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S.S. PAPADOPULOS & ASSOCIATES, INC.

ENVIRONMENTAL & WATER-RESOURCE CONSULTANTS

June 23, 2017

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Subject: Sparton Technology, Inc: Former Coors Road Plant Remedial Program 2016 Annual Report

Lady and Gentlemen:

On behalf of Sparton Technology, Inc. (Sparton), S.S. Papadopulos & Associates, Inc. (SSP&A) is pleased to submit the subject report. The report presents data collected at Sparton's former Coors Road Plant during the operation of the remedial systems in 2016, and evaluations of these data to assess the performance of the systems.

We certify under penalty of law that this document and all attachments were prepared under our direction and supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based upon our inquiry of either the person or persons who manage the system and/or the person or persons directly responsible for gathering the information, the information submitted is, to the best of our knowledge and belief, true, accurate, and complete. We further certify, to the best of our knowledge and belief, that this

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document is consistent with the applicable requirements of the Consent Decree entered among the New Mexico Environment Department, the U.S. Environmental Protection Agency, Sparton Technology, Inc., and others in connection with Civil Action No. CIV 97 0206 LH/JHG, United States District Court for the District of New Mexico. We are aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

If you have any questions concerning the report, please contact us.

Sincerely,

S.S. PAPADOPULOS & ASSOCIATES, INC.

Stavros S. Papadopulos, PhD, PE, NAE
Founder & Senior Principal

Alex Spiliotopoulos, PhD
Associate & Senior Hydrogeologist

cc: Secretary, Sparton Technology, Inc., c/o Mr. Ernesto Martinez
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Sparton Technology, Inc.
Former Coors Road Plant
Remedial Program

2016 Annual Report

Prepared for:

Sparton Technology, Inc.
Schaumburg, Illinois

Prepared by:

S.S. PAPADOPULOS & ASSOCIATES, INC.
Environmental & Water-Resource Consultants

June 23, 2017

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List of Acronyms

µg/L	Micrograms per liter
COA	City of Albuquerque
Cr	Chromium
DCE	1,1-Dichloroethylene
DFZ	Deep Flow Zone below the 4800 — foot clay
ft	foot or feet
ft MSL	feet above Mean Sea Level
ft/d	feet per day
ft/yr	feet per year
ft^2	square feet
ft^2/d	feet squared per day
ft^3	cubic feet
g/cm^3	grams per cubic centimeter
gpd	gallons per day
gpm	gallons per minute
kg	Kilogram
lbs	Pounds
LFZ	Lower Flow Zone (ULFZ and LLFZ)
LLFZ	Lower Lower Flow Zone
MCL	Maximum Contaminant Level
Metric	Metric Corporation
mg/L	Milligrams per liter
MSL	Mean Sea Level
ND	Not Detected
NMED	New Mexico Environment Department
NMWQCC	New Mexico Water Quality Control Commission
O/S	On-Site
RFI	RCRA Facility Investigation
rpm	Revolutions per minute
Sparton	Sparton Technology, Inc.
SSP&A	S.S. Papadopulos & Associates, Inc.
SVE	Soil Vapor Extraction
TCA	1,1,1-Trichloroethane
TCE	Trichloroethylene
UFZ	Upper Flow Zone
ULFZ	Upper Lower Flow Zone
USEPA	United States Environmental Protection Agency
USF	Upper Santa Fe Group
USGS	United States Geological Survey
VC	Vinyl Chloride
VOC	Volatile Organic Compound

Section 1 Introduction

The former Coors Road Plant of Sparton Technology, Inc. (Sparton) is located at 9621 Coors Boulevard NW (on the west side of the boulevard), Albuquerque, New Mexico, north of Paseo del Norte and south of the Arroyo de las Calabacillas (see Figure 1.1). Investigations conducted between 1983 and 1987 at and around the plant revealed that on-site soils and groundwater were contaminated by volatile organic compounds (VOCs), primarily trichloroethene (TCE), 1,1,1-trichloroethane (TCA) and 1,1-dichloroethene (DCE), and by chromium, and that contaminated groundwater had migrated beyond the boundaries of the facility to downgradient, off-site areas.

These investigations also indicated that groundwater contamination was primarily within a sandy unit that lies above a 2-4 feet (ft) thick clay unit referred to as the 4,800-ft clay unit. This unit was encountered in every deep well installed during site investigations and in the U. S. Geological Survey (USGS) Hunter Ridge Park 1 Boring about 0.5 mile north of the site. The saturated thickness of the sands above the clay unit is about 160 ft. Beneath the facility, and in an approximately 1,500 ft wide band trending north from the facility, a silty clay unit has been mapped between an elevation of about 4,965 ft above mean sea level (ft MSL) and 4,975 ft MSL. This unit is referred to as the 4,970-ft silt/clay unit. Depending on the depth of their screened interval, wells installed at the site and its vicinity during site investigations, or later, have been referred to as Upper Flow Zone (UFZ) wells if screened across, or within 15 ft of, the water table, Upper Lower Flow Zone (ULFZ) wells if screened 15-45 ft below the water table, Lower Lower Flow Zone (LLFZ) wells if screened more than 45 ft below the water table, and Deep Flow Zone (DFZ) wells if screened below the 4,800-ft clay. The USGS boring also indicates a 15-ft thick clay unit below the DFZ between elevations of 4,705 and 4,720 ft MSL. At the on-site area, the 4,970-ft silt/clay unit separates the UFZ from the ULFZ. Well locations are shown in Figure 1.2 and their screened interval in relation to these flow zones is shown in Figure 1.3.

On March 3, 2000, the United States Environmental Protection Agency (USEPA), the State of New Mexico Environment Department (NMED), the County of San Bernalillo, the City of Albuquerque (COA) and Sparton entered into a Consent Decree that set the terms for addressing soil and groundwater contamination. Under the terms of this Consent Decree, Sparton is currently operating an off-site and a source containment system to address groundwater contamination.[1] The off-site containment system consists of a containment well, CW-1, that fully penetrates the saturated portion of the sand unit above the 4,800-ft clay, a treatment building with an air stripper to treat the pumped water, a pipeline to the nearby Arroyo de las Calabacillas, and an infiltration gallery in the arroyo for returning the treated water to the

[1] Under the terms of the Consent Decree, Sparton also operated a Soil Vapor Extraction (SVE) system to address on-site soil contamination; this system was operated for a total of about 372 days between April 10, 2000 and June 15, 2001 and was dismantled in May 2002 after data indicated that the requirements and performance goals of the Consent Decree were met (Chandler and Metric Corp., 2001).

aquifer (see Figure 1.4). The source containment system also consists of a containment well, CW-2, with a 50-ft screen across the upper part of the sand unit, an on-site treatment building with an air stripper and a chromium removal unit[2] to treat the pumped water, and pipelines to two on-site ponds[3] for returning the treated water to the aquifer (see Figure 1.5).

Prior to the implementation of the remedial measures discussed above, the predominant contaminants at the off-site areas were VOCs, primarily TCE followed by DCE and TCA. In past Annual Reports the initial horizontal extent of these three contaminants was presented in plume maps prepared using November 1998 data from monitoring wells that existed at that time. At the on-site area, these plume maps did not distinguish between shallow wells completed above the 4970-ft silt/clay and deeper wells completed below the 4970-ft silt/clay. As a result of the increased chromium concentrations at the on-site area, which led to the installation of the chromium removal unit, the USEPA and NMED requested Sparton to include in the 2015 and subsequent Annual Reports maps showing the extent of the chromium plume.[4] In preparing chromium plume maps for the 2015 Annual Report, it became apparent that a distinction should be made between plume extent above and below the 4970-ft silt/clay unit. This distinction was made not only in preparing the initial and the 2015 chromium plume maps but also in revising the initial and preparing the 2015 plume maps for the predominant VOCs. The 2016 plume maps presented in this Annual Report also distinguish between plume extent above and below the 4970-ft silt/clay unit.

The extent of the initial TCE plume above the 4970-ft silt/clay unit (hereafter the on-site plume) is shown in Figure 1.6 and that of the plume below the 4970-ft silt/clay and at the off-site areas (hereafter the regional plume) is shown in Figure 1.7. The corresponding initial DCE plumes are shown in Figures 1.8 and 1.9, and the initial TCA plumes are shown in Figures 1.10 and 1.11. Dissolved chromium concentrations, or total chromium concentrations wherever dissolved chromium data were not available, were used in determining the initial extent of the chromium plumes. The extent of the initial on-site chromium plume is shown in Figure 1.12 and that of the regional chromium plume is shown in Figure 1.13.

As indicated by these figures, the largest initial plume was that of TCE. Based on the initial horizontal and vertical extent of the plume for this compound, and a porosity of 0.3, the initial pore volume of the plume was estimated to be approximately 150 million cubic ft (ft^3), or 1.13 billion gallons, or 3,450 acre-ft [see the 1999 Annual Report (S.S. Papadopulos & Associates, Inc. [SSP&A], 2001a)].

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2 The original treatment system consisted only of the air stripper; a chromium removal unit was added in early 2014 to address increased chromium concentrations in the influent.

3 The original design consisted of six infiltration ponds. Based on performance data from these ponds, two ponds were backfilled in late 2005 and another two in early 2014 with the approval of the regulatory agencies.

4 Letter dated February 5, 2016 from Chuck Hendrickson of USEPA and Dave Cobrain of NMED to Ernesto Martinez of Sparton, re: Approval with Modifications, Request for Approval of Changes to Reporting Requirements and to Sampling Methodology, Sparton Technology, Inc., Former Coors Road Plant Remedial Program, IPE ID No. NMD083212332.

Based on trends in the monthly mass removal rates by the off-site and source containment systems and the mass of VOCs removed as of the end of 2016, the initial dissolved VOC mass within the aquifer underlying the site and its vicinity is currently estimated to be about 8,600 kilograms (kg) or 18,960 pounds (lbs) consisting of about 7,900 kg (17,420 lbs) of TCE, about 670 kg (1,480 lbs) of DCE, and about 25 kg (55 lbs) of TCA.[5] Available data are not adequate for estimating the initial mass of dissolved chromium.

The off-site containment well began operating on December 31, 1998 and is currently operating at an average pumping rate of about 300 gallons per minute (gpm). The year 2016 constitutes the 18th year of operation of the off-site containment system. The source containment system began operating at an average rate of about 50 gpm on January 3, 2002. Thus, the year 2016 constitutes the 15th year of operation of this system. As discussed in the 2013 Annual Report (SSP&A, 2014), the source containment system was shut down on November 15, 2013 to implement corrective measures for addressing increased chromium concentrations in the pumped water. These corrective measures, which consisted of the addition of a chromium removal unit to the treatment system and of modifications to the plumbing to accommodate this unit, were implemented in early 2014, and the source containment system resumed operations on April 23, 2014.

Between the beginning of the current remedial operations in December 1998 and the end of May 2011, Metric Corporation (Metric) of Albuquerque and then of Los Lunas, New Mexico was responsible for the operation of the remedial systems, the collection of monitoring and system performance data, and for other field activities. After the passing away of Gary Richardson of Metric in May of 2011, SSP&A was responsible for these activities between June 1, 2011 and July 31, 2014. Since August 1, 2014 these activities are conducted by OCCAM/EC (formerly Easterling Consultants, LLC) of Albuquerque, New Mexico.

The objectives of the containment systems are:

- To contain and capture contaminated groundwater in the off-site area;
- To contain and capture most of the contaminated groundwater leaving the on-site area;
- To treat the captured water and return it to the aquifer; and
- Achieve ground water standards to the extent required by the terms of the Consent Decree (2000).

The purpose of this 2016 Annual Report is to:

- Discuss problems encountered during the 2016 operation of the systems;
- Present the data collected during 2016 from operating and monitoring systems; and
- Evaluate the performance of the systems with respect to meeting the above cited objectives, and the requirements of the site's permits.

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[5] This estimated initial VOC mass does not include VOCs that were removed from groundwater by SVE systems that were operated at the on-site area.

This report was prepared by SSP&A on behalf of Sparton. Issues related to the year-2016 operation of the off-site and source containment systems are discussed in Section 2. Data collected to evaluate system performance and to satisfy permit or other requirements are presented in Section 3. Section 4 presents evaluations of the data with respect to the performance and the goals of the remedial systems. A summary and conclusions of the report and a discussion of future plans are presented in Section 5. Section 6 lists previous reports and documents pertinent to site investigations and activities, including references cited in this report.

Section 2
System Operations

2.1 Monitoring Well System

During 2016, water levels were measured in and samples were collected from all monitoring wells. Water levels were measured quarterly and samples were collected from each well at the frequency specified either in the Groundwater Monitoring Program Plan[6] (Monitoring Plan) or in the State of New Mexico Groundwater Discharge Permit DP-1184 (Discharge Permit).

The completion flow zone, location coordinates, and measuring point elevation of all existing wells are presented on Table 2.1; their diameters and screened intervals are summarized on Table 2.2.

2.2 Containment Systems

2.2.1 Off-Site Containment System

The total hours of operation and the downtime for the Off-Site Containment System during the year are summarized on Table 2.3.

2.2.2 Source Containment System

The totals hours of operation and downtime for the Source Containment System during the year are summarized on Table 2.4.

2.3 Problems and Responses

As shown on Table 2.3, while the off-site containment system was shut down only on nine occasions during 2016, the duration of six of these shutdowns was longer than a day, in fact, they ranged from about 1.29 to 6.05 days. Three of them occurred in November 2016 and were all due to the same problem, the malfunction of the main switch in the air stripper control cabinet. The electrical contractor summoned to address the problem had to go through several trouble-shooting exercises before identifying the cause of the problem and repairing it.

The source containment system had a much larger number of shutdowns (Table 2.4), primarily due to the tank exchange for the chromium removal unit which is scheduled to occur every three weeks. Three of these shutdowns lasted a day or more. The longest of these three shutdowns, which occurred in January 2016, was a planned shutdown for cleaning up sediment build-up in the air stripper and replacing its gaskets for leak prevention.

At both containment systems, most of the longer duration shutdowns during 2016, and during the last several years, were due to monitoring equipment failures. The existing monitoring system, which was installed at the start of the remedial operations, has deteriorated and is outdated. The system often fails to notify the operator that a shutdown has occurred, and the

[6] Attachment A to the Consent Decree.

shutdown is not discovered until the next scheduled visit of the operator. To address this problem, Sparton has authorized the replacement of the monitoring system with a new system that will diagnose problems when they occur and assure that the operator is notified of all shutdowns or failures that may occur during system operation. The new system is scheduled for installation during 2017.

Section 3 Monitoring Results

The following data were collected in 2016 to evaluate the performance of the operating remedial systems and to meet the requirements of the Consent Decree and of the permits for the site:

- Water-level and water-quality data from monitoring wells;
- Data on containment well flow rates; and
- Data on the quality of the influent to and effluent from the water-treatment systems.

3.1 Monitoring Wells

3.1.1 Water Levels

Water levels during 2016 were measured quarterly, in February, May, August and November. During each round of measurements, the depth to water was measured in all monitoring wells, the off-site and source containment wells, the two observation wells near CW-1 (see Figure 1.2), and the piezometer installed in the infiltration gallery. The corresponding elevations of the water levels during each of the four measurement rounds, calculated from these data, are summarized on Table 3.1. Selected monitoring well hydrographs are presented in Figure 3.1. As these hydrographs indicate, until several years ago, regional water-levels had been declining. This declining trend was attributed to groundwater production from deeper aquifers and a reduction in the extent of irrigated lands in the vicinity of the Site. Since about 2013, however, water-levels have reversed this trend and have been rising primarily due to a reduction in groundwater pumping through surface water use from the San Juan-Chama Drinking Water Project (Powell and McKean, 2014); recent improvements at the Arroyo de las Calabacillas and resulting increases in recharge may also have contributed to these water-level rises.

Water levels in some on-site wells completed above the 4970-foot silt/clay unit are also affected by the operation of the source containment system; they particularly respond to the discharge, or lack of discharge, of treated water into the infiltration ponds, depending on their proximity to the pond that is active at a given time. (See, for example, the hydrographs of wells MW-17 and MW-22 in Figure 3.1.)

3.1.2 Water Quality

All monitoring wells at the site were sampled at the frequency specified in the Monitoring Plan and the Discharge Permit.[7] The samples from wells in the Monitoring Plan were analyzed for VOCs and for total chromium; the Fourth Quarter (November) samples from these wells were also analyzed for dissolved chromium. The samples from the infiltration gallery and pond monitoring wells were analyzed for VOCs and total chromium, iron, and manganese as

[7] During the Third Quarter sampling event, pond monitoring well MW-77 was mistakenly not sampled; monitoring well MW-73 was sampled instead.

required by the Discharge Permit; all quarterly samples for wells MW-17 and MW-78, the First and Fourth Quarter samples from MW-77, and the Fourth Quarter samples from the remaining pond and gallery monitoring wells were also analyzed for dissolved chromium, iron, and manganese. In addition, seven on-site monitoring wells (MW-14R, MW-19, MW-30, MW 31, MW-41, MW-72, and MW-73), which are normally sampled only during the Fourth Quarter, were sampled during the first two quarters of 2016; the samples from these quarterly sampling events were analyzed for total and dissolved chromium to provide data for the evaluation of chromium conditions at the on-site area. Also, as part of the evaluation of the effect of purging on total chromium concentrations, during the First Quarter sampling event, a second sample was collected from pond monitoring well MW-17 the day after purging, and analyzed for total chromium.

The results of the analysis of the samples collected from the groundwater monitoring program wells during all sampling events conducted in 2016, and for all analyzed constituents, are presented in Table 3.2. The results of the analysis of the samples collected from the infiltration gallery and pond monitoring wells during all sampling events conducted in 2016 are presented in Table 3.3. Concentrations of TCE, DCE, TCA and of chromium that exceed the more stringent of their Maximum Contaminant Levels (MCLs) for drinking water or their maximum allowable concentrations in groundwater set by New Mexico Water Quality Control Commission (NMWQCC) are highlighted on Tables 3.2 and 3.3.

3.2 Containment Systems

3.2.1 Flow Rates

The volumes of groundwater pumped by the off-site and source containment wells during 2016 and the corresponding flow rates are summarized on Table 3.4.

Since the installation of the chromium removal unit at the source containment system in early 2014, the influent flow rate and the flow rate of the water diverted to the chromium removal unit are monitored at frequent intervals. These flow rate data for 2016 are included on the table that presents chromium concentration data associated with the chromium removal unit (Table 3.7).

3.2.2 Influent and Effluent Quality

Concentrations of TCE, DCE, TCA, and of total chromium, iron, and manganese in monthly influent and effluent samples collected from the off-site containment system during 2016 are summarized on Table 3.5. The concentrations of the same constituents in monthly influent and effluent samples collected from the source containment system during 2016 are summarized on Table 3.6. Concentrations of TCE, DCE, TCA and of chromium that exceed the more stringent of their MCLs for drinking water or their maximum allowable concentrations in groundwater set by NMWQCC are highlighted on Tables 3.5 and 3.6.

Since the installation of the chromium removal unit at the source containment system, besides the monthly influent and effluent samples that are analyzed for the specified VOCs and metals, samples are also collected for chromium analysis from points along the chromium treatment unit. During 2016, these samples were collected primarily from the influent to the tanks, the effluent from the second tank, and the effluent from the air stripper that discharges into the ponds; on two occasions in December, samples were also collected from a point between the two tanks (mid-tank sample). This sampling was conducted every three weeks, just before the scheduled tank exchange for the chromium removal unit. The chromium concentrations in these samples are summarized on Table 3.7. To provide a complete picture of the 2016 chromium concentrations at the source containment system, chromium concentrations in the monthly influent and effluent samples, which were already presented on Table 3.6, are also included on Table 3.7; chromium concentrations that exceed the NMWQCC standard of 50 μg/L are highlighted.

Section 4
Evaluation of Operations

As stated in the Introduction (Section 1), the objectives of the off-site and source containment systems are:

- To contain and capture contaminated groundwater in the off-site area;
- To contain and capture most of the contaminated groundwater leaving the on-site area;
- To treat the captured water and return it to the aquifer; and
- Achieve ground water standards to the extent required by the terms of the Consent Decree (2000).

This section presents evaluations of the performance of the off-site and source containment systems, based on data collected during 2016, with respect to their meeting the above-stated objectives.

4.1 Hydraulic Containment

4.1.1 Water Levels and Capture Zones

The water-level elevation data presented in Table 3.1 were used to evaluate the performance of both the off-site and source containment wells with respect to providing hydraulic containment for the regional plumes and potential on-site source areas. Maps of the elevation of the on-site water table and of the water levels in the UFZ/ULFZ and the LLFZ during each quarterly round of water-level measurements in 2016 are shown in Figures 4.1 through 4.12. The quarterly on-site water tables are shown in Figures 4.1, 4.4, 4.7, and 4.10; also shown on these figures are the capture zone of the source containment well in UFZ/ULFZ and the extent of the on-site TCE plume. The quarterly water levels and the capture zones of the off-site and source containment wells within the UFZ/ULFZ are shown in Figures 4.2, 4.5, 4.8, and 4.11, and those within the LLFZ are shown in Figures 4.3, 4.6, 4.9, and 4.12; also shown on these figures is the extent of the regional TCE plume. The extent of the TCE plumes shown in Figures 4.1 through 4.9 is based on last year's (November 2015) water-quality data from monitoring wells, and that of those shown on the water-level maps for November 2016 (Figures 4.10 through 4.12) are based on the November 2016 water-quality data.

The on-site TCE plume lies along the southern limit of the 4970-ft silt/clay unit; the configuration of the on-site water table (Figures 4.1, 4.4, 4.7, and 4.10) indicates that groundwater from the plume area discharges into the regional aquifer over the edge of the 4970-ft silt/clay unit, mostly within the capture zone of the source containment well in the UFZ/ULFZ; vertical leakage of contaminated water across the silt/clay unit is also mostly within the capture zone of the source containment well. The water levels in the UFZ/ULFZ (Figures 4.2, 4.5, 4.8, and 4.11) and in the LLFZ (Figures 4.3, 4.6, 4.9, and 4.12) show that at a pumping rate that averaged about 277 gpm during 2016, the capture zone of the off-site containment well CW-1 extends beyond the November 2015 or November 2016 extent of the regional TCE plume and provides an ample safety margin to the hydraulic containment of this plume. These water levels also indicate that at an average pumping rate of about 50 gpm for the year, the source containment well CW-2 continued to capture contaminated groundwater leaving the on-site area.

The direction of groundwater flow and the hydraulic gradient in the DFZ during 2016 were not significantly different than previous years. Water-level measurements in the three DFZ wells, MW-67, MW-71R, and MW-79, and for the average water level in these wells in each quarterly round of the 2016 are shown in Figure 4.13. During 2016 the direction of groundwater flow in the DFZ ranged from W 14.2° N in August to W 22.6° N in November, and the hydraulic gradient from 0.00195 in May to 0.00363 in August. The average direction of groundwater flow in the DFZ during 2016 was W 17.6° N with an average hydraulic gradient of 0.00243.

4.1.2 Effects of Containment Well Shutdown on Capture

The containment systems are occasionally shut down for maintenance and repairs, and sometimes due to power or equipment failures (see Tables 2.3 and 2.4). Most shutdowns are of a relatively short duration, but as discussed in Section 2.3, shutdowns during 2016 included a six-day shutdown of the off-site containment system due to the failure of the main switch of the air stripper and difficulties in identifying the cause.

The capture zone of the source containment well lies within the capture zone of the off-site containment well, and its downgradient limit is within the plume area. Any shutdown of this well would cause some contaminants to escape beyond its capture zone, but these contaminants will remain within the capture zone of the off-site containment well and eventually be captured by this well.

Given the distance between the leading edge of the off-site plume and the limits of the capture zone of the off-site containment well, it is highly unlikely that any contaminants would escape beyond the capture zone of this well during a shutdown of limited duration. Under non-pumping conditions, the hydraulic gradient near the leading edge of the plume is about 0.003. The aquifer above the 4800-ft clay has a hydraulic conductivity of 25 feet per day (ft/d) and a porosity of about 0.3. Thus, the rate at which groundwater, and hence contaminants, would move under non-pumping conditions is 0.25 ft/d or about 90 feet per year (ft/yr). The downgradient distance between the limit of the capture zone of the off-site containment well and the leading edge of the plume is more than several hundred feet (see for example Figures 4.2 and 4.3 or 4.11 and 4.12). Thus, shutdowns of the length that have been experienced in the past, and of even much longer periods, could not cause any contaminants to escape beyond the capture zone of the well. Hydraulic containment of the plume has been, therefore, maintained during any past shutdowns of the off-site containment system, and will continue to be maintained during any future shutdowns of reasonable duration.

4.2 Groundwater Quality in Monitoring Wells

4.2.1 Concentration Trends

Plots showing temporal changes in the concentrations of TCE, DCE, TCA, and dissolved chromium, or total chromium when data on dissolved chromium were not available, were prepared for a number of on-site and off-site monitoring wells to demonstrate long-term water-quality changes at the Sparton site. Plots for on-site wells completed above the 4970-ft silt/clay unit are shown in Figure 4.14; plots for on-site wells completed below the silt/clay unit and for off-site wells are shown in Figure 4.15.

Except for a few wells, in general, VOC concentrations in both on-site and off-site wells have a decreasing trend. Significant decreases in VOC concentrations occurred in most on-site wells completed above the 4970-ft silt/clay unit between 1998 and the mid-2000s (see plots for wells MW-16, MW-23, MW-25, and MW-26 in Figure 4.14). This is primarily due to the operation of soil vapor extraction (SVE) systems at the site during short periods in 1998 and 1999, and again for about a year between April 2000 and June 2001, and to the flushing effects of the water infiltrating from the infiltration ponds of the source containment system since the start of the system operation in 2002. Wells along the southern limit of the 4970-ft silt/clay unit (see plots for wells MW-07 and MW-12 in Figure 4.14), however, have also a declining trend but do not appear to have been significantly affected by the SVE operations or the infiltration ponds; this is attributed to the presence of a low permeability zone that somewhat isolates the sands above the southern limit of the 4970-ft silt/clay unit from those to the north of this zone.

The VOC concentration trends in on-site wells completed below the 4970-ft silt/clay unit are illustrated by the plots for wells MW-19, MW-42, and MW-72 shown in Figure 4.15. Prior to the start of the source containment system, well MW-19 had a declining trend, and in fact VOC concentrations in this well had declined below the regulatory standards by 2000; however, after the start of the source containment system in 2002, VOC concentrations in the well sharply increased until 2004, primarily due to increased vertical leakage, and then resumed a declining trend. Most other on-site wells completed below the 4970-ft silt/clay unit, except MW-72, have a declining trend similar to that of MW-42, or are free of any VOCs. Well MW-72 had high concentrations of VOCs when it was installed in early 1995 but, after a few years, concentrations began declining; this declining trend continued until 2008 when VOC concentration started increasing again. During 2016, TCE and DCE concentrations in the well declined from 790 and 120 μg/L, respectively, in February to 26 and 1.3 μg/L in November (see Table 3.2).

The VOC concentration in most off-site wells are declining (see plots for wells MW-55, MW-60, and MW-37/37R in Figure 4.15). Well MW-60 continued to be the off-site well with the highest TCE concentrations; the November 2016 TCE concentration in the well was 800 μg/L.

Chromium concentrations in most monitoring wells completed above the 4970-ft silt/clay unit have been high, mostly above the NMWQCC standard of 50 μg/L, and remained high (see for example wells MW-16, MW-23, MW-25, and MW-26 in Figure 4.14); an increase occurred soon after the start of the source containment system due to the rise of the water levels in the sands above the 4970-ft silt/clay unit and the resulting mobilization of chromium that was present in the previously unsaturated zone above the former water table. A second, similar increase occurred during the last several years due to rising regional water levels (see Figure 3.1). Wells along the southern limit of the 4970-ft silt/clay unit (see plots for wells MW-07 and MW-12 in Figure 4.14), which are isolated as discussed above, were not affected by the higher chromium concentrations in the sands north of the low permeability zone.

Chromium concentrations in on-site monitoring wells completed below the 4970-ft silt/clay (see plots for wells MW-19, MW-42, and MW-72 in Figure 4.15) also began rising after the start of the source containment system; this is attributed to increases in the leakage through the 4,970-ft silt/clay unit that resulted from steeper downward gradients; these steeper gradients were caused by the rise in water levels above the 4970-ft silt/clay unit due to infiltration from the ponds and the decline of water levels below this unit due to pumping from well CW-2. Concentrations rose and remained relatively steady in some wells (MW-42), rose and then began declining in some (MW-19), and maintained a rising trend in others (MW-72). Wells in the off-site area (see plots for wells MW-37/37R, MW-55, and MW-60 in Figure 4.15) also display varying trends in chromium concentrations.

Of the three monitoring wells completed in the DFZ, wells MW-67 and MW-79 have been clean since their installation in 1996 and 2006, respectively. The third DFZ well, MW-71R, located about 70 ft south of MW-60, was installed in February 2002 as a replacement for DFZ well MW-71 which was plugged and abandoned in October 2001 because of contamination.[8] The first sample from MW-71R, obtained in February 2002, had a TCE concentration of 130 μg/L and the well has remained contaminated since then. Concentrations of TCE in the well during quarterly sampling events in 2016 declined from 46 μg/L in February to 36 μg/L in November (see Table 3.2).

4.2.2 Concentration Distribution and Plume Extent

In past Annual Reports, the extent of groundwater contamination near the end of the year was illustrated by presenting isoconcentration (plume) maps for TCE and DCE based on the Fourth Quarter water-quality data for that year.[9] As stated in Section 1, because of the increased chromium concentrations that led to the installation of the chromium removal unit at the source containment system, the USEPA and NMED requested Sparton also to include plume maps for chromium in the 2015 and subsequent Annual Reports (see footnote 4 on page 1-2). To prepare the 2016 plume maps for TCE, DCE, and chromium, the Fourth Quarter 2016 data presented in Tables 3.2 and 3.3 and the concentrations of these compounds in the CW-1 and CW-2 influent samples from the November monthly sampling event (see Tables 3.5 and 3.6) were used. Also, as mentioned in Section 1, a distinction was made between the extent of these compounds above the 4970-ft silt/clay unit (on-site plumes) and that below this unit and in the off-site areas (regional plumes).

The horizontal extent of the on-site TCE plume is shown in Figure 4.16 and that of the regional TCE plume is shown in Figure 4.17.[10] The concentration of DCE in wells completed above the 4970-ft silt/clay unit is shown in Figure 4.18; note that an on-site DCE plume does not currently exist and that the only well where DCE was detected is MW-26 at 1 μg/L; concentration at all other wells was below the detection limit of 1 μg/L. The extent of the

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[8] See 1999 Annual Report (SSP&A, 2001a) for a detailed discussion of the history of well MW-71, and SSP&A and Metric (2002) for actions taken prior to its plugging and abandonment.

[9] Until and including the 2008 Annual Report an isoconcentration map for TCA was also included in the Annual Reports. Because TCA concentrations since 2003 have been below regulatory standards, this practice was discontinued, with the approval of the agencies, starting with the 2009 Annual Report.

[10] At well cluster locations, the concentrations shown in Figures 4.17, 4.19 and 4.21 are those for the well with the highest concentration.

regional DCE plume is shown in Figure 4.19. The only wells in which TCA was detected above the detection limit of 1 µg/L in 2016 were monitoring wells MW-16, at 1.3 µg/L, and MW-52R, at 1.2 µg/L in February, and at 1.1 and <1 µg/L, respectively, in duplicate November samples.

The extent of the on-site chromium plume is shown in Figure 4.20 and that of the regional chromium plume is shown in Figure 4.21. These chromium plume maps were prepared using measured dissolved chromium concentrations except for the two containment wells where only total chromium data were available; given the continuous pumping of these two wells, dissolved chromium concentrations are not expected to be different than the measured total chromium concentrations; therefore, measured total chromium concentrations in these two wells are treated as being equal to the dissolved chromium concentrations at the well locations.

4.2.2.1 Changes in Concentrations

A total of 57 monitoring wells and the influent from the two containment wells were sampled in November 2016. Of these 59 wells, 42 are wells that existed in November 1998 (prior to the implementation of the current remedial activities), 7 are replacement or deepened version of wells that existed in November 1998, and the remaining 10 are wells that were installed in later years. Changes between the TCE, DCE, and chromium concentrations measured in these wells in November 2016 and those measured in November 1998, or during the first sampling event after their installation, are summarized on Table 4.1. Note that Table 4. 1 also identifies wells which have been used in the preparation of both the initial (Figures 1.4 through 1.9, 1.12 and 1.13) and the 2016 (Figures 4.16 through 4.21) extent of the TCE, DCE, and chromium plumes. The distribution of TCE, DCE, and chromium concentration changes that occurred since the implementation of the off-site and source containment systems wells completed above the 4970-ft silt/clay unit are presented in Figures 4.22, 4.24, and 4.26, and those in wells completed below the silt/clay unit or in the off-site area are presented in Figures 4.23, 4.25, and 4.27.

As this table and figures indicate, current VOC concentrations in most, if not all, wells are much lower than those that existed prior to the start of the current remedial operations. The only wells where a significant increase in VOC concentrations has occurred since 1998 are the off-site containment well CW-1, on-site monitoring well MW-19, and off-site monitoring well MW-52R. Increases in CW-1 were expected since this well has been drawing water from the entire plume area where higher concentrations existed and continue to exist. The increase in MW-19 is attributed to increased downward leakage through the 4,970-ft silt/clay unit and that in MW-52R is attributed to a separate DCE-dominated plume. Thus, with respect to VOCs considerable progress has been made towards aquifer restoration.

The changes in chromium concentrations, however, indicate significant increases, particularly in on-site wells completed both above and below the 4970-ft silt/clay unit. As discussed earlier (see Section 4.2.1), these increases in chromium concentrations are attributed to the mobilization of chromium that was present in the previously unsaturated zone above the former water table, and to increases in the leakage across the 4,970-ft silt/clay unit that resulted from steeper downward gradients. It should be also noted that, for most monitoring wells, the chromium concentration changes reported on Table 4.1 and shown in Figures 4.26 and 4.27 are based on a comparison between initial total chromium concentrations, which are affected by chromium containing sediments; and dissolved chromium concentrations measured in November 2016.

4.3 Containment Systems

4.3.1 Flow Rates

The volume of water pumped from the off-site containment well during 2016 was approximately 146 million gallons and that pumped from the source containment well was about 26 million gallons (see Table 3.4). The corresponding average annual pumping rates were 277 gpm and 50 gpm, respectively, and the average pumping rates during operating hours were about 292 gpm and 51 gpm, respectively. A plot of the volume of water pumped by each well during each month of 2016 and of the total monthly volume is presented in Figure 4.28. The total volume of water pumped by both wells during 2016 was about 172.3 million gallons, and corresponds to an average pumping rate of about 327 gpm for the year.

The volume of water pumped during each year of the operation of the containment wells is summarized on Table 4.2, and a plot of the cumulative volume pumped by the wells since the beginning of their operation is presented in Figure 4.29. As shown on this table and figure, the total volume of water pumped by the off-site containment well since the beginning of its operation in December 1998 is about 2.32 billion gallons, and that pumped by the source containment well since the beginning of its operation in January 2002 is about 0.35 billion gallons; these volumes of pumped water correspond to 205 percent and 31 percent, respectively, of the initial plume pore volume. The total volume pumped from both wells since the beginning of remedial pumping is about 2.7 billion gallons, and corresponds to an average rate of 282 gpm over the 18 years of operation. This volume represents approximately 236 percent of the plume pore volume.

4.3.2 Influent and Effluent Quality

The concentrations of TCE, DCE, TCA, and of total chromium, iron, and manganese in the monthly samples of influent to and effluent from the off-site treatment system during 2016 were presented on Table 3.5; the corresponding concentrations in the monthly samples of influent to and effluent from the source treatment system were presented on Table 3.6. Plots of the TCE, DCE, and total chromium concentrations in the influent to both systems, prepared from these data, are presented in Figure 4.30. Fifty percent of the monthly effluent samples from the off-site containment system had detections of TCE at levels below the MCL of 5 μg/L for this compound (ranging from 1 μg/L in the July sample to 4.2 μg/L in the February sample); DCE and TCA concentrations in the effluent were below detection limits. Chromium, which was present in most influent samples from the off-site system at levels considerably below the NMWQCC standard of 50 μg/L was also detected in the effluent samples at about the same levels. VOC concentrations in the effluent from the source containment system were below detection limits throughout the year; however, chromium concentration in the November sample of the effluent, collected on October 31, 2016, exceeded the NMWQCC standard of 50 μg/L. Another exceedance of the chromium standard occurred on November 21, 2016 in an effluent sample collected prior to a scheduled tank exchange on that date (see Table 3.7). Both of these exceedances were attributed to an inadvertent increase in the rate of flow diverted to the chromium removal unit from the design rate of about 35 to about 40 gpm (see Table 3.7). The NMED was notified of these exceedances and corrective measures were taken to address them. The corrective measures consisted of reducing the flow rate diverted to the chromium unit to 35 gpm, and exchanging both chromium removal tanks during the next scheduled exchange of December 12, 2016.[11]

4.3.3 Contaminant Mass Removal

The monthly and total mass of VOCs removed by the off-site and source containment Systems (TCE and DCE) during 2016, calculated from the monthly flow volumes reported on Table 3.4 and the influent concentrations reported on Table 3.5 and 3.6, are summarized on Table 4.3; also shown on this table is the total mass of VOCs removed by both systems.

A total of 158 kg (347 lbs) of VOCs, consisting of 141 kg (310 lbs) of TCE and 17.1 kg (37.6 lbs) of DCE were removed by the two containment wells during 2016. A plot of the TCE, DCE and total VOC mass removed by the two containment wells during each month of 2016 is presented in Figure 4.31. The total mass of VOCs removed by the two containment wells during each year of their operation is summarized on Table 4.4, and a plot of the cumulative TCE, DCE, and total VOC mass removed by the wells is presented in Figure 4.32. As shown on Table 4.4, the total VOC mass removed by the containment wells, since the beginning of the current remedial operations in December 1998, is about 7,760 kg (17,100 lbs), consisting of about 7,200 kg (15,900 lbs) of TCE, 533 kg (1,170 lbs) of DCE, and 20.4 kg (44.9 lbs) of TCA. This represents about 90 percent of the total dissolved VOC mass currently estimated to have been present in the aquifer prior to the testing and operation of the off-site containment system.

The monthly and total mass of chromium removed by the chromium removal unit at the source containment system, based on the monthly flow volumes (see Table 3.4) and the average monthly chromium concentrations in the influent to and effluent from the treatment system (calculated from the monthly sampling data presented on Table 3.6), are summarized on Table 4.5. As shown on this table, a total of about 7.2 kg (15.9 lbs) of chromium was removed during 2016. The total chromium removed by this removal unit, and by a removal unit that operated at the off-site containment system between December 15, 2000 and October 31, 2001, is about 18.6 kg (41.0 lbs), as summarized on Table 4.6.

4.4 Site Permits

The infiltration gallery associated with the off-site containment system and the rapid infiltration ponds associated with the source containment system are operated under a State of New Mexico Groundwater Discharge Permit (DP-1184). This Discharge Permit was originally issued by the Groundwater Bureau of the NMED for a five-year period on June 23, 1998 and renewed for two more five-year periods on December 29, 2006 and on October 18, 2012.

The air stripper associated with the off-site containment system is operated under Air Quality Source Registration No. NM/001/00462/967, issued by the Air Quality Services

[11] Samples of effluent collected since that time have remained below the NMWQCC standard.

Section, Air Pollution Control Division, Environmental Health Department, City of Albuquerque, and the source containment system air stripper is operated under Albuquerque/Bernalillo County Authority-to-Construct Permit No. 1203.

The performance of the off-site and source containment systems with respect to the requirements of these permits is discussed below.

4.4.1 Off-Site Contaminant Systems

Discharge Permit DP-1184 requires monthly sampling of the treatment system effluent, and the quarterly sampling of the infiltration gallery monitoring wells MW-74, MW-75 and MW-76. The results of these sampling events during 2016 (see Tables 3.3, and 3.5) were reported to the NMED Groundwater Bureau in the 2016 Annual Monitoring Report for the permit submitted to the Bureau on January 24, 2017.[12]

Calculations of VOC emissions made in June 1999 indicated that the off-site air stripper was in in full compliance with the limits (0.32 pound per hour [lb/hr] or 1.37 tons/yr) specified in Registration No. NM/001/00462/967. Under the terms of the registration, further monitoring and/or reporting of the emissions from the air stripper was not required, and has not been carried out since that time.

No violation notices were received during 2016 for activities associated with the operation of the off-site containment system.

4.4.2 Source Containment Systems

The rapid infiltration ponds associated with the source containment system are also subject to the above-stated requirements of Discharge Permit DP-1184. The monitoring wells for this system are MW-17, MW-77 and MW-78; the quarterly data collected from these wells (see Table 3.3) and from the monthly and other sampling of the treatment system effluent (see Tables 3.6 and 3.7) were included in the 2016 Annual Monitoring Report for the permit.[12]

Emissions of VOCs from the source containment system air stripper during 2016 (0.00039 lb/hr or 0.0017 ton/yr) met the requirements of The Authority-to-Construct Permit No. 1203 and were reported to the Albuquerque Environmental Health Department, Air Quality Division in the 2016 Annual Report on Air Emissions which was submitted on March 8, 2017[13].

No violation notices were received during 2016 for activities associated with the operation of the source containment system.

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[12] Letter to Mr. Steve Pullen of the Ground Water Quality Bureau, NMED from Stavros S. Papadopulos and Alex Spiliotopoulos of SSP&A on the subject "2016 Annual Monitoring Report for Discharge Permit DP-1184."

[13] Letter to Regan Eyerman, Health Scientist, Air Quality Division, Environmental Health Department, City of Albuquerque, from Stavros S. Papadopulos and Alex Spiliotopoulos of SSP&A on the subject "Authority-to-Construct Permit #1203 – 2016 Annual Report on Air Emissions".

4.5 Contacts

Under the terms of the Consent Decree[14] Sparton is required to prepare an annual Fact Sheet summarizing the status of the remedial actions, and after approval by USEPA/NMED, distribute this Fact Sheet to property owners located above the plume and adjacent to the off-site treatment plant water discharge pipeline. After the approval of the 2015 Annual Report on November 29, 2016[15] Sparton prepared a Draft 2016 Fact Sheet and submitted it to the USEPA/NMED for approval on December 13, 2016[16]. Agency approval of this Fact Sheet has not been received as of the date of this report.

[14] Public Involvement Plan for Corrective Measure Activities. Attachment B to the Consent Decree in Albuquerque v. Sparton Technology, Inc., No. CV 07 0206 (D.N.M.).

[15] Letter from Mr. Dave Cobrain of NMED and Mr. Chuck Hendrickson of USEPA to Mr. Ernesto Martinez of Sparton, Re: Approval with Conditions, 2015 Annual Report, Sparton Technology, Inc., EPA ID NO. NMD083212332.

[16] Email from Alex Spiliotopoulos of SSP&A to Chuck Hendrickson of USEPA and Dave Cobrain of NMED, on the subject of "Sparton Technology Remedial Program – Draft 2016 Fact Sheet".

Section 5
Conclusions and Future Plans

5.1 Summary and Conclusions

During 2016, considerable progress was made towards achieving the goals of the remedial measures:

- The off-site containment well operated 94.7 percent of the time available in 2016 at an average rate of 292 gpm and maintained hydraulic containment of the off-site plume.
- The concentrations of constituents of concern in the water treated at the off-site containment system met the requirements of the Discharge Permit for the site.
- The source containment well operated 98.2 percent of the time available in 2016 at an average rate of 51 gpm, and the well contained most of contaminated groundwater leaving the on-site area.
- Except for two occasions in November, the concentrations of constituents of concern in the water treated at the source containment system met the requirements of the Discharge Permit for the site. Corrective measures were taken to address the November exceedances.
- The treated water from both systems was returned to the aquifer through the infiltration gallery in the Arroyo de las Calabacillas and the on-site infiltration ponds.
- Groundwater monitoring was conducted as specified in the Monitoring Plan and the Discharge Permit.[17]
- Samples were obtained monthly from the influent and effluent of the treatment plants for the off-site and source containment systems and analyzed for VOCs, and total chromium, iron, and manganese as specified in the Discharge Permit.
- Water levels in all accessible wells and/or piezometers were measured quarterly. Samples were collected for water-quality analyses from monitoring wells at the frequency specified in the Monitoring Plan and analyzed for VOCs and chromium.
- Samples were obtained from the infiltration gallery and infiltration pond monitoring wells at the frequency specified in the Discharge Permit.[18] All samples were analyzed for VOCs, and chromium, iron, and manganese.
- Changes in contaminant concentrations observed in monitoring wells since the implementation of the current remedial measures indicate that VOC concentrations decreased significantly both at the on-site and off-site area, and that chromium concentrations increased, primarily at the on-site area.

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[17] Except for the Third Quarter when pond monitoring well MW-77 was mistakenly not sampled.

- A total of about 172.3 million gallons of water were pumped from the wells. The total volume of water pumped since the beginning of the current remedial operations on December 1998 is about 2.67 billion gallons and represents 236 percent of the initial volume of contaminated groundwater (pore volume).
- A total of about 158 kg (347 lbs) of VOCs were removed from the aquifer by the two containment wells during 2016. The total VOC mass that was removed since the beginning of the of the current remedial operations through the end of 2016 is about 7,760 kg (17,100 lbs), and represents about 90 percent of the total dissolved VOC mass estimated to have been initially present in groundwater.

5.2 Future Plans

The off-site and source containment systems will continue to operate during 2017 at pumping rates as close as possible to their current design pumping rates of 300 gpm and 50 gpm, respectively.

Data collection will continue in accordance with the Monitoring Plan and the Discharge Permit, and as necessary for the evaluation of the performance of the remedial systems.

The USEPA and the NMED will continue to be kept informed of any significant milestones or changes in remedial system operations. The goal of the systems will continue to be the return of the contaminated groundwater to beneficial use.

The existing operations monitoring system, which has deteriorated and often fails to notify the operator that a shutdown has occurred, will be replaced with a new system that will diagnose problems when they occur and assure that the operator is notified of all shutdowns or failures that may occur during system operation.[18]

A renewal application for Discharge Permit DP-1184, which expires on October 18, 2017, will be prepared and submitted to the NMED.[19]

As a condition of the approval of the 2015 Annual Report (see November 29, 2016 letter referenced in Footnote 15), the agencies requested Sparton to analyze groundwater samples collected from monitoring wells and from the influent and effluent of the containment systems during the next two scheduled quarterly monitoring events for 1,4-dioxane. These samples for 1,4-dioxane analysis will be collected during the First and Second Quarter sampling events of 2017.[20]

A Draft 2016 Fact Sheet was submitted to the USEPA and NMED for review and approval on December 13, 2016. Since approval of this Fact Sheet has not been received as of the issue of this report, Sparton proposes that a combined Draft 2016-2017 Fact Sheet is prepared

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[18] Installation of the new operations monitoring system started in early 2017, and the system is expected to be fully operational by the Summer of 2017.

[19] This renewal application was submitted to NMED on May 4, 2017.

[20] These sampling events were conducted in February and May 2017 and the 1,4-dioxane results were submitted to the agencies on June 20, 2017.

after the approval of this Annual Report and submitted to the USEPA and NMED for approval and distribution.

Section 6
List of Reports and Documents

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