemical evidence of biodegradation).

The remedial action will be considered complete and monitoring will be discontinued when compliance with the cleanup goal concentrations has been demonstrated for all onsite monitoring wells included in the monitoring program. If measured concentrations in any well achieve target cleanup goal concentrations for four consecutive quarters during the monitoring period, the well will be dropped from the monitoring program. After eight quarters of monitoring, data from any wells remaining in the monitoring program will be evaluated statistically using post-excavation data and any subsequently collected datasets.

CONCLUSIONS

This section provides conclusions drawn from the evaluation of the natural attenuation remedy based on data collected during the LTM period covering eight consecutive quarterly groundwater sampling events from November 2010 to August 2012. Recommendations for future monitoring activities are also provided to ascertain compliance with the RAO-based groundwater target cleanup goal concentrations.

VOC Results

Four VOCs (PCE, TCE, VC, and cis-1,2-DCE) in the Upper Groundwater Zone have RAOs based target cleanup goals. To assess the status of the monitoring endpoints for each of these four COC, a comparison of their concentrations to target cleanup goal concentrations was made for all results compiled. This comparison showed that three wells had PCE concentrations greater than the target cleanup goal, one well had a single TCE concentration greater than its target cleanup goal, and one had VC concentrations greater than the target cleanup goal.

The COC cis-1,2-DCE had no exceedances of its RAO-based target cleanup goal during the same period. However, NYSDEC has requested that cis-1, 2-DCE concentrations also be compared to NYSDEC groundwater quality standard of 5 µg/L. That comparison showed four wells with cis-1, 2-DCE concentrations exceeding the NYSDEC standard.

VOC Attenuation Summary

As detailed below, the analytical results and a statistical analyses based on historical VOC data indicate that natural attenuation is occurring. MNA is generally controlling the VOCs from migrating downgradient, although there is some variability as demonstrated by the increasing trends of TCE and PCE at well MW-32S and a stable to slightly increasing trend of VC at well MW-34S.

VOC Concentration Trend Analysis

- In the Upper Groundwater Zone, a total of four monitoring wells had at least one COC with a concentration that exceeded a target cleanup goal during the LTM period. Target cleanup goals for the following COCs were exceeded as follows:
  - PCE at wells MW-30S, MW-32S and MW-41S, with an apparent increasing trend at well MW-32S, and fairly stable trends at wells MW-30S and MW-41S.
  - TCE at MW-32S, with an apparent increasing trend
  - VC at well MW-34S, with a stable to slightly increasing trend.
- The VOCs 1, 1-DCE and trans-1, 2-DCE, which are Compounds of Interest (COI), have either been less than their detection limits, or less than the NYSDEC screening values and MCLs since 2008.
- In the Lower Groundwater Zone, VOC (including the COC and COI) concentrations were generally absent, indicating that the downward migration from the Upper Groundwater Zone was likely limited by the Upper Clay.

VOC Historical Data Trend Analysis and Spatial Moment Analysis

- The results show that COC concentrations in historically high concentration areas range from non-detect at MW-40S and no-trend or predominantly stable concentrations at MW-41S to likely increasing trends at MW-30S, MW-32S and MW-43S. The likely increasing trends appear to be related to the lower groundwater elevations recorded during the August 2012 sampling event.
- Generally stable concentration trends or non-detect concentrations were identified within the historically low concentration areas, especially in monitoring wells located southeast of the railway track. There is an increasing trend of cis-1,2-DCE at well MW-37S, but the highest concentration detected during the LTM program (48 μg/L) is much less than the target cleanup goal of 1,800 μg/L.
- The spatial moment analysis for the Upper Groundwater Zone shows that total COC masses are stable and that areas with COC masses are decreasing, suggesting MNA is effectively reducing COC across the Colonie site.
- COC are generally absent in the Lower Groundwater Zone.

Metal Attenuation Summary

- Dissolved lead was generally absent in the Upper Groundwater Zone, with detections at monitoring wells MW-08S and MW-43S at estimated values less than 1 μg/L and at monitoring wells MW-10S and MW-40S ranging from 1.0 to 10 μg/L. Total lead was not detected at well MW-21S. At face value, total lead concentrations appear to be displaying an increasing trend at well MW-10S, a decreasing trend at well MW-43S, and stable trends at the other three monitoring wells. However, the lack of dissolved lead suggests that lead detected in the total lead samples is associated with sediment within the groundwater, originating from the very fine-grained overburden material in which the wells are screened.

- As in the case for the Upper Groundwater Zone wells, lead in the Lower Groundwater Zone wells appears to be primarily associated with sediment in groundwater. Dissolved lead was not detected in the Lower Groundwater Zone wells. Total lead concentration in well MW-41M exceeded the NYSDEC standard and EPA action level. This well typically has high turbidity readings, perhaps indicating the presence of particulate in the groundwater samples. Lead is not expected to be mobile or travel with groundwater, and overall, lead concentrations remained historically stable between 2008 and 2012, despite possible large ranges of seasonal variations.

Radionuclide Attenuation Summary

- Radiological constituents were present at relatively low concentrations in the Upper Groundwater Zone in comparison to the NYSDEC standards and the MCLs. Radium-228 and gross beta concentrations did not exceed the MCL or NYSDEC screening values at any location, while exceedances of radium-226 and uranium were limited to well MW-32S. Gross alpha exceedances were limited to monitoring wells MW-32S, MW-41S, and MW-42S. Uranium, gross alpha and gross beta were attenuated over distance in the Upper Groundwater Zone; however, a specific mechanism for attenuation over distance cannot be discerned from the data.

- In the Lower Groundwater Zone, concentrations of radium and gross alpha in the dissolved phase were well below MCLs and the NYSDEC standards, whereas total radium and total gross alpha concentrations exceeded the standards in the area around wells MW-32M, MW-37M, and MW-41M. Uranium and gross beta were detected at levels significantly lower than the regulatory levels, with the exception of total gross beta in well MW-41M, which exceeded the NYSDEC standard. All radiological constituents including radium, uranium, gross alpha, and gross beta were stable or decreasing over time, with the exception of monitoring well MW-41M. The increases of total gross alpha and total gross beta in well MW-41M were likely caused by higher levels of turbidity in the monitoring well.

Geochemical Indicators of MNA

- The assessment of geochemical indicators in the Upper Groundwater Zone presented evidence that geochemical conditions support reductive dechlorination of VOCs, yet are not optimal. Conditions are favorable for VOC reduction and the immobility of lead and uranium.

- In the Lower Groundwater Zone, field geochemical parameter data demonstrate that although conditions are favorable for reductive dechlorination, this process is not currently dominating because VOCs are largely absent.

Natural Attenuation Rate Estimation

- Attenuation rate calculations were performed at monitoring wells MW-30S, MW-32S, MW-34S, and MW-41S only, because at least one COC was detected in post-excavation sampling at these locations at concentrations exceeding the target cleanup goal.

- The estimated attenuation rate of PCE varied from 0.06 to 0.62 per year, with corresponding half-lives ranging from 1.1 to 12.4 years. Based on these factors, it is projected that PCE concentrations will decline to the target cleanup goal of 5.5 μg/L in approximately 0.3, 3.6, and 30.4 years at MW-30S, MW-32S, and MW-41S, respectively.

- The attenuation rate of TCE is estimated at 0.46 per year, with a half-life of 1.5 years, if the recent increase in August 2012 is excluded from the assessment. The projected cleanup time is 0.1 year, reflecting the fact that, until August 2012, TCE concentrations were less than the cleanup goal.

- Cis-1,2-DCE concentrations have been well below the target cleanup goal at the four monitoring wells (MW-30S, MW-32S, MW-34S, and MW-41S) since the completion of the soil removal action in September 2007.

- Since the completion of the soil removal action, VC has been detected at concentrations exceeding the target cleanup goal at monitoring well MW-34S only. VC concentrations have been gradually increasing and currently exceed the target cleanup goal. Due to the increasing trend, it is not possible to estimate an attenuation rate or time to meet the target cleanup goal.

- Since COCs are generally absent in the Lower Groundwater Zone, natural attenuation rates and cleanup times were not calculated at the wells within this zone.

EPA/AFCEE Biodegradation Screening

- In the Upper Groundwater Zone, upgradient monitoring well MW-08S and downgradient monitoring well MW-35S displayed inadequate evidence of reductive dechlorination. This result indicates that the conditions in the areas that are not impacted by COC are generally unfavorable for reductive dechlorination

- In addition, the five monitoring wells that historically had little to no impact by COC (MW-10S, MW-36S, MW-38S, MW-39S, and MW-43S) showed, on average, inadequate

evidence of reductive dechlorination. Among the monitoring wells impacted by COC, one monitoring well (MW-21S) displayed inadequate to limited evidence of reductive dechlorination, six monitoring wells (MW-30S, MW-32S, MW-34S, MW-37S, MW-40S, and MW-41S) exhibited mostly limited evidence of reductive dechlorination, while one well (MW-42S) demonstrated limited to adequate evidence of reductive dechlorination.

- With the exception of monitoring well MW-21S, the scores for the monitoring wells impacted by COC are notably higher than those of the upgradient or downgradient monitoring wells. The dissolved oxygen and oxidation / reduction potential (ORP) values for well MW-21S during 2011 – 2012 suggest that the groundwater chemistry at this location varies seasonally between oxidative and reductive conditions. These results are similar to the results from the 2010 – 2011 sampling events.

- Since COC are generally absent in the Lower Groundwater Zone, biodegradation screening was not performed.

RECOMMENDATIONS

Overall, continued monitoring for another two years is recommended but at fewer locations and less frequently. Since compliance with ROD-stipulated target cleanup goals for groundwater has not been achieved for all COC at all monitoring wells, the following LTM program is suggested:

- Continue sampling COC (i.e., PCE, TCE, cis-1,2-DCE, and VC) in the Upper Groundwater Zone at reduced locations and frequencies as follows:

  - Sample monitoring wells MW-30S, MW-32S, MW-34S, and MW-41S on a semi-annual basis for the extended two-year LTM period, since one or more COC concentrations exceeded target cleanup goals at these locations during the initial two-year LTM period.

  - Sample downgradient monitoring well MW-37S and MW-42S semi-annually for the additional two-year LTM period. These wells have had fairly consistent detections of all four COC, and although there were no COC exceedances at these locations, upgradient monitoring well MW-32S showed recent increases in COC concentrations associated with a groundwater elevation decline in August 2012.

  - Monitoring MW-08S sampled annually to continue monitoring upgradient groundwater conditions.

- Discontinue COC sampling (i.e., PCE, TCE, cis-1,2-DCE, and VC) in the Lower Groundwater Zone, since detection of these VOCs is virtually nonexistent.

- Discontinue sampling for lead in the Upper and Lower Groundwater Zones. The lead detections (total lead) were primarily associated with relatively turbid samples (i.e., containing particulate) in groundwater. Dissolved lead was not detected during the initial LTM period.

- Continue limited sampling of radionuclides on a semi-annual basis for total and dissolved uranium only at the following locations: MW-32S and MW-37S in the Upper Groundwater Zone.

- Retain sampling of geochemical indicators of MNA in the Upper Groundwater Zone to specifically address the selected remedy. Sample the following Upper Groundwater Zone monitoring wells annually for MNA parameters: MW-30S, MW-32S, MW-34S, MW-37S, MW-41S, and MW-42S.

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