
Final

**Pioneer AOC Remedial Investigation
Addendum: Former Wilkins
Air Force Station, Shelby, Ohio
FUDS Property Number G05OH0972**

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Acronyms and Abbreviations

ADR	Automated Data Review
AFS	Air Force Station
ANOVA	analysis of variance
AOC	area of concern
APP	accident prevention plan
COPC	constituent of potential concern
DO	dissolved oxygen
DQO	data quality objective
EDD	electronic data deliverable
FUDS	formerly used defense site
GCAL	Gulf Coast Analytical Laboratory
HHRA	human health risk assessment
HI	hazard index
IDW	investigation-derived waste
LCG	Louisville Corps Guidelines
LEL	lower explosive limit
MCL	maximum contaminant level
MDL	method detection limit
mg/L	milligrams per liter
MRL	method reporting limit
MS	matrix spike
MSD	matrix spike duplicate
Ohio EPA	Ohio Environmental Protection Agency
ORP	oxidation-reduction potential
PA	preliminary assessment
PAH	polynuclear aromatic hydrocarbon
PARCC	precision, accuracy, representativeness, completeness, and comparability

PCB	polychlorinated biphenyl
PCTC	Pioneer Career and Technology Center
Plexus	Plexus Scientific Corporation
PRG	preliminary remediation goal
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RI	remedial investigation
SI	site inspection
SOP	standard operating procedure
SVOC	semivolatile organic compound
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
work plan	<i>Pioneer Remedial Investigation Addendum Work Plan</i>

SECTION 1

Introduction

Between October 2008 and July 2009, CH2M HILL completed a supplemental remedial investigation (RI) of the Pioneer Area of Concern (AOC) at the former Wilkins Air Force Station (AFS) in Shelby, Ohio. The supplemental RI was conducted to determine whether levels of arsenic, manganese, and thallium present in groundwater at the Pioneer AOC are naturally occurring or are site-related. During this investigation, CH2M HILL conducted four rounds of additional groundwater sampling from three monitoring wells located within the AOC and from two upgradient background monitoring wells. This RI Addendum summarizes the methods and results of the supplemental field investigation, sample analysis and verification, and data evaluation in support of determining if concentrations are naturally occurring or are site-related.

1.1 Wilkins AFS Background

Wilkins AFS is a formerly used defense site (FUDS) located in Shelby, Ohio (Figure 1). The site occupies 486 acres and was acquired by the U.S. Air Force in 1943 for use as a storage depot for medical supplies, airplane parts, clothing, rations, and vehicle parts and supplies. In 1960, the U.S. Air Force declared the facility excess, and it was closed in June 1961. The former AFS was sold to various businesses, local government entities, Shelby County Board of Education, and individuals. Currently, the largest property owners are the Central Ohio Industrial Park, Shelby Horizons, Pioneer Career and Technology Center (PCTC), and the City of Shelby, Ohio. The site has always been connected to the City of Shelby public water supply and has been zoned heavy industrial for many years. This RI Addendum addresses the Pioneer AOC, which is located on the west portion of the PCTC property (Figure 2).

1.2 Site Location and Description

The Pioneer AOC is located west of the intersection of Curtis Road, and west of the PCTC on the site of the former Wilkins AFS, Richland County, Shelby, Ohio (Figure 2). The area is vegetated with high grass, brush, and trees.

The Pioneer AOC consists of two separate disposal areas. The main area is located on the west end of the PCTC property (Figure 2) and consists of a 2-acre landfill mound, which was used by the Wilkins AFS to dispose of rubbish, concrete demolition debris, and medical/laboratory glassware. After PCTC bought the property, PCTC excavated a ditch through this disposal area to facilitate surface drainage. The second smaller disposal area is approximately 0.25 acre, and is located approximately 200 feet northeast of the landfill. This smaller area was identified as an anomaly during a geophysical survey conducted in 2001. Further information regarding the previous investigations and findings is presented below.

1.3 Previous Investigations at the Pioneer AOC

Work completed at the Pioneer AOC includes a preliminary assessment (PA), which was conducted by Plexus Scientific Corporation (Plexus) in 2000 at the former Wilkins AFS, as

well as a site inspection (SI) of the Pioneer and Shelby Horizons AOCs in 2001. Field activities completed at the Pioneer AOC during the SI included surface soil sampling, subsurface soil sampling, monitoring well installation, groundwater sampling, a passive soil gas survey, and a geophysical survey. Soil sampling identified several compounds above United States Environmental Protection Agency (USEPA) Region 9 residential soil preliminary remediation goals (PRGs), making them constituents of potential concern (COPCs). These constituents include arsenic, iron, polynuclear aromatic hydrocarbons (PAHs), and dioxins.

Three shallow groundwater monitoring wells were installed and sampled during the SI, and groundwater samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), PAHs, dioxins, metals (total and dissolved), and cyanide. Arsenic, manganese, and iron were identified in groundwater above PRGs for tap water, making them COPCs. The SI did not determine if the COPCs identified for the soil or groundwater media are the result of past disposal activities at the Pioneer AOC or if they are naturally occurring. Because contaminant levels were found to be relatively low and the nearest potential groundwater user is located downgradient approximately 0.5 mile northwest of the AOC, it was concluded in the SI that it is unlikely that groundwater poses a significant threat to human health.

Two anomalies were identified during the SI geophysical survey. Soil gas collectors were distributed over both of the anomalies and concentrated over the strongest portions of the anomalies. A number of compounds were detected in the soil gas, but most were near the detection limit. Chloroform and three diesel-range alkanes were detected at low to moderate concentrations in the soil vapor of the first anomaly, the 2-acre landfill mound. Chloroform was detected in the central portion of the landfill mound, and diesel-range alkanes were found at several locations around the perimeter of the mound. No constituents were detected during the soil gas survey in the second anomaly (0.25-acre disposal area).

An RI was performed in 2003 to investigate potential soil and groundwater contamination following the identification of an area used to dispose and burn debris, rubbish, and medical/laboratory glassware on the west end of the PCTC property. Activities included installing two background groundwater monitoring wells; collecting surface soil samples and background surface soil samples at the AOC; redeveloping, sampling, and analyzing all five of the monitoring wells (AOC wells and background); monitoring soil gas for landfill gases; and surveying the topography and sample locations.

The RI determined that levels of contamination present within soil of the Pioneer AOC are acceptable for the current use (commercial/industrial); however, under a future residential use scenario, levels of soil contamination present would not be acceptable. Metals detected in the groundwater samples were elevated in the samples collected from well MW-05. Arsenic was above its maximum contaminant level (MCL) in all of the groundwater samples analyzed from MW-05 and was also detected in most of the wells sampled, including the background wells. Manganese was above the tap water PRG in groundwater from MW-08, and thallium was detected sporadically in groundwater above the MCL. Both manganese and arsenic may be naturally occurring in the site area, and based on comments from the Ohio Environmental Protection Agency (Ohio EPA), it is unknown if these metal concentrations are similar to background or site-related. According to the RI, the risk from groundwater to human receptors is incomplete (Plexus, 2006).

1.4 Investigation Objectives

The Ohio EPA concluded in its review of the RI report for the Pioneer AOC that there was not enough data collected to determine whether detected concentrations of arsenic, manganese, and thallium in groundwater are background or site-related; therefore, additional groundwater data was collected to fill these data gaps. The objective of the additional investigation was to collect groundwater data to assess the potential risk to human health. The outcome of this RI Addendum data evaluation will be used to identify and recommend appropriate follow-up actions, if any.

1.5 Data Quality Objectives

The data quality objective (DQO) process is an important tool for project managers and planners to define the type, quality, and quantity of data needed to make defensible decisions (USEPA 2006). The structure of the DQO process provides an effective planning tool that can save resources by making data collection operations more resource effective.

DQOs were established based on the overall purpose of the media collection, the analytical detection limits necessary to support planned data screening, quality assurance (QA)/quality control (QC) needs, and knowledge of existing data. The DQOs for this RI Addendum investigation are provided in Table 1.

1.6 Scope

1.6.1 Groundwater Sampling

Groundwater samples were collected from five monitoring wells and analyzed for arsenic, manganese, and thallium. The monitoring wells were sampled quarterly for 1 year. Three of the five monitoring wells are located within the Pioneer AOC. Two of the monitoring wells, shown on Figure 3, are located approximately 1,800 feet south of the Pioneer AOC (hydraulically upgradient) and are considered background wells. AOC and background analytical groundwater data were collected to assess potential risks to human health. Upon completion of the four quarters of groundwater sampling, analytical results were evaluated statistically as described in Section 4.3.

SECTION 2

Pioneer AOC Groundwater Sampling and Analysis

This section presents an overview of the procedures that were implemented during the Addendum investigation to the Pioneer AOC RI at former Wilkins AFS in Shelby, Ohio. The fieldwork was conducted in accordance with the *Pioneer Remedial Investigation Addendum Work Plan* (work plan) (CH2M HILL 2008). Any deviations from the approved work plan are noted.

2.1 Site Access

United States Army Corps of Engineers (USACE) notified the appropriate stakeholders and secured access agreements from all property owners/lessees before commencing work. Stakeholders include representatives from the USACE, Ohio EPA, and PCTC.

2.2 Health and Safety

The health and safety accident prevention plan (APP) (CH2M HILL 2007) was prepared specifically for this site and approved by CH2M HILL's health and safety manager. Fieldwork was performed in accordance with the APP.

2.3 Groundwater Monitoring

Four rounds of quarterly groundwater monitoring were conducted at the five existing wells, which include two upgradient wells (BG-1 and BG-2) that serve as background wells, plus three wells (MW-05, MW-06, and MW-08) that are located adjacent to and within the AOC (Figure 3). The RI Addendum event field forms are included in Appendix A. Because the wells had not been sampled for approximately 3 years, the wells were redeveloped as specified in the field standard operating procedure (SOP), *Monitoring Well Development* (Appendix A of the work plan [CH2M HILL 2008]). Monitoring wells BG-2 and MW-05 recharged slowly during the development. Four well volumes of water were removed from MW-05, and 3.7 well volumes of water were removed from BG-2 before they went dry during development, which is in compliance with the 3 well volumes required for development as specified in the field SOP, *Monitoring Well Development* (Appendix A of the work plan [CH2M HILL 2008]). During each of the quarterly sampling events, water levels were measured in each of the five wells prior to the start of sampling activities as specified in field SOP, *Water Level Measurements* (Appendix A of the work plan [CH2M HILL 2008]). The water level measurements were converted to groundwater elevations using the top-of-casing elevations as references (Table 2).

The groundwater samples were collected using low-flow sampling techniques as specified in field SOP, *Low Flow Groundwater Sampling Techniques* (Appendix A of the work plan [CH2M HILL 2008]), except for wells BG-1, BG-2, and MW-05 during the first quarter event. The water levels at well BG-1, BG-2, and MW-05 would not stabilize during sampling (that

is, exhibit a drawdown of less than 0.5 foot per three field readings). Therefore, sampling was switched to a volumetric purging methodology and three well volumes were removed prior to sample collection at wells BG-1, BG-2, and MW-05. At MW-05, the well went dry once three well volumes of water were removed and samples could not be collected. MW-05 was allowed to recharge overnight, and then the field team measured the water quality parameters and collected the sample with no further purging as described in the field SOP, *Low Flow Groundwater Sampling Techniques* (Appendix A of the work plan [CH2M HILL 2008]). During the remaining three quarterly events, water levels stabilized and low-flow sampling techniques were used at all five wells. No deviations were necessary during purging activities at wells MW-06 and MW-08 for all four quarters.

Groundwater field parameters (dissolved oxygen [DO], specific conductance, oxidation-reduction potential [ORP], temperature, and turbidity) were measured and recorded for each well during purging, as specified in the field SOP, *Field Measurements Water Quality* (Appendix A, work plan [CH2M HILL 2008]). The parameters measured just before sampling are presented in Table 3. As indicated in Table 3, the final January event turbidity reading for BG-1 was not recorded because the turbidity meter malfunctioned in the cold weather. The other parameters had stabilized prior to sampling, indicating the sample collected in January was representative of groundwater. The October 30, 2008, quarter DO readings ranged from 6.92 to 13.33 milligrams per liter (mg/L) for all sampled wells. DO concentrations for the remaining three quarters were less than 1 mg/L (with one exception in background well BG-2). In addition, the July 27, 2009, quarter DO readings were negative at two wells (BG-2 and MW-6). The cause of these discrepancies is not known, but is likely related to instrument malfunction, operator error, or calibration problems during the October 30, 2008 and July 27, 2009 sampling events.

The samples were field filtered before transfer to the sample bottles as specified in field SOP, *Low Flow Groundwater Sampling Techniques* (Appendix A of the work plan [CH2M HILL 2008]), and were analyzed for arsenic, manganese, and thallium.

2.4 Quality Control Sampling

QC groundwater samples were collected in accordance with the quality assurance project plan (QAPP; Appendix B of the work plan [CH2M HILL 2008]). These include:

- Field duplicates were required at a frequency of one per 10 samples; five wells were sampled quarterly, one field duplicate was collected for each quarterly event, for a total of four duplicate samples.
- Equipment blanks were required at a frequency of one per 20 samples collected from nondedicated sampling equipment; sample sets were collected quarterly from dedicated sampling equipment. Therefore, equipment blanks were not required.
- Matrix spike (MS)/matrix spike duplicates (MSDs) were required at a frequency of one per 20 samples; five wells were sampled quarterly, one MS and one MSD were collected during each quarterly event, for a total of four MS samples and four MSD samples.

2.5 Sample Analysis

Sampling and analytical methods and requirements were performed in accordance with the work plan (CH2M HILL 2008) using USEPA Method 6010B for analysis of arsenic, manganese, and thallium. The laboratory method detection limits (MDLs) for manganese (0.004 mg/L or 0.0019 mg/L) and thallium (0.0013 mg/L or 0.0015 mg/L) were below the tap water PRG for manganese and the MCL for thallium, respectively. The laboratory MDL for arsenic (0.0022 mg/L or 0.0031 mg/L) was above the tap water PRG (0.000045 mg/L), but below the MCL (0.01 mg/L). Table B-1 in Appendix B lists the laboratory reporting limits and MDLs compared to the analyte screening limits for each quarter.

Although Gulf Coast Analytical Laboratory (GCAL) was listed as the laboratory in the work plan, it was determined just before the first field event that GCAL could not comply with the laboratory standards presented in the site QAPP (Appendix B of the work plan [CH2M HILL 2008]). Therefore, with the review and approval of USACE, CH2M HILL contracted CT Laboratories of Baraboo, Wisconsin, for the laboratory analysis of all RI samples. CH2M HILL formally documented this change in a technical memorandum submitted to USACE on October 24, 2008.

Groundwater samples were submitted to CT Laboratories for analysis for arsenic, manganese, and thallium by USEPA Method SW6010/SW6020. As identified in the QAPP (Appendix B of the work plan [CH2M HILL 2008]), laboratory MDLs were established below appropriate screening levels. For arsenic and thallium, the MDLs were below the associated MCLs. For manganese, the MDL was below the USEPA Region 9 tap water PRG. The laboratory analytical reports are included in Appendix B. Table B-1 in Appendix B lists the laboratory reporting limits and MDLs compared to the analyte screening limits for each quarter.

2.6 Sample Identification

Before sample collection, all sample containers were labeled with the project name, sample number, analysis to be performed, date and time of collection, and sample processor's initials. An independent identification number was assigned to groundwater duplicate samples collected for analysis. Sample labels used the following format for sample identification:

Media Location ID-date-QC type

where:

- *Media*: Groundwater = "MW" (for "monitoring well")
- *Location*: 2-digit well ID (for groundwater)
- *Date* = *mmddyy*

For example, a groundwater sample collected from Monitoring Well 12 on May 1, 2007, would be identified as MW12-050107.

QC sample labels will use the following format for sample identification:

- *QCNumber- date- QCtype*

- *Number*: two-digit unique numerical identifier
- *Date*: mmddyy
- *QCtype*: FD = field duplicate; EB = equipment blank; TB = trip blank; MS = matrix spike; MSD = matrix spike duplicate

Note that QC sample identification was not tied to a location. Locations where QC samples were collected were noted on the field sheets.

For example, a duplicate surface soil sample collected from location 6 on May 3, 2007, would be identified as QC01-050307-FD.

The unique sample identification numbers were affixed to each sample container before sample collection and then recorded on the chain-of-custody. Field team members maintained a listing of the sample identification numbers on the field sheets.

The procedures for proper packaging, shipping, and documentation of samples being transported from the field to the laboratory for analysis were followed as described in the field SOP, *Sample Management* (Appendix A of the work plan [CH2M HILL 2008]).

2.7 Equipment Decontamination

Any sampling equipment that was reused in the field was decontaminated in accordance with the field SOP, *Field Decontamination Procedures* (Appendix A of the work plan [CH2M HILL 2008]).

2.8 Investigation-Derived Waste

Investigation-derived waste (IDW) was handled in accordance with federal and state regulations and the field SOP, *Investigative-Derived Waste (IDW) Handling and Disposal* (Appendix A of the work plan [CH2M HILL 2008]). IDW generated at the site consisted of purge and development water, and spent decontamination water. The waste was containerized in 55-gallon drums and classified as nonhazardous based on groundwater sampling results. In addition, general trash (personal protective equipment, paper towels, etc.) also was containerized during field activities. After completing the sampling events, the waste handling firm, Penn Ohio, was contacted to remove the IDW from the site. Penn Ohio was onsite to remove IDW in January 2009, April 2009, and July 2009. IDW generated during the RI Addendum activities has been removed from the site.

SECTION 3

Data Management and Validation

This section identifies the processes that were established to ensure that data are of sufficient quality to be used for their intended purpose, and to ensure that data will be managed in a manner that ensures their integrity and long-term storage.

Analytical data for the RI Addendum must meet the precision, accuracy, completeness, comparability, representativeness, and sensitivity specifications as stated in the QAPP (Appendix B of the work plan [CH2M HILL 2008]). The laboratory used a QA/QC program to ensure analytical data are of known and documented usable quality. The laboratory followed the QAPP (Appendix B of the work plan [CH2M HILL 2008]) and their laboratory QA manual, which provides guidelines to ensure the reliability and validity of work conducted at the laboratory.

CH2M HILL performed a data review and data verification for all the primary samples collected and obtained electronic data deliverables (EDDs) that are compatible with the Automated Data Review (ADR) software. CH2M HILL verified the quality of the laboratory EDD using the EDD checker and performed data review as defined in the Louisville Corps Guidelines (LCG), using the QAPP requirements that are incorporated into the ADR software's libraries. Results of the data review and data validation efforts are presented in Appendix B.

Data validation, as defined in the LCG, was performed by CH2M HILL for the Pioneer AOC at a frequency of 10 percent. The remaining 90 percent of the analytical results underwent data review and data verification only. Following data review, data verification, and data validation, the analytical data was entered into a central database, where it was accessible for evaluation, interpretation, and reporting activities.

The goal of the data review and validation is to demonstrate that a sufficient number of representative samples were collected and the resulting analytical data can be used to support the decision-making process. The procedures for assessing the precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters were based on the QAPP (Appendix B of the work plan [CH2M HILL 2008]). The Data Evaluation Report in Appendix B provides details on the PARCC findings for the four RI Addendum groundwater sampling events. The following summary highlights these PARCC findings:

- Precision of the data was verified through the review of the field and laboratory data quality indicators that include field duplicate and laboratory duplicate relative percent differences. Precision was acceptable.
- Accuracy of the data was verified through the review of the calibration data, laboratory control samples, MS, interference check standards, method reporting limit (MRL) recoveries, and the evaluation of method blank data. Accuracy was generally acceptable with the exception of a few instances where compounds were qualified as estimated detected results due to MS and/or MRL issues. Arsenic and thallium were detected in one method blank. Results associated with that method blank having detections less

than five times the concentration in the method blank were qualified with a “B”, indicating the detection was attributed to blank contamination; therefore, essentially a nondetect. Data users should consider the impact to any result that is qualified as estimated as it may contain a bias that could affect the decision-making process.

- Representativeness of the data was verified through the sample’s collection, storage, and preservation procedures and the verification of holding time compliance. The laboratory did not note any issues related to sample preservation or storage of the samples. All data were reported from analyses within the USEPA-recommended holding time.
- Comparability of the data was verified using standard USEPA analytical procedures and standard units for reporting. Results obtained are comparable to industry standards in that the collection and analytical techniques followed approved, documented procedures.
- Completeness is a measure of the number of valid measurements obtained in relation to the total number of measurements planned. Completeness is expressed as the percentage of valid or usable measurements compared to planned measurements. Valid data are defined as all data that are not rejected for project use. All data were considered valid. The completeness goal was met for all analytes.

As identified in the QAPP (Appendix B of the work plan [CH2M HILL 2008]), laboratory MDLs were established below appropriate screening levels. Table B-1 in Appendix B lists the laboratory reporting limits and MDLs compared to the analyte screening limits for each quarter. As shown in Table B-1, the laboratory MDL and reporting limits are below the MCL (0.010 mg/L) but above the USEPA Region 9 tap water PRG (0.000045 mg/L) for arsenic. For thallium, the laboratory MDL is below both the MCL (0.002 mg/L) and the USEPA Region 9 tap water PRG (0.0024 mg/L), but the laboratory reporting limit is above both the MCL and PRG. For manganese, the laboratory MDL and reporting limits are below the USEPA Region 9 tap water PRG (0.88 mg/L).

SECTION 4

Data Evaluation and Results

This section identifies how data and information obtained during performance of the work were evaluated and reported.

4.1 Groundwater Flow Direction

Potentiometric surface maps depicting the generalized groundwater flow direction are provided for each quarter as Figures 4 through 7. Groundwater flow direction is to the north-northwest in the area of the Pioneer AOC. The potentiometric contours in the Pioneer AOC area are straight lines based on the three data points in the Pioneer AOC (the three wells), and do not reflect any small scale variations in flow that could potentially be caused by topography, drainage ditches, or stratigraphy. The background wells are located approximately 1,800 feet south of the Pioneer AOC. Because of the distance between the background wells and the Pioneer AOC wells, the shallow water table, variable lithology (for example, sand strata within clayey glacial till), and variations in ground surface topography, the groundwater potentiometric surface between the background wells and the Pioneer AOC cannot be accurately depicted. Plexus attempted to map groundwater flow directions between the two background wells and the AOC wells in the RI report (Figure 3-3, Plexus 2006); however, it is unlikely this depiction accurately reflects groundwater flow directions.

The groundwater flow direction in the vicinity of the two background wells is also difficult to evaluate, as the two wells are screened in different lithology (some sand seams were encountered in BG-1, while BG-2 was entirely in fine grained clay and silt). The groundwater elevation in BG-2 ranged from 5 to 8 feet higher than in BG-1. The lower potentiometric level in BG-1 may be a function of groundwater flowing at a higher rate through the sandy strata at BG-1; thus, the local stratigraphy may control the direction of groundwater flow in this area.

Because groundwater elevations in the background wells are higher than those in the Pioneer AOC wells indicates that the background wells are upgradient of the Pioneer AOC, and therefore would not be affected by any potential releases from the Pioneer AOC. No significant changes in groundwater flow direction were observed over the four events.

4.2 Groundwater Analytical Results

The water quality parameters measured during each quarterly sampling are shown on Table 3 (the last measurements before collecting the groundwater samples). As discussed in Section 2.3, the October 30, 2008, quarter DO readings were elevated above the remaining quarter DO readings, and the July 27, 2009, quarter DO readings were negative at two wells. The cause of these discrepancies is not known, but is likely related to instrument malfunction, operator error, or calibration problems during the October 30, 2008 and July 27, 2009 sampling events. Therefore, the DO readings were not used in the evaluation of groundwater geochemistry. The ORP measurements were generally negative, except for

well MW-08, which had ORP measurements ranging from slightly negative to slightly positive.

The analytical results for all four quarters of groundwater sampling are presented in Table 4 and are compared against the USEPA MCL and the USEPA October 2004 Region 9 PRGs (USEPA 2004). Region 9 PRGs are used to keep consistency of the screening criteria throughout the RI documents. The lower of these values was taken as the main screening value for each constituent. For arsenic, the tap water PRG was used; for thallium, the MCL was used. Since manganese has no primary (enforceable) MCL, the tap water PRG was used.

Since the screening level for arsenic (tap water PRG) is two orders of magnitude less than the reporting limit for the arsenic analyses, any detection of arsenic exceeded the screening level. Arsenic was either not detected or was detected at an estimated concentration between the detection limit and the reporting limit (J flag in Table 4). For the July 27, 2009, sampling event, arsenic was detected in the method blank. Results for this sampling event less than five times the concentration in the method blank were qualified as not detected (B flag in Table 4). The maximum detected concentration (estimated) of arsenic was 0.0076 mg/L, which did not exceed the MCL for arsenic (0.01 mg/L). The Pioneer AOC groundwater results are compared to background groundwater results in Section 4.3.

Except for one detection in background well BG-2, thallium was either not detected or detected at an estimated concentration (J flag in Table 4) between the detection limit and the reporting limit. All thallium detections (flagged as estimated) exceeded the MCL for thallium (0.002 mg/L). For the July 27, 2009, sampling event, thallium was detected in the method blank. Results for this sampling event less than five times the concentration in the method blank were qualified as not detected (B flag in Table 4). The Pioneer AOC groundwater results are compared to background groundwater results in Section 4.3.

Manganese was either not detected or detected below the tap water PRG (0.88 mg/L) in both background wells and site wells MW-05 and MW-06. At well MW-08, elevated concentrations of manganese exceeding the tap water PRG (Table 4) were detected each quarter. Concentrations detected at MW-08 (maximum concentration 4.92 mg/L) were orders of magnitude greater than those detected in the other monitoring wells within the Pioneer AOC.

The elevated manganese concentrations detected in MW-08 (relative to the other wells) are consistent with previous sampling results reported in the SI (Plexus 2001) and RI (Plexus 2006). Plexus speculated in the RI that the source of manganese is unknown and may be associated with fill material in the vicinity of MW-08. The solubility of manganese in groundwater can be affected by the groundwater geochemistry; manganese is generally more soluble in groundwater under reducing conditions indicated by lower DO concentrations and negative ORP values. Table 3 shows that except for the apparently anomalous first sampling event and the negative readings from the fourth event, DO concentrations are low (less than 1 mg/L) for all wells, including the two background wells. ORP for MW-08 is higher than the other wells, including the background wells (with one exception for BG-02). Sulfur odors were noted at times during well development and sampling for wells MW-06 and MW-08, and hydrogen sulfide was detected in the MW-06 casing during the April 2009 sampling event. The hydrogen sulfide, low DO, and negative

ORP values for MW-06 suggest reducing conditions in that well, which should increase the solubility of manganese; however, manganese concentrations in MW-06 were not elevated. The low DO and sulfur odor associated with MW-08 also suggest reducing conditions, but given the apparently stronger reducing conditions at MW-06, it is not clear what geochemical conditions might be responsible for the elevated manganese in MW-08.

The lower explosive limit (LEL) was measured at 34 percent in the wells casing of MW-05 during the April 2009 sampling event (see field forms in Appendix A), indicating the possible presence of methane in the subsurface in the vicinity of MW-05. While MW-05 does not have elevated manganese concentrations, dissolved iron concentrations were detected in MW-05 during the RI (Plexus 2006) at concentrations an order of magnitude higher than the other wells. Combined with the hydrogen sulfide in MW-06 and the sulfur odor in MW-08, it appears that degradation of the waste material in the Pioneer AOC may be causing reducing conditions in the immediate vicinity of the AOC. These reducing conditions may be enhancing dissolution of certain metals such as manganese and iron; the dissolved concentrations of these metals may be related to specific waste materials in the vicinity of the respective wells in which these metals were detected.

As discussed in Section 5.3.3 of the RI report (Plexus 2006), dissolution of inorganic constituents at the site appear to be controlled by oxidation-reduction reactions (redox), and that the ORP and pH measurement appear to indicate “neutral” redox conditions, for example, between strongly reducing and strongly oxidizing conditions. The data collected for this RI Addendum support this possibility with the exception of the ORP measurements for MW-06. However, the sulfur odors, hydrogen sulfide, and methane (LEL reading) indicate reducing conditions exist in the subsurface around the AOC. As groundwater flows away from the AOC, a transition to less reducing or oxidizing conditions would result in the precipitation (and immobilization) of the metals that were soluble under reducing conditions.

4.3 Nonparametric Statistical Comparison of Site Well Data to Background Well Data

Quarterly analytical data from the three Pioneer AOC monitoring wells (MW-05, MW-06, and MW-08) from October 2008 through July 2009 were compared with the background data from the two background wells (BG-1 and BG-2) using analysis of variance (ANOVA) techniques. Because the percentage of nondetected values was so high for some of the parameters, it was inappropriate to use a parametric ANOVA technique that requires an assumption that the residuals of the ANOVA model follow a given statistical distribution (that is, a normal one). For this reason, a nonparametric ANOVA method, the Kruskal-Wallis test, was used (USEPA 1992). The p-values from this test were compared with a significance level of 0.05. When the p-value was below this level, a significant difference between the central tendency of at least one of the wells and the other multiple well groups was suggested.

The calculated probabilities from the initial ANOVA step are presented in Table 5 and were compared with a significance level of 0.05. When the probability was below this level, a significant difference between the central tendency of at least one of the wells and the other multiple well groups was suggested. Note that this comparison only indicates significant

differences between wells, but does not indicate whether an exceedance of background has occurred. For cases with a significant difference, a post-hoc test (multiple comparison test) was employed to determine which Pioneer AOC wells, if any, exceed the background wells. The post-hoc test is described in USEPA guidance (USEPA 1992) and is recommended whenever the initial ANOVA probability is less than 0.05, as in the case for manganese (Table 5). This post-hoc test offers a conclusion as to whether the significant difference is caused by one or more downgradient wells statistically exceeding background, and if so, which downgradient well(s) is responsible. Each of the Pioneer AOC site wells was compared to the background wells, using a significance level of 0.05 and the protocol described in the guidance.

For arsenic and thallium, the calculated probability was greater than 0.05; therefore, no significant difference between wells was concluded. For manganese, a significant difference between wells was concluded because the calculated probability was less than 0.05 (Table 5). This result is because manganese concentrations at MW-08 exceeded concentrations detected at the other Pioneer AOC site wells and background wells (Table 4).

SECTION 5

Human Health Risk Assessment Update

A human health risk assessment (HHRA) was conducted as part of the original RI (Plexus 2006), evaluating the potential effect of COPCs on human health for current and reasonably anticipated future site use (industrial). The HHRA was conducted in accordance with USACE, USEPA, and Ohio EPA guidelines for risk assessment (Plexus 2006).

The HHRA (Plexus 2006) concluded that the cancer risk estimates for the site worker, trespasser, and construction worker soil exposure scenarios were below or within target levels for cumulative cancer risks for USEPA (cancer risk range of 1×10^{-6} to 1×10^{-4}). The HHRA noncancer evaluation resulted in hazard indices (HIs) less than or equal to the noncancer goal of one for the site worker (1) and site trespasser (0.4) scenarios. The evaluation of future residential scenario was included in the initial HHRA to provide an upperbound estimate of risk posed by the site to support risk management decisions. Results of the risk assessment indicated that potential future residential use would pose noncancer hazards (2 for adult resident and 13 for child resident) and cancer risks (4×10^{-5} for lifetime residents) above target levels. The construction worker scenario noncancer HI (6) was six times the noncancer target level of one; however, the HHRA concluded that “the construction worker scenario resulted in a minor exceedance of the noncancer benchmark.” Since the HHRA concluded that the HI of 6 for the construction worker scenario was a minor exceedance of the noncancer target level of 1, a review of the results of the risk calculations for the construction worker scenario was conducted to verify the results. This section provides an update to the HHRA based on the findings of the review.

The Pioneer AOC includes a 2-acre landfill mound and a 0.25-acre disposal area located approximately 200 feet northeast of the landfill. Prior to construction of new structures at the Pioneer AOC, authorization from Ohio EPA would have to be obtained in accordance with Ohio Administrative Code 3745-27-13. There are no plans for the construction of new structures in the Pioneer AOC area, and the property owners do not have any plans for residential development.

The human health conceptual site model that was presented in the HHRA indicated that exposure pathways associated with potable use of groundwater are incomplete for current and future human receptor populations at Pioneer AOC. Therefore, potential groundwater exposure pathways were not evaluated. However, exposure scenarios for direct contact with soil and soil particulates in air for current and future receptor populations were evaluated as complete exposure pathways for site workers, trespassers, construction workers, and hypothetical future residents. The current and future land use of the site is still industrial with incomplete exposure pathways to groundwater.

The HHRA examined soil data collected in April 2003 and identified COPCs. The chemicals detected in surface soil samples (collected from 0 to 6 inches bgs) and aggregate soil (collected from 0 to 10 feet bgs) were screened to select the COPCs through a comparison to USEPA Region 9 PRGs for residential soil (USEPA 2004). For the purposes of COPC identification, PRGs based on noncarcinogenic effects were divided by 10 to account for

potential exposure to multiple constituents. PRGs that were based on carcinogenic effects were used without adjustment, which corresponds to a target risk of 1×10^{-6} . In cases where a constituent had both a cancer and noncancer PRG, the lower of the two values was used. Contaminant intake levels were calculated for potential receptor populations. Toxicological properties were applied to estimate potential public health threats posed by detected contaminants. Screening levels and toxicity criteria were not updated to current values to support a direct comparison between the HHRA risk results and the revised risk results. Toxicity changes have occurred since 2006 for a small number of the COPCs (mercury, thallium, and vanadium). However, the toxicity criteria for manganese, the greatest contributor to noncancer hazard for the construction worker scenario in the HHRA, have not changed.

Noncancer HIs and cancer risks are based on the relationship between chemical intake for the pathway and toxicity criteria. The exposure assumptions, toxicity criteria, equations, and input parameters used to calculate the construction worker noncancer HIs and risk estimates were reviewed. The methods and assumptions used to calculate hazards and risks for the identified receptor populations remain valid. Risks were recalculated using the same toxicity information that was presented in the HHRA.

The calculated particulate emission factor (PEF) for the construction scenario in the HHRA, which was used to calculate the inhalation intake, included assumptions that the areal extent of contamination is 10 acres and 30 vehicles would drive across the site during the construction period (8 hours per day for 125 days). These assumptions were conservative and resulted in an overestimation of exposure and noncancer hazards because the areal extents of the anomalies at the Pioneer AOC are both less than 3 acres. Additionally, the dermal reference doses for manganese and mercury were transposed, which also resulted in the overestimation of the noncancer hazard for manganese and a slight underestimation of the hazard for mercury.

Hazards and risk estimates were recalculated for the construction worker scenario using more site-specific assumptions for the construction scenario PEF calculation and using the correct chemical-specific dermal reference doses for manganese and mercury. Risk estimates were recalculated using the exposure point concentrations for COPCs and exposure parameters presented in the initial HHRA. For this re-evaluation, the construction scenario PEF (Table 6) was calculated assuming 3 acres of areal extent and three vehicles (one 20-ton truck and two 2-ton cars) would travel across the site during the construction period (8 hours per day for 125 days). Noncancer and cancer toxicity values used in the risk estimates are the same as those presented in the HHRA with the exception of using the appropriate dermal reference dose for both manganese and mercury (Table 7). Table 8 provides the noncancer and cancer doses (or intakes) for each COPC. Tables 9 and 10 summarize the risk and hazard to the construction worker exposures to soil, respectively. The carcinogenic risk (4×10^{-7}) is below USEPA's risk management range of 1×10^{-6} to 1×10^{-4} . The noncarcinogenic HI (0.9) is below USEPA's target HI of 1. Therefore, the recalculated numerical estimates indicated that potential exposure to soil at Pioneer AOC by construction workers would not pose unacceptable risks to human health.

SECTION 6

Summary and Conclusions

Groundwater samples collected from wells within the Pioneer AOC, quarterly for 1 year, contained concentrations of dissolved arsenic, manganese, and thallium exceeding screening levels (either the USEPA tap water PRGs [USEPA 2004] or the USEPA MCLs if no PRG was available). Groundwater samples collected from background wells also contained concentrations of arsenic and thallium exceeding screening levels. Concentrations of arsenic, manganese, and thallium detected in groundwater from the five monitoring wells sampled during the supplemental RI were similar to those detected during the original RI (Plexus 2006).

The concentrations of arsenic and thallium were commonly flagged as estimated values below the laboratory reporting limits. For the July 2009 quarter results, arsenic and thallium were detected in the method blank, which indicated potential laboratory contamination for these metals; therefore, the detections of these metals in the July 2009 quarter were flagged as not detected.

Based on a direct and statistical comparison of the AOC data to the background data, concentrations of arsenic and thallium in the AOC wells appear to be naturally occurring in groundwater. Concentrations of manganese in the groundwater at well MW-08 appear to be elevated above what is naturally occurring.

Evidence indicating reducing conditions in groundwater near the Pioneer AOC was observed in all three wells around the AOC. Reducing conditions are conducive for the dissolution of manganese (and other metals such as iron) from subsurface materials such as organic-rich soil or buried waste. Although groundwater from only one well contained elevated dissolved manganese, groundwater from another well contained evidence of elevated iron. The reducing conditions may be causing the unusually elevated concentrations of dissolved manganese based on organic rich soils or buried materials that may exist near the respective wells. If groundwater reverts to less reducing conditions as it flows away from the Pioneer AOC area, the dissolved metals would be expected to precipitate and thus be immobilized.

The Wilkins AFS has been zoned heavy industrial for many years and it is the most reasonable expected use in the future. No future construction is planned for the west side of the campus in the area of the AOC. Construction of buildings or other structures over the AOC in the future also will be constrained by the geotechnical, permitting, and building design challenges of building on a landfill. Any future buildings near the AOC would be connected to the local municipal water supply, thereby eliminating exposure to groundwater via drinking water. Therefore, the remedial investigation (Plexus 2006) concluded that the groundwater pathway was incomplete and was not assessed. The scope of work for this study included an updated assessment of the construction worker risks from exposure to soil at the Pioneer AOC with site-specific information and corrected toxicity information. Risk results were less than the USEPA target HI and target carcinogenic risks, and no unacceptable risks were identified for the construction workers'

exposure to soil. Therefore, the cancer risks and noncancer hazards for the site worker, trespasser, and construction worker soil exposure scenarios were at or below USEPA target levels. Overall, there are no unacceptable risks to human health under the industrial land use scenario based on the original RI (Plexus 2006)

Future residential use is not planned for the AOC; however, the cancer risk for lifetime residents (4×10^{-5}) is within the USEPA's risk management range of 1×10^{-6} to 1×10^{-4} , and the noncancer HIs for adult resident (2) and child resident (13) exceed the USEPA target HI of 1 (Plexus 2006).

This investigation confirmed no unacceptable risk for a construction worker exposed to soils. However, the risk assessment at Pioneer AOC did not address the groundwater pathway. A risk assessment of the groundwater pathway would be needed to adequately evaluate the construction worker exposed to soil and groundwater, as well as potential offsite receptors should additional wells and monitoring confirm groundwater flow to the west. Therefore, it is recommended that a human health risk assessment be performed for the groundwater pathway.

SECTION 7

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