Weiss Associates Environmental Science, Engineering, and Management

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2017 ANNUAL WATER MONITORING REPORT

for the

Laboratory for Energy-related Health Research/ Old Campus Landfill Superfund Site University of California, Davis

prepared for

Environmental Health and Safety
University of California, Davis
One Shields Avenue
Davis, California 95616

March 31, 2018
Rev. 0

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Weiss Associates' work for the Laboratory for the Energy-related Health Research/Old Campus Landfill was conducted under my supervision. To the best of my knowledge, the data contained herein are true and accurate and satisfy the scope of work prescribed by the client for this project. The data, findings, recommendations, specifications, or professional opinions were prepared solely for the use of the University of California, Davis, Navarro Research and Engineering, Inc., and the U.S. Department of Energy in accordance with generally accepted professional engineering and geologic practice. We make no other warranty, either expressed or implied, and are not responsible for the interpretation by others of the contents herein.

Robert O. Devany 3-31-2018
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ACRONYMS AND ABBREVIATIONS

1,1-DCA	1,1-dichloroethane
1,1,2-TCA	1,1,2-trichloroethane
1,2-DCA	1,2-dichloroethane
1,2-DCP	1,2-dichloropropane
1,2,3-TCP	1,2,3-trichloropropane
Cal EPA	California Environmental Protection Agency
COC	constituent of concern
CrPWM	chromium pilot test monitoring wells
Cr(VI)	hexavalent chromium
DDC	density-driven convection
DOE	U.S. Department of Energy
EC	electrical conductivity
ft/ft	feet per foot
gpm	gallons per minute
GWETS-PS	groundwater extraction and treatment system pilot study
HFSDA	Hopland Field Station Disposal Area
HSU	hydrostratigraphic unit
IRA	interim removal action
LEHR	Laboratory for Energy-related Health Research
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
mg/L	milligrams per liter
MOC	monitoring-only constituent
NWC	new well constituent
pCi/L	picoCuries per liter
RD/RAWP	*Remedial Design/Remedial Action Work Plan for the Former Laboratory for Energy-Related Health Research Federal Facility, University of California, Davis*

Site	Laboratory for Energy-related Health Research/Old Campus Landfill Superfund Site
ST	Southern Trenches
SWRA	Site-Wide Risk Assessment
µg/L	micrograms per liter
µS/cm	microSiemens per centimeter
UC Davis	University of California, Davis
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound
WWTP	wastewater treatment plant

1. INTRODUCTION

This report presents the results of water monitoring performed in calendar year 2017 at the Laboratory for Energy-related Health Research (LEHR)/Old Campus Landfill Superfund Site (Site), located at the University of California, Davis (UC Davis) (Figure 1). Water monitoring at the Site was performed by UC Davis and the U.S. Department of Energy (DOE) as two separate water sampling programs that monitor adjacent and overlapping areas of the Site. This report includes water monitoring results for groundwater samples collected during 2017 from monitoring wells installed in three hydrostratigraphic units (HSUs) at the Site, a density-driven convection (DDC) groundwater remediation system, effluent from the interim removal action (IRA) system, chromium pilot test monitoring wells, a groundwater extraction and treatment system pilot study (GWETS-PS), and DOE sampling results.

1.1 Report Organization

Groundwater monitoring results for the UC Davis and DOE sampling programs are discussed in Sections 2 and 3, respectively. Storm water monitoring results are discussed in Section 4. Conclusions and recommendations are provided in Section 5, and references are shown in Section 6. The figures, tables, and appendices for this report are organized as shown below.

1.1.1 Figures

Figures in this report include:

- A site vicinity map (Figure 1);
- Southern Trenches (ST) and Hopland Field Station Disposal Area (HFSDA) study areas (Figure 2);
- Water sampling locations (Figure 3);
- Hydrogeological cross-section (Figure 4);
- Groundwater elevations and trends (Figures 5, 6, and 7);
- UC Davis constituents of concern (COC) concentrations and trends (Figures 8 through 29); and
- DOE Areas monitoring (Figures 30 through 33).

1.1.2 Tables

Tables in this report include:

- Dates and methods of field measurements (Table 1) and laboratory analyses (Table 2);

- Well details (Table 3);
- Data validation and analytical completeness (Tables 4 and 5);
- Groundwater elevation data (Tables 6, 7, and 8);
- COC analytical results (Tables 9 through 17);
- DDC performance (Table 18);
- IRA/GWETS-PS discharge analytical results (Table 19);
- IRA performance and analytical results (Table 20);
- Chromium pilot test monitoring well analytical results (Table 21);
- GWETS-PS performance and analytical results (Tables 22 and 23); and
- DOE Areas summaries (Tables 24 through 29).

1.1.3 Appendices

The following appendices are included in this report:

- Appendix A – Physical Setting, Scopes, and Methods
- Appendix B – Field Forms
- Appendix C – Historical Monitoring Results for Chemicals of Concern, 2011-2017
- Appendix D – Interim Removal Action and Density-Driven Convection Systems Operating Logs
- Appendix E – Analytical Report for UC Davis Area Groundwater Monitoring
- Appendix F – Analytical Reports for the IRA and GWETS-PS Systems
- Appendix G – Analytical Reports for DOE Areas Groundwater Monitoring Wells
- Appendix H – Re-evaluation of Background Value for Constituents in Groundwater Near DOE Areas

1.2 Investigation Activities in 2017

In June 2017, UC Davis undertook a supplemental chromium background investigation, including advancing several direct-push borings in areas south (in the vicinity of Becker Road) and northeast (in the vicinity of West Chiles Road) of the Site (Figure 1). These borings included cone penetrometer tests and hydropunch groundwater sampling to characterize the distribution of chromium in groundwater. Concurrently, a set of samples from Site wells was collected and analyzed for certain stable isotopes, including chromium, and isotopic groundwater age dating. UC Davis plans to issue a report summarizing the results of these activities in 2018.

In November 2017, UC Davis conducted a trenching study in the ST area and HFSDA to identify and sample buried waste for radionuclides. A total of eight trenches were dug, five in the ST area and three in HSFDA, each approximately 20 to 25 feet long and 6 to 12 feet in depth (Figure 2). Additional investigation of the HSFDA will likely be completed in early 2018, and UC Davis plans to issue a report summarizing the results of these activities in 2018.

In May 2017, two tracer dyes were introduced into the GMW-2 set of monitoring wells in the GWETS-PS area. Rhodamine WT was introduced in GMW-2C (screened in HSU-2) and Fluorescein was introduced into wells GMW-2A and GMW-2B (both screened in HSU-1). Selected GWETS-PS extraction wells and the IRA well are being regularly sampled for these dyes, along with two down-gradient HSU-2 wells. UC Davis plans to incorporate the results of this dye study into future reporting on the performance of the GWETS-PS regarding the remediation of hexavalent chromium (CrVI) in groundwater at the Site.

2. UC DAVIS GROUNDWATER SAMPLING RESULTS

This section describes the results of the UC Davis-specific groundwater monitoring activities, including sampling of monitoring wells and groundwater extraction/treatment wells, and discharges from groundwater remedial action systems. The results of the DOE-specific groundwater monitoring activities are discussed in Section 4. Some elements of the UC Davis program are relevant to the DOE program, including groundwater elevation mapping and site-wide spatial analyses of DOE COCs.

2.1 Groundwater Monitoring

Groundwater monitoring for the UC Davis and DOE sampling programs was performed by Weiss Associates (Weiss). Figure 3 presents well and water sampling locations. Tables 1 and 2 present the dates of sample collection and field measurements, and methods for laboratory analyses, respectively. Table 3 shows well construction details and the type of pump installed in each well, if applicable.

Water level measurements were taken at 142 locations at the Site, including quarterly measurements for groundwater elevation contouring at 96 locations:

- 50 HSU-1 wells, of which 12 are DOE wells;
- 31 HSU-2 wells;
- Five HSU-4 wells;
- One extraction well;
- Six GWETS-PS monitoring wells; and
- Three UC Davis wastewater treatment plant (WWTP) wells.

These locations are shown on Figures 5, 6, and 7. Groundwater elevations were also measured quarterly in 18 DDC wells (six locations of three nested wells each), 15 DDC piezometers (five locations of three nested piezometers each), four chromium pilot test monitoring wells (CrPMW), and nine GWETS-PS extraction wells to assist in evaluating the performance of these systems. These evaluations are presented in Sections 2.3, 2.4, and 2.6. Dates of field measurements and laboratory analyses are provided in Table 1. Data validation and analytical completeness are presented in Tables 4 and 5, respectively. Groundwater elevation data are provided in Table 6.

Included in the 142 locations measured in 2017 are continuous water level measurements in three DOE wells (UCD1-071, UCD1-079, and UCD1-081) and nine UC Davis wells (EW1-01 through EW1-09) using pressure transducers with built-in data loggers to better understand changes in groundwater levels throughout the year at the Site.

Groundwater level elevations in HSU-1, HSU-2, and HSU-4 (Figures 5, 6, and 7, respectively) were notably higher in 2017 than in 2016, as heavy winter rains ended drought conditions that had persisted over the last 5 years. The highest measured groundwater elevations occurred during the first quarter; the lowest measured elevations occurred during the third quarter (dry season) for each HSU. Historically, groundwater elevations have declined in the summer months mainly due to decreased recharge and regional agricultural pumping. Elevations historically rise in the fall, winter, and spring due to the more limited groundwater use and increased groundwater recharge during the wet season.

Estimated groundwater flow directions in 2017 were more strongly oriented to the east than in previous years, with stronger lateral and vertical gradients. The lateral groundwater gradient in HSU-1 was generally to the north in the first quarter and trended east to southeast in the remaining three quarters, converging toward the area of the IRA and GWETS, and ranged from approximately 0.0016 to 0.0078 feet per foot (ft/ft). The lateral groundwater gradient of HSU-2 was oriented to the east in all four quarters of 2017 and ranged from approximately 0.0003 to 0.0011 ft/ft. The apparent lateral groundwater gradient of HSU-4 was to the east in the second quarter and to the southeast in the third and fourth quarters and ranged from approximately 0.0002 to 0.0052 ft/ft. The first quarter groundwater gradient in HSU-4 could not be reliably determined from available data, but in the remaining three quarters, the gradient trended east to southeast. In 2017, one water level measurement was deemed anomalous out of a total of 384 levels measured, for an acceptance rate of 99.7 percent (Table 7). A strong north-to-south gradient was observed in the northern portion of the Site in the third quarter for HSU-1, which is attributed to flood irrigation of agricultural fields directly to the north.

The vertical gradients between HSU-1 and HSU-2 (Table 8) were in a wider range (-0.154 to 0.570 ft/ft) from vertical gradients in the previous year. Upward vertical gradients were stronger than 2016 in all four well pairs within the GWETS area in each of the four quarterly observations, with notably stronger upward vertical gradients in the GMW-1B/GMW-1C and GMW-2B/GMW-2C well pairs. This is most likely due to the optimization and continuous operation of the GWETS system throughout 2017, with extraction wells in HSU-1 creating sufficient drawdown to maintain an upward gradient. Downward vertical gradients occurred in the most upgradient well pairs (UCD1-004/ UCD2-015 and UCD1-034/UCD2-035), with each of the four quarters showing a stronger downward vertical gradient than 2016. The remaining well pairs showed vertical gradients comparable to 2016.

2.2 Analytical Results for Groundwater

The analytical results for groundwater samples Site-wide, including both DOE and UC Davis wells, were generally consistent with previously established chemical concentration trends with the following exceptions:

- Site-wide chloroform levels in HSU-1 and HSU-2 for 2017 in many wells are slightly elevated relative to 2016 values, possibly related to increased precipitation and groundwater elevations related to the prolific 2016-2017 wet season (Table 9; Figures 8 through 13). Chloroform exceeded the U.S. Environmental Protection Agency (USEPA) Maximum Contaminant Level Goal (MCLG) of 70 micrograms per liter (μg/L) in eight of 34 HSU-1 wells and three of 20 HSU-2 wells sampled in 2017. Chloroform concentrations did not exceed the MCLG in any of the samples collected and analyzed from five HSU-4 wells. Well UCD1-050, which is proximal to the DDC remediation system, showed decreased concentrations of chloroform in 2017 likely due to DDC system operation. Chloroform was detected downgradient of the DDC area at concentrations up to 4,800 μg/L in HSU-1 (UCD1-088) and 660 μg/L in HSU-2 (UCD2-085). The HSU-1 chloroform plume expanded slightly on the east side and contracted slightly on the north side, relative to 2016. The HSU 2 plume widened laterally downgradient (east) and the zone of higher concentrations measured along the main plume axis expanded to the east. These plume changes occurred in areas where chloroform concentration are well below the chloroform MCLG of 70 µg/L, and in most cases in areas where the reported concentrations are less than 10 µg/L. Apparent lateral contraction in the upgradient (western) area of the plume is related to better lateral control on the plume extent obtained from data in wells UCD2-039 and UCD2-048.

- Chloroform concentrations in several wells exceeded their previous maximum measured concentrations. A group of these are HSU-1 wells within the area of influence of the GWETS-PS system, which suggests chloroform is being drawn upward from higher-concentration areas of lower HSU-1/upper HSU-2 by the vertical hydraulic gradient created by the GWETS-PS extraction wells:
  - UCD1-028: 7.5 µg/L; previous high of 1.8 µg/L
  - UCD1-052: 49 µg/L; previous high of 16 µg/L
  - UCD1-053: 1.3 µg/L; previous high of 0.42 µg/L
  - GMW-1A: 0.91µg/L; previous high of 0.44 µg/L
  - GMW-1B: 7.7 µg/L; previous high of 2.6 µg/L
  - GMW-2B: 9.6 µg/L; previous high of 1.9 µg/L

  Well GMW-1C, monitoring HSU-2 in the GWETS-PS area, also measured a new maximum chloroform concentration (9.8 µg/L; previous high of 2.7 µg/L).

  Outside the GWETS-PS area, five additional wells (two in HSU-1 and three in HSU-2) exceeded their previous maximum measured chloroform concentrations. These wells are spatially distributed and likely reflect a slight overall increase in concentration and aerial extent of the chloroform plume related to higher groundwater levels in 2017:
  - UCD1-062: 0.55 µg/L; previous high of 0.19 µg/L
  - UCD1-072: 2.4 µg/L; previous high of 1.5 µg/L
  - UCD2-077: 14 µg/L; previous high of 8.9 µg/L
  - UCD2-086: 130 µg/L; previous high of 73 µg/L
  - UCD2-089: 1.1 µg/L; previous high of 0.89 µg/L

- Total chromium (Table 10) was detected at concentrations up to 510 µg/L in HSU-1 (GMW-2B in GWETS-PS area), slightly below the 2016 maximum value for HSU-1, and 95.6 µg/L in HSU-2 (UCD2-089, approximately 360 feet south-west of GWETS-PS area), slightly above the 2016 maximum value for HSU-2. Plume extents for 2017 were similar to 2016 in HSU-1 and HSU-2, with minor variations (Figures 14 and 15); the majority of measured wells in both HSU-1 and HSU-2 showed decreases in 2017 (Figures 16 and 17). Twenty-seven of 38 HSU-1 wells and 10 of 29 HSU-2 wells sampled in 2017 exceeded the California Maximum Contaminant Level (MCL) of 50 µg/L, and seven wells (UCD1-049, UCD1-064, UCD1-069, UCD1-070, UCD1-072, UCD2-085, and UCD2-089) with more than a 2-year history showed slight increases above previous historical high concentrations.

- Chromium concentrations dropped in the GWETS-PS area of influence in both HSU-1 and HSU-2. Notable decreases relative to 2016 values occurred in wells GMW-1B, GMW-2B, UCD1-028, and UCD1-053 (all HSU-1 wells; all measuring new low concentrations). HSU-2 wells in the GWETS-PS area, including wells UCD2-029, UCD2-031, GMW-1C, and GMW2-C, continue in decreasing chromium trends established in 2015 after GWETS-PS operations commenced.

  Outside the GWETS-PS extraction area, the general distribution of chromium concentrations remained consistent with 2016 and increases/decreases at specific wells did not appear to follow any consistent pattern.

- Nitrate (as nitrogen) was detected at concentrations up to 90 milligrams per liter (mg/L) in HSU-1 (UCD1-050) and 90 mg/L in HSU-2 (UCD2-085); these values are above the 2016 highs (Table 11). Plume extents for 2017 were similar to 2016 in HSU-1, with only minor differences. The overall nitrate plume in HSU-2 was slightly smaller than 2016, contracting on the west and southeast sides, and expanding slightly to the northeast. (Figures 18 through 21). Twenty-six of 33 HSU-1 wells and 10 of 26 HSU-2 wells sampled in 2016 contained concentrations that exceeded the USEPA MCL of 10 mg/L; and five wells (UCD1-064, UCD1-066, UCD2-030, UCD2-031, and UCD2-085) with more than a 2-year history showed slight increases above previous historical high concentrations. The furthest downgradient well (UCD2-046), located off-site in an agricultural area, shows an increase in 2017 as compared to 2016, in line with the overall increasing trend in that well over the last 10 years.

  Within the GWETS-PS area of influence, nitrogen concentrations in HSU-1 show a possible pattern of decrease relative to 2016. Wells UCD1-028, UCD1-052, and GMW-1B all measured concentrations notably below 2016 values. Well UCD1-028 measured a new low concentration of 28J µg/L (estimated), continuing a downward trend that began in 2016. This is likely related to the vertical gradients established by the GWETS-PS extraction wells.

- Carbon-14 activities in groundwater at the Site remain well below the USEPA MCL of 2,000 picoCuries per liter (pCi/L) (USEPA, 1976). The maximum 2017 carbon-14 activity (203 pCi/L) was reported for a sample collected from well UCD1-013 (Figure 22; Table 12) and is on-trend with historical data from that well. Historical carbon-14 trends are shown on Figures 23 and 24. The plume contours shown on Figure 22 are expanded relative to 2016, however this is likely a function of increased sampling in 2017 rather than actual increases in carbon-14 activities in groundwater.

- Tritium activities in groundwater at the Site remain well below the USEPA MCL of 20,000 pCi/L (USEPA, 1976). Two HSU-1 wells (UCD1-013 and UCD2-014) were sampled for tritium in 2017. Both wells are located downgradient of the Waste Burial Holes where radiological waste was historically disposed (and showed the highest tritium concentrations). Tritium was not detected in samples from either well (Table 13). Historical tritium trends are shown on Figures 23 and 24.

- Concentrations of 1,4-dioxane were detected up to 170 µg/L in HSU-1 (UCD1-088), slightly lower than 2016, and 47 µg/L in HSU-2 (UCD2-084) slightly higher than 2016. Concentrations of 1,4-dioxane were detected at levels above the USEPA Regional Screening Level of 0.46 µg/L for tap water in 11 of 18 HSU-1 wells and four of 11 HSU-2 wells sampled for this constituent in 2017 (Figures 25 and 26; Table 14). The plume extent in HSU-1 for 2017 was slightly smaller than 2016, with a contraction on the southern and western sides (Figure 25). In HSU-2, the overall plume was smaller than 2016, contracting on the eastern and northern sides, but the central area of high concentration expanded due to higher values measured in UCD2-084 (47 µg/L), UCD2-085 (22 µg/L), and UCD2-086 (13 µg/L) (Figure 26). The 1,4-dioxane plume source has not been determined; potential sources include scintillation vials disposed in landfill units, sewer leaks, and detergent use.

- 1,2,3-trichloropropane (1,2,3-TCP) concentrations were detected up to 9.2 µg/L in UCD1-088 (screened at or near the lower HSU-1/upper HSU-2 boundary), a slight decrease from 2016 (Figures 27 and 28; Table 15). 1,2,3-TCP was measured in a total of 64 wells, including 35 wells analyzed by USEPA Method 524.2, with a reporting limit of 0.005 µg/L (equal to the 2018 MCL). The other 29 wells included 1,2,3-TCP analyzed by USEPA Method 8260B (along with chloroform and other VOCs), with a reporting limit of 1.0 µg/L. In 27 of the 35 wells analyzed with USEPA Method 524.2, 1,2,3-TCP concentrations exceeded the 0.005 µg/L MCL (Cal-EPA, 2018), with three of the other eight wells showing trace detections below the MCL. The 29 wells analyzed for 1,2,3-TCP with only USEPA Method 8260B all reported non-detects (<1 µg/L), except for UCD1-062, which measured 1.6 µg/L. In HSU-1, two 1,2,3-TCP plumes are centered in the DDC area and on well UCD1-062 (Figure 27). The plume in the DDC area showed only minor changes relative to 2017, while the plume centered on UCD1-062 expanded to the west, based on results from well UCD1-013. The plume in HSU-2 expanded slightly to the north and showed somewhat higher values in the DDC area and around well UCD2-089, but overall maintained a shape similar to the chloroform plume (Figure 28).

- In 2017, a total of 154 individual electrical conductivity (EC) measurements were taken from 44 HSU-1 wells, 29 HSU-2 wells, five HSU-4 wells, and A, B, and C intervals in four DDC wells.[1] EC results, including identification of maximum EC values in each well prior to 2017, are shown in Table 16. The highest EC measurements taken in HSU-1, HSU-2, and HSU-4 during the 2017 sampling event were 3,040 microSiemens per centimeter (µS/cm) in well GMW-2A, 1,594 µS/cm in well UCD2-085, and 807 µS/cm in well UCD4-041, respectively. Eight HSU-1 wells (GMW-2A, UCD1-064, UCD1-006, UCD1-068, UCD1-069, UCD1-070, UCD1-080, and UCD1-081) recorded EC measurements above prior historical maximum. All HSU-2 and HSU-4 measurements were below historical maximum.

[1] In the *2007 Comprehensive Annual Water Monitoring Report* (B&C, 2008), it was recommended that total dissolved solids analyses be substituted by field measurements of EC.

- One or more other volatile organic compounds (VOCs) (e.g., 1,1,2-trichloroethane [1,1,2-TCA], 1,1-dichloro-ethane [1,1-DCA], 1,2-dichloropropane [1,2-DCP], 1,2-dichloroethane [1,2-DCA], and vinyl chloride), co-located with chloroform, were detected at concentrations exceeding their respective MCLs in groundwater samples collected from two of four DDC wells, eight nearby HSU-1 wells that monitor the DDC system, and three nearby HSU-2 wells (Figure 29). Both the number of wells measuring concentrations exceeding their MCLs, and the maximum concentration of measured constituents at the Site increased relative to 2016, coinciding with increased chloroform concentrations and a slightly larger chloroform plume.

  As shown in Table 17:

  - 1,1,2-TCA was detected at concentrations up to 28 μg/L (UCD1-049);
  - 1,1-DCA was detected at concentrations up to 33 μg/L (UCD1-087);
  - 1,2-DCP was detected at concentrations up to 98 μg/L (UCD2-088); and
  - 1,2-DCA was detected at concentrations up to 89 μg/L (UCD2-088).

- The higher groundwater elevations and associated stronger vertical and horizontal gradients may have affected chloroform and 1,4-dioxane concentrations, showing a slight overall increase and a spreading of the downgradient portion of these plumes. Other constituents did not appear to be affected in any consistent pattern.

- HSU-4 wells are not sampled for carbon-14, tritium, chromium, or nitrate as past sampling of these wells showed concentrations consistent with HSU-4 background. The HSU-4 wells are also not sampled for 1,4-dioxane and 1,2,3-TCP because they are present at such low concentrations in HSU-2 that migration to HSU-4 is considered highly unlikely.

For 2017, a total of 256 samples were collected which produced 7,423 individual results (Table 5). Of the data collected, 98 percent were valid and useable, satisfying the completeness requirement of 95 percent useable data as listed in Table 3.1b ("Quality Assurance Objectives for Water Samples") of the *Quality Assurance Project Plan Revisions* (Weiss, 2008).

2.3 Density-Driven Convection System

The DDC groundwater treatment system consists of six nested DDC wells screened in three depth intervals in HSU-1 (Figure 3, Inset A). Four of the six wells were in operation from February 17 through November 10, 2017 (Table 18), which is the longest duration of seasonal DDC operation since 2011. Well DDC-1 has not been in operation since January 2013 due to poor performance. Well DDC-2 was not operated due to an unresolved blockage in the discharge piping. Maintenance was performed on the DDC system every two weeks while wells were operating.

Samples were collected from the deep and intermediate zones of the operational DDC wells on April 25, 2017; the shallow zone of each DDC cluster remained dry throughout the year. Chloroform concentrations increased slightly in all four wells in the DDC area in 2017 when compared to 2016. Based on performance and analytical data from the DDC wells, an estimated 2.4 pounds of chloroform was removed in 2017; a total of approximately 328 pounds of chloroform have been removed since system inception in December 2000 (Table 18).

2.4 Interim Removal Action System

The IRA system began operation in May 1998 to minimize off-Site migration of chloroform and other co-located VOCs in HSU-2. The system operates by pumping water from one extraction well (EW2-01) (Figure 3, Inset B), located approximately 800 feet east of the DDC remediation area, into a 2,000-gallon influent tank that discharges directly to the UC Davis WWTP.

The IRA system operated 98 percent of the time in 2017, similar to the 99 percent uptime reported for 2016. During the 372-day measurement period in 2017, the system pumped approximately 31.7 million gallons of water from extraction well EW2-01 at an average rate of 59 gallons per minute (gpm). On May 11, 2017, flow was reduced from 100 gpm to approximately 60 gpm, while still maintaining the required capture area. Discharge from the system was compliant with applicable UC Davis WWTP effluent discharge limits (Table 19). Based on analytical data for samples from the IRA, an estimated 2.8 pounds of chloroform was removed from groundwater in 2017, slightly higher than the amount removed in 2016; a total of approximately 157 pounds of chloroform has been removed since system startup (Table 20).

2.5 Chromium Treatment Pilot Test Monitoring Results

Pilot test monitoring wells were installed in 2010 as part of an *in situ* reduction field pilot test conducted in the vicinity of an on-Site chromium “hot spot” in HSU-1 (Figure 3, Inset B). This test consisted of injecting calcium polysulfide into HSU-1 and upper HSU-2 to examine its potential to reduce the concentrations of Cr(VI) in groundwater. Wells were installed and sampled before and after the injection to establish baseline results and monitor the effectiveness of the test. The *Draft Implementation and Performance Monitoring Report for in situ Reduction of Hexavalent Chromium* (Weiss, 2011) details the field pilot test and discusses the results from the first 16 months of monitoring (through June 2011). Monitoring for this pilot test was discontinued in 2016; however, three of the wells (CrPMW1-025s, CrPMW1-025i, and CrPMW1-025d) were sampled for chromium (Table 21) as part of the GWETS-PS monitoring. Concentrations of chromium, manganese, nitrate, and sulfate measured in these wells during 2017 were similar to those measured in the wells during 2016. In wells CrPMW1-025s and CrPMW1-025i, chromium concentrations remained substantially below the respective baseline levels, while the sulfate concentration remained above its baseline level.

2.6 Groundwater Extraction and Treatment System Pilot Study

The GWETS-PS was constructed to study the remediation of elevated Cr(VI) in HSU-1 (Figure A3, Appendix A). The GWETS-PS consists of nine HSU-1 extraction wells whose combined effluent is discharged into the IRA system influent tank. The combined GWETS-PS and IRA groundwater is then directly discharged to the UC Davis WWTP. There are 16 associated monitoring wells (nine HSU-1 and seven HSU-2 wells) which are sampled quarterly while the system is in operation. Although not considered GWETS-PS monitoring wells, nine additional downgradient HSU-2 wells are monitored annually for chromium and nitrate in support of pilot study objectives.

The GWETS-PS was initially operated from December 1, 2015 through May 13, 2016, at which time the system was shut down due to low water levels in HSU-1. The system was returned to operation on December 5, 2016 and continued to operate through the entirety of 2017. A total of 5,675,823 gallons of groundwater was extracted in 2017, with an average combined flow rate of 9.7 gpm (Table 22). Water discharged from the IRA and GWETS-PS are combined prior to discharge to the sanitary sewer. Combined effluent samples were collected quarterly during 2017 (Table 23). The associated GWETS-PS monitoring wells were sampled quarterly and the nine associated downgradient HSU-2 wells were sampled as part of the Site-wide annual groundwater sampling event (Appendix A).

The extraction wells in the GWETS-PS area appear to be establishing a consistent upward vertical groundwater gradient in this area. Contouring of groundwater elevation data indicates groundwater flow in HSU-1 converged toward the GWETS-PS extraction area in all four quarters of 2017 (Figure 5). Upward vertical gradients from HSU-2 to HSU-1 were stronger in 2017 than 2016 in all four well pairs within the GWETS-PS area during each of the four quarterly observations, with notably stronger upward vertical gradients in the GMW-1B/GMW-1C and GMW-2B/GMW-2C well pairs.

Monitoring wells in the GWETS-PS extraction area have shown a noticeable trend of decreasing chromium concentrations, as discussed in Section 2.2. In HSU-1, wells GMW-1B and GMW2-B (installed to monitor the GWETS-PS; monitoring HSU-1 since 2014) show steep downward trends, and wells UCD1-028 and UCD1-053 (monitoring HSU-1 in the GWETS-PS area since 1997 and 1999, respectively) show a continuation of an already declining concentration trend to all-time low values (Figure 16). HSU-2 wells in the GWETS-PS extraction area, including wells UCD2-029, UCD2-031, GMW-1C, and GMW2-C, show continued decreasing chromium trends, established in 2015 after GWETS-PS operations commenced. These decreases in chromium concentrations are attributed to pumping at the GWETS-PS. Based on analytical data from GWETS effluent, an estimated 7.8 pounds of chromium was removed from groundwater in 2017, and 9.8 total pounds of chromium was removed from the start of pumping in 2015 through the end of 2017 (Table 22).

3. DOE GROUNDWATER SAMPLING RESULTS

Long-term groundwater monitoring is a remedial component included in the *Record of Decision for DOE Areas* (DOE, 2009) to verify that residual contaminants in soil are not impacting groundwater at the Site. This section describes the results of the DOE-specific groundwater monitoring activities.

In 2017, groundwater was monitored at the following locations (Figure 30):

- Seven wells (UCD1-013, UCD1-021, UCD1-068, UCD1-069, UCD1-070, UCD1-071, and UCD1-072) located downgradient of the DOE Areas;
- Two established off-site background wells (UCD1-018 and UCD1-063); and
- Two prospective off-site background wells (UCD1-073 and UCD1-079).

The DOE-related analytes are divided into three categories: Constituents of Concern (COCs), Monitoring-only Constituents (MOCs), and New Well Constituents (NWCs). Each category is described below (Table 24):

- ***COCs*** are constituents identified in the *Site-Wide Risk Assessment*, *Volume I: Human Health Risk Assessment (Part B – Risk Characterization for DOE Areas)* (SWRA) (Weiss, 2005) based on their presence in soil at levels statistically above background and at concentrations contributing to human health cancer risks above 1 in 1 million, and/or their potential to impact groundwater at concentrations above background levels.
- ***MOCs*** were identified in the SWRA as constituents that should be included in a site monitoring plan; these compounds were identified as having a very low, but possible, potential to impact groundwater in the future.
- ***NWCs*** are compounds that are potentially present above background levels in wells UCD1-068 through UCD1-072 based on full-suite analyses performed on samples collected from wells installed in 2011.[2]

This section presents the data evaluation conducted for the COCs, MOCs, and NWCs.

3.1 2017 DOE Sampling

The DOE Areas groundwater sampling took place on March 21-23, 2017 for select COCs, MOCs, and NWCs as shown in Table 24. Samples were not collected in 2017 for most COCs, MOCs, and NWCs because their sampling frequency is biennial and they were sampled in 2016. The decisions, rationale, and statistical evaluation supporting the 2017 sample collection program are documented in the *First Five-Year Review* (DOE, 2016) and the *2016 Annual Water Monitoring Report* (Weiss, 2017).

[2] NWCs are not documented in the *Record of Decision* (DOE, 2009).

Samples were collected from background wells for metals, radionuclides, nitrate, and Cr(VI) during the first three quarters of 2017. Rationale for background sample collection is discussed in the background data evaluation in Appendix H. Established background wells UCD1-018 and UCD1-063 were sampled all three quarters. Prospective background well UCD1-073 was sampled in the first quarter and prospective background well UCD1-079 was sampled in the second and third quarters. The dates of background sample collection by quarter were:

- Quarter 1: March 21 and 23, 2017;
- Quarter 2: May 24-25, 2017; and
- Quarter 3: July 19-20, 2017

Additional samples were collected on May 25, 2017 (second quarter) to evaluate potential increases in some first quarter 2017 results:

- Nitrate in well UCD1-021;
- Selenium and carbon-14 in well UCD1-068;
- Carbon-14 in well UCD1-070; and
- Chloroform, total chromium, and Cr(VI) in well UCD1-072

Additional samples were collected on July 19-20, 2017 (third quarter) to further evaluate potential increases:

- Selenium in well UCD1-068;
- Carbon-14 in well UCD1-070; and
- Chloroform and Cr(VI) in well UCD1-072

Additional samples were collected on November 10, 2017 (fourth quarter) to further evaluate potential increases:

- Selenium in well UCD1-068;
- Uranium-238 in well UCD1-069;
- Carbon-14 in well UCD1-070; and
- Chloroform in well UCD1-072

In 2017, samples were collected from the DOE Areas and background wells with dedicated bladder pumps per the sample collection procedures specified in the *Remedial Design/Remedial Action Work Plan* (RD/RAWP) (DOE, 2010) and shipped to the laboratory under appropriate chain-of-custody. Groundwater samples were analyzed for various well-specific parameters for each of the three categories (COCs, MOCs, or NWCs) of DOE constituents as shown in Table 24.

Constituent sample results underwent data validation as summarized in Table 4; each applicable requirement was met. Analytical data from the DOE groundwater monitoring program in 2017 are included in Appendix G.

3.1.1 Background and Baseline Conditions

Background and baseline values were originally established and reported in the *2012 Comprehensive Annual Water Monitoring Report* (Weiss, 2014a). Background has been re-evaluated and updated using data collected from wells UCD1-018 and UCD1-063 in 2011, 2012, 2016, and 2017. Data from wells UCD1-73 and UC1-79 were not used in the background re-evaluation (Appendix H) as groundwater gradient conditions near these wells is still being evaluated (see Section 3.4). Baseline was established using data collected from DOE Areas wells UCD1-013, UCD1-021, UCD1-023, UCD1-054, and UCD1-068 through UCD1-072 in 2011 and 2012. The updated background and previously established baseline values (Table 25) were used as benchmark criteria in evaluating 2017 groundwater monitoring results according to the procedures specified in the RD/RAWP (DOE, 2010). Constituents where baseline condition changed due to the background update are noted in Table 25 and discussed in Appendix H.

3.1.2 DOE Constituents of Concern Analysis

The 2017 COC sample results are summarized in Table 26. Results were not reported for most of the COCs because they are on biennial sampling frequency and were not sampled in 2017. COCs having 2017 results were compared to the updated background and established baseline values in accordance with the procedures specified in the RD/RAWP (DOE, 2010) to determine if COC concentrations increased significantly.

For purposes of this analysis, the requirement of the RD/RAWP to monitor for a particular COC in a specific well is defined here as a *well-specific COC*. A total of eight well-specific COCs have established baseline values above their updated background values, and 23 well-specific COCs have established baseline values below or the same as their updated background values (Table 26). These two types of COCs were evaluated separately and are discussed below.

3.1.2.1 Well-specific COCs with Established Baseline Values Above Updated Background Values

In accordance with the procedures specified in the RD/RAWP (DOE, 2010), the above-background well-specific COCs were compared to their established baseline values to determine if a significant increase has occurred (Table 26). Two of the four well-specific COCs sampled in 2017 were below the established baseline values and did not require further evaluation. Nitrate results from well UCD1-021 (27 and 29 mg/L) were equal to or slightly above the established baseline value (27 mg/L). Carbon-14 results from well UCD1-070 in 2017 (17.6 to 46.7 pCi/L) ranged from below to more than twice the established baseline value (18.9 pCi/L).

The above-baseline COCs were analyzed for trends per the RD/RAWP (DOE, 2010) and time series plots were prepared as shown on Figure 31. The plotted data were used in the trend tests, with field duplicates averaged. The Mann-Kendall trend test was conducted in accordance with the USEPA guidance *Data Quality Assessment: Statistical Methods for Practitioners* (USEPA, 2006). The decision error (alpha significance level) used in the Mann-Kendall test was 1 percent, indicating a 1 percent chance the statistical test will conclude the data represent a trend when they do not. The trend test results indicated increasing trends for nitrate in well UCD1-021 and carbon-14 in well UCD1-070.

The maximum concentration of nitrate in well UCD1-021 in 2017 is only 2 mg/L higher than the established baseline value (27 mg/L). As shown on the plot on Figure 31, the nitrate concentration in well UCD1-021 declined to baseline in 2017. Although nitrate in well UCD1-021 tested positive for an increasing trend, the trend plot shows that the concentration is consistent with baseline.

Dixon’s outlier test was conducted on the carbon-14 data from well UCD1-070 and indicated no upper tail outliers at 1, 5, and 10 percent significance levels. As shown on the plot on Figure 31, the carbon-14 activity-concentration in well UCD1-070 declined continuously until it was below baseline by the end of 2017. Although carbon-14 in well UCD1-070 tested positive for an overall increasing trend, the activity-concentration appears to have decreased below baseline by the end of 2017.

Based on the results of the baseline comparison, visual inspection of the time-series plots, and statistical tests and evaluation, none of the five historically above-background well-specific COCs sampled showed a significant concentration increase in 2017, except for a temporary increase in carbon-14 in well UCD1-070 that declined to below baseline by the end of the year.

3.1.2.2 Well-specific COCs with Established Baseline Values Below Updated Background Values

As specified in the RD/RAWP (DOE, 2010), the 2017 monitoring data for well-specific COCs having established baseline values below the updated background values were compared to the updated background values to determine if any significant increases occurred. As shown in Table 26, all the well-specific COCs sampled in 2017 were below or the same as the updated background values, except for selenium in well UCD1-068.

Selenium in well UCD1-068 tested positive for an increasing trend. The maximum concentration of selenium in well UCD1-068 in 2017 (3.59 µg/L) was above the updated background value (2.92 µg/L) by 0.67 µg/L. Dixon’s outlier test was conducted on the selenium data and did not indicate the maximum was an upper tail outlier at 1, 5, or 10 percent significance levels. Concentrations of selenium in well UCD1-068 were slightly above updated background in 2017 except for the third quarter selenium result (2.05 µg/L) which was below both established baseline (2.24 µg/L) and updated background.

Based on the results of the background comparison, none of the four historically below-background well-specific COCs showed significant concentration increases in 2017, except possibly selenium in well UCD1-068. The trend evaluation for selenium background (Appendix H) indicated an increase over time based on the time series plot, and the background value increased accordingly (from 1.74 to 2.92 µg/L). The elevated selenium concentrations in well UCD1-068 in 2017 are likely reflective of the selenium background level increase.

3.1.3 DOE Monitoring-only Constituents Analysis

MOCs were evaluated to determine if a significant concentration increase occurred in 2017. Three well-specific MOCs have established baseline values above the updated background values and 14 well-specific MOCs have established baseline values below or the same as the updated background values (Table 27). These two types of MOCs were evaluated separately and are discussed below.

3.1.3.1 Well-specific MOCs with Established Baseline Values Above Updated Background Values

The one above-background well-specific MOC sampled in 2017 was compared to its established baseline value to determine if a significant increase has occurred (Table 27). The well-specific MOC was below its established baseline value. Based on the result of the baseline comparison, the historically above-background well-specific MOC sampled in 2017 did not show a significant concentration increase.

3.1.3.2 Well-specific MOCs with Established Baseline Values Below Updated Background Values

Three well-specific MOCs having established baseline values below the updated background values were sampled in 2017 and compared to the updated background values to determine if any significant increases occurred. As shown in Table 27, the well-specific MOCs sampled were the same or below the updated background values.

Based on the results of the background comparison, none of the historically below-background well-specific MOCs sampled in 2017 showed significant concentration increases.

3.1.4 DOE New Well Constituents Analysis

NWCs were evaluated to determine if a significant concentration increase occurred in 2017. Results were not reported for some NWCs because they are on biennial sampling frequency and were not sampled in 2017. As of 2017, a total of 19 well-specific NWCs have established baseline values above the updated background values, and five well-specific NWCs have established baseline values below the updated background values (Table 28). Specifically, the baseline status for Cr(VI) and uranium-238 in well UCD1-068, and uranium-238 in wells UCD1-069, UCD1-070, and UCD1-072 changed from above background to below background in 2017 as determined in Appendix H.

Table 28 contains a summary of NWC monitoring results for 2017, in comparison to updated background and established baseline values. Of the 12 well-specific NWCs sampled, eight were below established baseline and updated background values in 2017. The following four of 12 well-specific NWCs sampled were above the established baseline and updated background values in 2017:

- Uranium-238 in well UCD1-069;
- Chloroform in well UCD1-072;
- Total chromium in well UCD1-072; and
- Cr(VI) in well UCD1-072.

Mann-Kendall trend tests with a decision error of 1 percent were conducted and plots were prepared for the listed NWCs (Figure 32). Trend test results indicated no trends for uranium-238 in UCD1-069 and total chromium in well UCD1-072 and increasing trends for chloroform and Cr(VI) in well UCD1-072 (Table 28). These increasing trends are characterized below.

Chloroform concentrations in well UCD1-072 increased continuously during the first three quarters of 2017 from 1.6 to 2.4 µg/L and decreased to 1.6 µg/L in the fourth quarter. The increased chloroform concentrations occurred during a year of significantly higher water levels than previous years. The increase may be related to increased mobilization from high groundwater levels during the 2016-2017 wet season. The concentrations detected are all low and close to the reporting limit (2.4 µg/L or less compared with the 0.5 µg/L reporting limit), and do not represent a substantial concentration increase.

Results for Cr(VI) samples collected from well UCD1-072 in 2017 (60 to 64 µg/L) were slightly above the established baseline value (57 µg/L). Although the trend test results indicated an increasing trend with 1 percent decision error, Cr(VI) concentrations in well UCD1-072 have wavered close to baseline throughout the monitoring history and the 2017 results do not represent a significant increase.

Based on the results of the baseline comparison, visual inspection of the time-series plots, and statistical tests and evaluation, none of the well-specific NWCs had substantial concentration increases in 2017 and several were below the updated background value.

3.2 DOE Monitoring Well Program Uncertainty

As discussed in Section 7.10 (“Data Quality Assessment”) of the RD/RAWP (DOE, 2010), decision errors may occur if qualified data are used in groundwater monitoring program decisions. In 2017, no well-specific COCs had maximum concentrations that were qualified; as such, DOE Areas decisions made with these maximum concentrations are expected to have low probability of decision error. Uncertainty issues were identified for MOCs and NWCs; these are identified and discussed below.

3.2.1 Monitoring-only Constituents

The maximum concentration of aluminum in well UCD1-069 (11.8J µg/L) was qualified due to trace detection. The qualified concentration was below the established baseline value, leading to a decision to maintain annual sampling. Confidence in this decision is good because the qualified concentration was well below the established baseline value of 1,080 µg/L and the baseline concentration is not qualified.

3.2.2 New Well Constituents

Results for gross beta (wells UCD1-068, UCD1-070, UCD1-071, and UCD1-072) and iron (well UCD1-069) were J-qualified due to trace detections below the reporting limit. These qualified results were below their established baseline values leading to decisions to maintain annual sampling.

Confidence in decisions for gross beta in wells UCD1-068, UCD1-071, and UCD1-072 and iron in well UCD1-069 is good because their results were well below established baseline values, and the baseline values are not qualified (Table 28). The decision for gross beta in well UCD1-070 is less confident because the baseline activity-concentration (4.4J pCi/L) is qualified due to field duplicate imprecision. Yet, the gross beta activity-concentration in well UCD1-070 (1.98J pCi/L) is below the average of baseline and its field duplicate (average = 2.9 pCi/L), indicating reasonable decision confidence.

3.3 Laboratory Audits

Laboratories contracted to analyze DOE Areas groundwater monitoring program samples were audited in 2017 to assess their management systems, operational practices, and compliance with the Department of Defense/Department of Energy *Consolidated Quality Systems Manual (QSM) for Environmental Laboratories* (DOE/DOD, 2017). GEL Laboratories, LLC of Charleston, South Carolina, was audited on April 4-6, 2017 (DOE, 2017) and Eurofins Calscience, Inc. of Garden Grove, California, was audited on June 15-19, 2017 (ANSI/ANAB, 2017). The findings of the audits indicate the contract laboratories are proficient in the fields of testing in which they are contracted.

3.4 DOE Continuous Water Level Monitoring

In 2012, pressure transducers and water level data loggers were installed in monitoring wells UCD1-054, UCD1-071, and UCD1-073 near the northwest corner of the Site (Figure 30). The purpose of the DOE continuous water level monitoring was to refine the conceptual model of groundwater flow in the vicinity of monitoring well UCD1-073, which was installed by DOE in 2011 to monitor HSU-1 groundwater background concentrations of COCs and MOCs of the DOE Areas.

Evaluations of the water level monitoring data indicated a higher degree of hydrogeologic isolation between HSU-1 and HSU-2 in the vicinity of well UCD1-073, creating a lag in response to seasonal groundwater elevation fluctuations. The apparent differences in hydraulic communication have prevented a decision on selecting well UCD1-073 as a representative background well.

On May 4, 2017, the transducers and data loggers were staged in wells UCD1-071, UCD1-079, and UCD1-081 to evaluate if groundwater elevation and gradient data support well UCD1-079 as a viable background well for HSU-1. Well UCD1-079 was installed by UC Davis in May 2014, along with wells UCD1-078 and UCD1-080 to assess Cr(VI) and nitrate background concentrations (Weiss, 2014b). Well UCD1-079 is located approximately 180 feet north of well UCD1-073 (Figure 30) and would be used to represent background in the vicinity of the northwest corner of the Site.

Data were logged throughout 2017 and the resulting water level plot is shown on Figure 33. As shown on Figure 33, water levels in the northwest corner of the Site ranged from a peak of approximately 19 feet above mean sea level in late April to a minimum of approximately 1-foot below mean sea level in early August. Groundwater levels increased dramatically in 2017 over recent years. The peak water level in 2017 was approximately 18 feet higher than the peak in 2016 due to above-average rainfall preceded by 3 years of drought. Water levels were approximately 14 feet higher at the end of 2017 than the beginning, and by mid-2017, were the highest overall since continuous water level monitoring began in 2012.

Between the time the transducers and data loggers were moved in May 2017 and the last data logger download in December 2017, water levels in well UCD1-079 were consistently higher than UCD1-081 indicating a general easterly flow direction. Water levels in well UCD1-071 were identical or slightly higher than well UCD1-081 during drawdown between early May and late July with a few dips below UCD1-081 in late June/July. When recharge began in early September, water levels in well UCD1-071 rose above levels in well UCD1-081 to become almost indistinguishable from well UCD1-079 levels from October through December 2017. This pattern indicates a southeasterly flow direction during drawdown and northeasterly flow during recharge. Water level data collection will continue in wells UCD1-071, UCD1-079, and UCD1-081 in 2018 and the data will be evaluated in detail when 1-year of continuous water level measurements is complete.

3.5 DOE 2018 Monitoring Plan

Sampling frequencies were specified in the *First Five-Year Review* (DOE 2016) for the DOE Areas groundwater monitoring program. Biennial sampling (once every two years) was specified for most COCs, MOCs, and NWCs and took effect in 2016. The biennial COCs, MOCs, and NWCs will be sampled in 2018.

The evaluations of groundwater data collected in 2017 and the Mann-Kendall trend test results did not indicate significant increasing trends above the updated background or established baseline values for the COCs, MOCs, and NWCs, with the possible exception of carbon-14 in well UCD1-070 which will be sampled during the first quarter of 2018. The planned sample collection for the DOE Areas groundwater monitoring in 2018 is presented in Table 29.

As specified in the RD/RAWP (DOE, 2010), laboratory audits are conducted every three years. The findings of the audits for 2017 indicate that the contract laboratories are proficient in the fields of testing in which they are contracted. Audits will be implemented next in 2020. Water level data collection using pressure transducers and data loggers will continue in 2018 in wells UCD1-071, UCD1-079, and UCD1-081 to evaluate the viability of wells UCD1-079 and UCD1-073 as representative background wells. If the water level data continue to confirm a dominant flow direction to the east, then groundwater background will be re-evaluated using data collected from wells UCD1-079 and UCD1-073.

4. UC DAVIS STORM WATER SAMPLING RESULTS

Storm water runoff monitoring at the Site consists of sampling at any of three locations: LS-01, LF-01, and LF-03 (Figure 3).

No storm water samples were collected from any Site locations during the 2017 calendar year. Due to the nature of the early 2016/2017 rainy season and the late 2017/2018 season, no sampling events occurred during the calendar year represented by this report. However, the required two events per rainy season have been collected for both seasons.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The 2017 UC Davis Areas groundwater monitoring data indicate that COC concentrations in groundwater are generally stable or declining, except for a slight increase in chloroform and other associated organic VOCs, likely related to increased mobilization from high groundwater levels during the 2016-2017 wet season. Slight expansions were observed in the chloroform and carbon-14 plumes, although the apparent expansion of the carbon-14 plume is likely a function of increased sampling in 2017, rather than actual increases in carbon-14 activities in groundwater. Organic COC (VOCs and 1,4-dioxane) concentrations reported for 2017 surpassed 2016 in both maximum concentration and the number of wells exceeding MCLs.

The GWETS-PS extraction wells have established a localized depression in the groundwater elevation in HSU-1 and an upward vertical hydraulic gradient between HSU-2 and HSU-1, which were observed in all four quarters of 2017. Concentrations of chromium in the GWETS-PS extraction area continue to decline, and an estimated 7.8 pounds of chromium was removed from groundwater in 2017. Wells UCD1-028, UCD1-053, GMW-1B, and GMW-2B (monitoring HSU-1 in the GWETS-PS area) show a continuation of the strong trend of decreasing chromium established at the beginning of GWETS remediation pumping in 2015. Wells UCD2-029, UCD2-031, GMW-1C, and GMW2-C (monitoring HSU-2 in the GWETS-PS area) also continue in decreasing chromium trends established after GWETS-PS operations commenced. Chloroform concentrations in HSU-1 exceeded their maximum measured concentrations in several wells within the GWETS-PS extraction area. This is likely a function of the upward vertical hydraulic gradient pulling water upward from HSU-2.

The 2017 DOE Areas groundwater monitoring data did not show significant increasing concentration trends above established background or baseline values, except for a temporary increase in carbon-14 in well UCD1-070 that declined below baseline by the end of 2017. Some of the analytical results were qualified, and trend evaluations led to decisions by DOE to maintain the biennial sampling frequencies established in the *First Five-Year Review* (DOE, 2016) for most well-specific constituents. Results for gross beta (wells UCD1-068, UCD1-070, UCD1-071, and UCD1-072) and iron (well UCD1-069) were J-qualified due to trace detections below the reporting limit. These qualified results were below their established baseline values leading to decisions to maintain annual sampling.

5.2 Recommendations

Annual sample collection will continue in 2018, and the following is recommended:

- Groundwater extraction and treatment be continued at the IRA and GWETS-PS;
- Continued operation of the DDC be re-evaluated to consider that portions of the system are reaching an end of their useful life; and
- The 2018 Sampling and Analysis Plan (see Section 3.5 of this report) will be presented to the LEHR Project Team in early 2018 for discussion and finalization.

5.3 Additional Site Information

The following representatives may be contacted for more information:

- Christopher Wright
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- Jeffrey Murl
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Documents relating to site investigation and cleanup may be found at:

- Yolo County Public Library, Davis Branch – Reference Desk
  (530) 756-2332

Selected DOE site documents are available at the Yolo County Public Library, Davis Branch in Davis, and the Administrative Record is available at the DOE Office of Legacy Management website: https://www.lm.doe.gov/lehr/Sites.aspx.

Additional information and site documents are available at the USEPA Region 9 Superfund website: https://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0904786.

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