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Report on Completion of Construction, Phase II Iron Permeable Reactive Barrier (PRB) for DuPont Oakley Site

INTRODUCTION, SUMMARY AND CONCLUSIONS

INTRODUCTION

GeoSierra LLC (GeoSierra) was retained by DuPont to design and construct a full-scale extension to the pilot iron permeable reactive barrier (PRB) previously installed at the DuPont Oakley facility (the Site) in March 2001. The Site is located in Oakley, California. The pilot PRB, referred to as Phase I, of 110 feet in length was constructed in 2001 from a depth of 45feet down to a total depth of 117 feet below ground surface (bgs). The full-scale PRB, also referred to as Phase II, is comprised of two segments: 1) Lower Panel – 375 feet in length, installed from a depth of approximately 55 to 60 feet bgs to a total depth of 115 to 117 feet bgs; and 2) Upper Panel – 485 feet in length, installed from a depth of approximately 35 to 40 feet bgs to a total depth of 55 to 60 feet bgs. The panels have varying average iron-effective thicknesses of 3, 4.5, and 6 inches to treat differing levels of influent contamination, which varies along the alignment of the PRB. This Construction Report has been prepared for the Phase II PRB.

Groundwater containing constituents of potential concern (COPCs) and constituents of interest (COIs, such as inorganic elements) has been identified at the Oakley Site, with sources related to the former manufacturing areas and Waste Management Areas. For convenience, the contaminated groundwater has been categorized into three regions identified as Plumes 1, 2, and 3. The plume designations are based on differences in apparent source areas, transport pathways, areal distribution, and, to some degree, differences in plume COPCs and COIs. The PRB installation program is directed at mitigating potential off-site migration of contaminants from Plume 1 in the Upper and Lower Aquifers.

The purpose of the PRB is to significantly reduce the levels of volatile organic compounds (VOCs) present in the plume including carbon tetrachloride (the primary constituent based on concentration and mass), 1,1,2-trichlorotrifluoroethane, and trichlorofluoromethane. PRB performance monitoring results will be reported as part of the annual and semi-annual groundwater monitoring reports submitted separately by DuPont.

GeoSierra submitted the Final PRB Installation Design Report on January 31, 2005, including the Construction Plans and Technical Specifications. This report formed the basis for the construction of the Phase II PRB. The California Department of Toxic Substances Control (DTSC) approved the installation of the PRB in a letter to DuPont dated March 23, 2005.

PRB construction activities were initiated on February 14, 2005, with site preparation activities, pre-PRB hydraulic pulse interference testing (HPIT) and the drilling and installation of resistivity receiver strings and hydrofracturing (frac) wells. The PRB was constructed perpendicular to the natural groundwater flow direction. The PRB's geometry was monitored and mapped in real time by the active resistivity method, with images of the fracture PRB geometry displayed during the injections. The PRB was constructed from frac wells, spaced approximately 15 feet apart

along the PRB alignment. For the lower panel (F-8 through F-31), each frac well had four frac casings for the four distinct injection horizons. For the upper panel (F-32 through F-62), each frac well had one frac casing for the injection horizon with the exception of F-50 through F-62, which had two frac casing for the two injection horizons. The final geometry of the PRB involved the injection of 1420 tons of iron filings to construct two PRB panels. For the lower panel, the PRB has an average thickness as follows: 1) F-8 to F-25 – 6 inches; 2) F-26 to F-28 – 4.5 inches; and 3) F-29 to F-31 – 3 inches. The total injected cross-sectional area is approximately 25,822 square feet. For the upper panel, the PRB has an average thickness as follows: 1) F-32 to F-43 – 4.5 inches; and 2) F-44 to F-62 – 3 inches. The total injected cross-sectional area is approximately 21,796 square feet. The injections from the frac wells formed coalesced fractures, as quantified by the active resistivity mapping and confirmed from adjacent well response.

Post-PRB quality assurance/quality control (QA/QC) verification testing was completed to evaluate the impact on the groundwater flow regime by the installation method and to quantify the in-place installed PRB average thickness. Pre- and post-PRB hydraulic pulse testing indicated that the installed PRB did not impact the formation hydraulic characteristics. Inclined borings (30^{o}) from the vertical inclination and quantification of the subsurface materials in the borings using an electrical resistivity probe (ERP) were completed at twelve locations along the upper and lower PRB panels. These inclined borings confirmed that the PRB panels were installed at the design-specified thicknesses along the PRB alignments.

The following subcontractors were retained by GeoSierra to provide services during construction of the PRB:

- Electrical installation services during site preparation were provided by Contra Costa Electric of Martinez, California;
- Water line repair services during the project were provided by UCI Construction, Inc., of Martinez, California;
- Underground utility location services were provided by DuPont;
- Surveying services were provided by Ronald Greenwell and Associates, Inc. (RGA) of Antioch, California; and
- Drilling, hydrofracturing well, active resistivity strings installation, and angled boring services were provided by Gregg Drilling & Testing, Inc., of Martinez, California.

This report is divided into the following key elements:

- Section 1 provides an introduction to the report and objectives;
- Section 2 presents the pre-barrier installation and field activities;
- Section 3 presents the PRB construction activities and results;
- Section 4 presents the QA/QC audits performed during the installation of the PRB; and
- Section 5 presents summary and conclusions.

SUMMARY AND CONCLUSIONS

Site preparation activities were initiated on February 14, 2005, and completion of the Phase II PRB installation including QA/QC verification testing, site restoration, and demobilization was completed by August 2, 2005. Prior to PRB hydrofracturing activities, water and power utilities, 55 hydrofracturing wells, and 30 resistivity receiver strings were installed for the construction and QA/QC real time monitoring during installation of the Phase II PRB panels.

In 2001, the Phase I PRB was constructed from seven hydrofracturing wells (F-1 through F-7) by the same construction technology as the Phase II PRB. Phase II PRB hydrofracturing activities were initiated on April 14, 2005, and completed on July 11, 2005. Hydrofracturing production rates for the completion of the Phase II PRB averaged 26.5 tons per day, and a total of 1420 tons of iron were injected. The installation of the PRB included pre- and post-PRB HPIT testing. The Phase II PRB, comprised on a lower panel and an upper panel, was constructed from hydrofracturing wells F-8 through F-62 installed along the PRB alignment. A special downhole packer, frac casing, and wellhead system was inserted into each well, and a controlled vertical fracture was initiated at the required azimuth orientation and depth. Upon initiation of the controlled fracture within the well, the gel/iron mixture was then injected to form a continuous permeable iron reactive wall. For the lower panel (F-8 through F-31), each frac well had four frac casings for the four distinct injection horizons. For the upper panel (F-32 through F-62), each frac well had one frac casing for the injection horizon with the exception of F-50 through F-62, which had two frac casings for the two injection horizons. The final geometry of the PRB involved the injection of 1420 tons of iron filings to construct two PRB panels. For the lower panel, the PRB has an average thickness as follows: 1) F-8 to F-25 – 6 inches; 2) F-26 to F-28 – 4.5 inches; and 3) F-29 to F-31 – 3 inches. The total injected cross-sectional lower panel area is approximately 25,822 square feet. For the upper panel, the PRB has an average thickness as follows: 1) F-32 to F-43 – 4.5 inches; and 2) F-44 to F-62 – 3 inches. The total injected cross-sectional upper panel area is approximately 21,796 square feet.

The final geometry of the constructed Phase II lower PRB panel extends approximately 375 feet in overall length from a depth of approximately 55.5 feet down to a maximum depth of 115 to 117 feet bgs. The final geometry of the constructed Phase II upper PRB panel extends approximately 485 feet in overall length from a depth of approximately 35.5 feet down to a maximum depth of 60 feet bgs. The total Phase II as-built PRB panels have a cross-sectional area of 47,618 square feet. The overall PRB remedy with Phase I and Phase II have a cross-sectional area of 54,733 square feet.

Post-PRB QA/QC verification testing was completed to evaluate the impact on the groundwater flow regime by the installation method and to quantify the in-place installed PRB average thickness. Post-PRB hydraulic pulse testing indicated that the installed PRB did not impact the formation hydraulic characteristics.

The Phase II PRB was profiled by an inclined direct push electrical resistivity probe to determine that the PRB thickness was within specification at various chosen locations along the PRB alignment. The inclined profiles quantified that the PRB was installed to the correct thickness at various locations along its alignment.