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MEMO

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From:

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ARCADIS

Date:

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ARCADIS Project No.:

AZ000987.0002

Subject:

Technical Memorandum – Progress of IRZ Treatability Studies, PGA-North Superfund Site, Goodyear, Arizona

Introduction

This technical memorandum has been prepared by ARCADIS on behalf of Crane Co. to provide an update on *in-situ* treatability testing work currently in progress in support of the ongoing remediation activities at the Phoenix-Goodyear Airport North (PGA-N) Superfund Site (Site). This memorandum presents a brief summary of the following:

- Field activities (i.e., sample collection) performed to date in support of the treatability studies,
- Results of laboratory analyses performed on soil and groundwater samples,
- Initial results from the treatability studies.

Both the field work and laboratory testing related to the treatability studies have been performed in accordance with the approved Revised *In-Situ* Reactive Zone™ (IRZ) Treatability Study Workplan for the Phoenix-Goodyear Airport North Superfund Site (Workplan) (ARCADIS, 2004a).

Field Activities

Following USEPA approval of the Workplan, ARCADIS mobilized to the field to conduct the field work. The goals of the field work were to collect soil and groundwater samples from the Site to be used as the media for the treatability testing, as well as to collect depth specific soil and groundwater data to support our understanding of Site conditions. This field work was completed during the period of August 30, 2004 through September 3, 2004. Field activities included the installation of one test boring (ID - IRZ-TSB1) at

the Site. This boring was located approximately 200 feet due north of Drywells area. As outlined, all field activities were performed pursuant to the Workplan (ARCADIS, 2004a), as well as the associated Quality Assurance Project Plan (QAPP) (Geomatrix, 2003) and addendum (ARCADIS, 2004b) and the Site Health and Safety Plan (HASP) (ARCADIS, 2004c). Figure 1-1 shows the study area as per the approved Workplan.

On August 30, 2004, drilling activities commenced under the supervision of Mr. Christopher Shepherd of ARCADIS with oversight provided by Mr. Sachin Chawla, of CH2M Hill, a USEPA contractor. A 10-inch diameter boring was advanced using air rotary drilling methods. The drilling subcontractor was Layne Christense Company (Layne) of Chandler, Arizona.

As the boring was advanced, soil samples were collected using both a split spoon sampler (for lithlogic characterization) and a Simulprobe™ sampler (for analytical sample collection). Groundwater samples were also collected from the saturated portion of the boring using the Simulprobe™ sampler as well as disposable bailers. Bailer sampling was utilized only when the quantity of groundwater collected in the Simulprobe™ was not sufficient to perform the planned analyses. The bailed samples were collected for the treatability study and quality control samples.

Boring and sampling activities continued through September 3, 2004 when the boring was completed to the target depth of approximately 160 feet below ground surface (bgs). Following the completion of the boring the borehole was abandoned by filling the borehole with grout.

Investigation derived wastes (IDW) were contained in a roll-off container supplied by Environmental Response Inc. A characterization sample was collected from the roll-off container and subsequently the IDW has been disposed in accordance with appropriate regulations, at an off-site facility.

Split spoon samples collected from the soil boring were logged according to ASTM Method D 2488-00 (Visual-Manual). Soil sampling logs were prepared and are included as Attachment A. In addition, a photographic log was also maintained during field activities. Copies of these photographs are included as Attachment B.

The soil and groundwater samples collected from soil boring for laboratory analysis were analyzed by Con-Test Analytical Laboratories Inc. (Con-Test), of East Longmeadow, MA. Con-Test is an Arizona Department of Health Services accredited laboratory. Several analytical samples were sub-contracted to other laboratories, as outlined in the QAPP. Analytical results underwent a validation process pursuant to TIER I data validation procedures set forth by the USEPA. Data validation was performed by Nankoweep Environmental Consultants, Inc., an independent data validation contractor. Attachment C contains the full laboratory report.

Attached Table 1 contains a summary of the depth intervals of the soil and groundwater samples collected for laboratory analysis. Attached Table 2 contains a summary of the analytical results from the soil and groundwater samples. Data validation reports are included as Attachment D.

The following section contains a summary of the analytical results from the soil and groundwater samples collected.

Results

Volatile Organic Compounds (VOCs)

The following is a brief summary of the VOC soil and groundwater sampling results;

- The predominant VOCs detected in the soil were trichloroethene (TCE) and acetone.
    - In the soil samples collected, the highest concentration of TCE detected was 0.442 milligram per kilogram (mg/kg) (139 feet bgs).
    - The highest concentration of acetone detected was 0.156 mg/kg (125 feet bgs).
    - Both of the above soil samples were obtained from the saturated zone.
    - No TCE degradation products (specifically cis-1,2-dichloroethene [DCE] or vinyl chloride [VC]) were detected in the samples collected.
- Similar to soils samples, the predominant VOCs detected in the groundwater samples were also TCE and acetone.
    - The highest concentration of TCE detected was 2,180 microgram per liter (ug/L) (139 feet bgs).
    - The highest concentration of acetone detected was 273 ug/L (115 feet bgs).
    - Methyl ethyl ketone (MEK) was also detected in the groundwater samples at depths of 100 and 115 feet bgs with a maximum concentration of 32.1 ug/L.
- VOC impacts were detected throughout the portion of the saturated zone in which samples were collected (from roughly 100 feet bgs where groundwater was encountered to the planned termination of the boring at 160 feet bgs).
    - TCE was detected in all groundwater samples collected (from 100 to 155 feet bgs) and in soil samples collected from 98, 115, 125,135, and 139 feet bgs.
    - Acetone was detected in groundwater samples collected from depths of 115, 119, 125, and 155 feet bgs. Acetone was detected in soil samples collected from 100, 115, and 125 feet bgs.
    - MEK was detected in groundwater at samples from 100 and 115 feet bgs.

In comparing this data to the Phase II Source Area Groundwater Investigation at The Former Unidynamics Phoenix, Inc. Facility, January 2004 report prepared by CH2MHill ("Phase II"), the VOCs detected in groundwater during this investigation are within the range of previously reported concentrations. The Phase II report did not mention the detection of MEK.

Inorganics

In addition to analysis of groundwater samples for VOCs, these samples were also analyzed for several inorganic parameters to evaluate the biogeochemical environment present in the saturated zone. The following is a brief summary of those results;

- Nitrate was detected throughout the saturated zone at concentrations of approximately 20 mg/L.
- Sulfate was detected throughout the saturated zone at concentrations ranging from 633 to 1020 mg/L.
- Perchlorate was detected in all groundwater samples collected at concentrations ranging from 36.7 ug/L to 48.4 ug/L.
- No dissolved iron was detected in the groundwater samples.
- Dissolved Manganese was detected in all of the groundwater samples collected at concentrations ranging from 0.156 to 2.25 mg/L.
- Field measurement of conductivity of the groundwater samples ranged from 4,310 to 4,600 micromhos per centimeter (umhos/cm.)
- The alkalinity (as calcium carbonate) of the groundwater samples ranged from 160 to 279 mg/L.
- Dissolved organic carbon (DOC) was detected in three of the groundwater samples at concentrations ranging from 54 to 130 mg/L.

Overall the inorganic sampling data provided the results as expected, suggesting the aquifer is an aerobic system. The levels of DOC detected were not expected. Due to the aerobic conditions within the aquifer,as well as the presence of excess nitrates and sulfates, the local microbes would be expected to utilize and degrade DOC present. Additional evaluation of this data will be required in future characterization efforts to fully assess the biogeochemical conditions in the aquifer.

IRZ Treatability Study

Following collection of the soil and groundwater samples as outlined above, several treatability studies were initiated per the Workplan. These activities are being undertaken at the ARCADIS treatability laboratory located in Durham, NC. These studies are currently on-going. The following section provides a brief update on findings to date.

Phase 1 - Microcosm Study

Serum bottle microcosms were prepared in accordance with the Workplan to evaluate biological treatment of VOCs and perchlorate via the addition of an organic carbon reagent (in this case corn syrup). Each microcosms contains site soil and groundwater collected as outlined above. In addition, soil and groundwater in bottles in four batches were amended differently to represent the following study groups; 1) abiotic controls, 2) un-amended biological controls, 3) low-dose corn syrup treatment, and 4) high-dose corn syrup treatment. Construction of the microcosms was completed on October 4, 2004. The following analyses of the microcosms have been conducted to date;

- Baseline analysis of the groundwater used to prepare the microcosms (see attached Table 3),
- Time = 0 (October 5, 2004) samples of microcosms (see attached Table 3), and
- Headspace screening analyses of microcosms approximately six weeks into the testing (November 16-17, 2004).

In the attached Table 3, it should be noted that "Baseline – Water" is the un-amended, homogenized groundwater used in the microcosms, whereas the Time = 0 microcosm samples reflect addition of perchlorate and TCE to the groundwater to reach the desired levels outlined in the Workplan.

The serum bottle headspace samples were screened in-house by ARCADIS to determine whether TCE daughter products were present and thus whether to perform the next round of aqueous laboratory analysis. A gas chromatograph was used in the screening analysis to detect if any DCE and/or VC were present. The results, outlined in the Table below, indicate that neither DCE nor VC were present at concentrations sufficient to justify aqueous phase sacrificial sampling of the microcosms. These results suggest that minimal TCE degradation had occurred as of six weeks into the microcosm test. The absence of daughter products at this stage of the test was not unexpected, given the nature of the aquifer at the site (aerobic and high level of sulfates). It is also consistent with ARCADIS' field experience and with similar serum bottle tests in the ARCADIS treatability laboratory.

Six Week Headspace Screening Results

Microcosm Description	Headspace DCE (nanograms/microliter)	Headspace VC (nanograms/microliter)
Abiotic Control	< 0.114	< 0.011
Unamended Control	< 0.114	< 0.011
Low-Dose Corn Syrup	< 0.114	< 0.011
High-Dose Corn Syrup	< 0.114	< 0.011

Phase 2 - Nanoscale ZVI Column Study

In addition to the serum bottle studies outlined above, column studies using Polyflon PolyMetallix™ nano-scale zero-valent iron (ZVI), Polyflon product # NSPP-GAM2M and product # NSPP-GAM2MPd (palladized material) were also initiated to evaluate chemical reduction of VOCs and perchlorate. The ZVI column study was initiated on December 2, 2004. Site soils were homogenized and loaded into four up-flow columns per the Workplan. Soils for the columns were dosed with three levels of PolyMetallix™ nano-scale ZVI media (0.5%, 1% and 2% - by weight). In addition, one column was dosed with 0.5% of ZVI media which also contained trace palladium catalyst. Once the columns were prepared, groundwater from the site (amended with initial TCE and perchlorate concentrations of 6,000 ug/L and 150 ug/L, respectively, to meet the levels discussed in the Workplan) was then pumped through the columns at a rate of 0.13 ml/min. This flowrate was selected to simulate the estimated groundwater velocities in the Sub-unit A aquifer at the Site.

The final constructed flow columns were slightly shorter than outlined in the Workplan (actual column lengths are approximately 8.5 inches). Therefore, the length of time required to pass the specified number

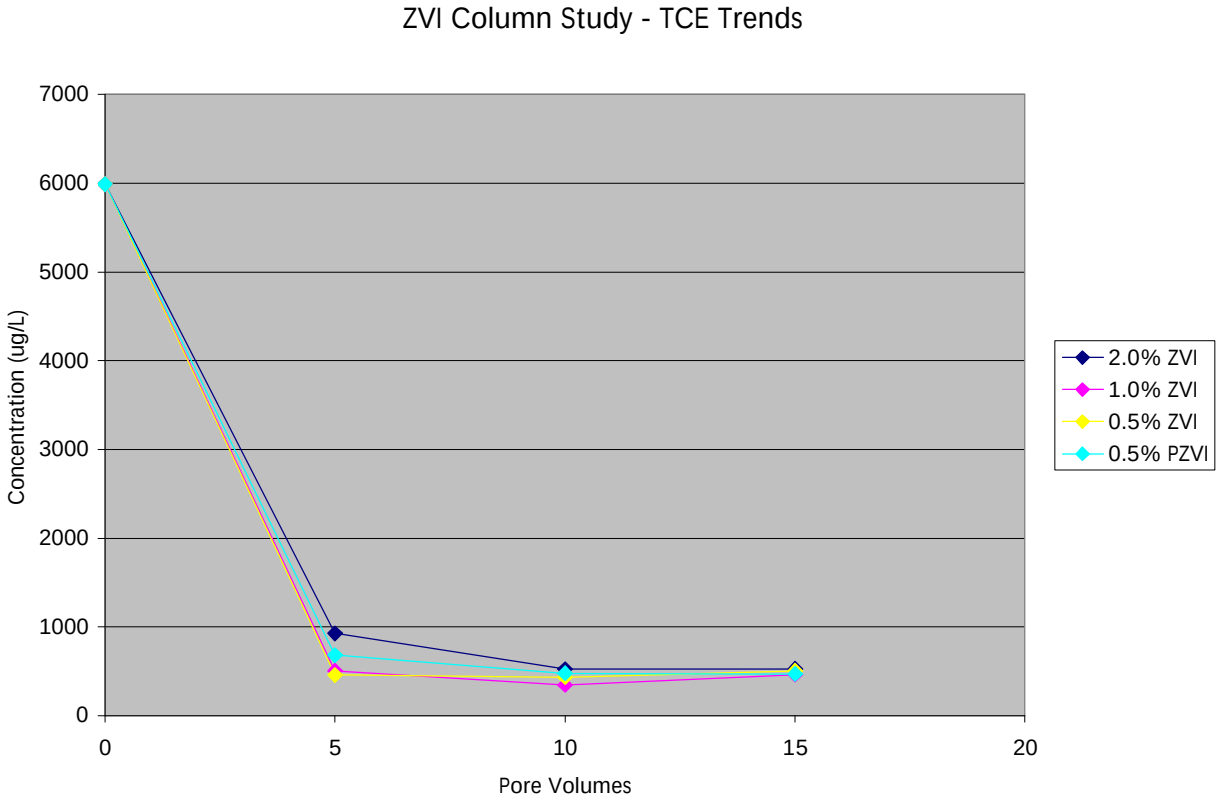
of saturated pore volumes through the system (as outlined in the Workplan) was also shorter. The three sampling intervals of 5, 10 and 15 pore volumes were thus completed in approximately 3.5, 7 and 10.5 days (December 6, 10 and 13, 2004).

Results from the ZVI column studies demonstrate that the PolyMetallix ZVI treatment resulted in significant reductions of TCE in the groundwater pumped through the columns. Initial influent concentrations of TCE in the water provided to the four columns was 5,990 ug/L. Effluent results from the column testing are summarized as follows;

- Effluent results following five pore volumes (December 6, 2004) - 459 ug/L to 930 ug/L TCE.
- Effluent results following ten pore volumes (December 10, 2004) - 347 ug/L to 526 ug/L TCE.
- Effluent results following fifteen pore volumes (December 13, 2004) – 463 ug/L to 528 ug/L TCE.

No noticeable reductions in perchlorate concentrations were observed during the column testing.

A summary of the laboratory data has been included in attached Table 3. In addition, the following figure illustrates the ZVI treatment data for TCE. These data demonstrate up to 83% reduction in TCE concentrations by the chemical reduction from the PolyMetallix ZVI.



Although the bench-test is still underway, the following observations can be made.

- The PolyMetallix ZVI media was effective at rapidly reducing TCE concentrations.
- The TCE treatment was essentially similar at all ZVI loadings.
- At these loadings - the addition of palladium catalyst did not alter treatment kinetics or overall TCE reduction.
- Bench-testing achieved approximately 83% TCE reduction over the duration of the test. It is expected that the technology can achieve greater efficiency - however, the contact or residence time in the columns is likely the limiting factor, here. Field pilot testing can confirm the *in-situ* treatment efficiency.

Once the bench test is complete, a Workplan for PolyMetallix ZVI Field Pilot Testing will be submitted to USEPA for review and comment. This submittal will be made in mid-February.

References

ARCADIS 2004a. Revised Treatability Workplan – *In-Situ* Reactive Zone™ Technology – Phoenix-Goodyear Airport North Superfund Site, Goodyear, AZ. May 14, 2004.

ARCADIS 2004b. Draft Quality Assurance Project Plan Addendum – *In-Situ* Reactive Zone™ Technology – Phoenix Goodyear Airport North Superfund Site, Goodyear, AZ. May 14, 2004.

ARCADIS 2004c. Site Health and Safety Plan - Soil Vapor Extraction Pilot Testing, Operation, and Sampling. May 4, 2004.

CH2MHill 2004. Phase II Source Area Groundwater Investigation at The Former Unidynamics Phoenix, Inc. Facility. January 2004,

Geomatrix 2004. Sitewide Quality Assurance Project Plan. April 2003.

ATTACHMENT A
Soil Sampling Logs

ATTACHMENT B
Photograph Log

ARCADIS

ATTACHMENT C
Laboratory Report

ATTACHMENT D
Data Validation Report