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VIA FEDERAL EXPRESS

September 15, 2006

United States Environmental Protection Agency
Region V
Corrective Action Section, DW-8J
77 West Jackson
Chicago, Illinois 60604

Attention: Ms. Patricia J. Polston, Project Manager
Waste Management Branch

Reference: RCRA CA750 Environmental Indicators Report
Vernay Laboratories, Inc.
Yellow Springs, Ohio
Project No. 0292.11.44

Dear Ms. Polston:

The Payne Firm, Inc. is pleased to submit, on behalf of Vernay Laboratories, Inc., the attached Resource Conservation and Recovery Act Corrective Action Facility CA750 Ground Water Environmental Indicators Report (CA750 Report), as agreed to by the Administrative Order on Consent journalized by the United States Environmental Protection Agency on September 27, 2002. An electronic version of this CA750 Report is also included on a CD-Rom in the Appendix of the report.

Should you have any questions regarding the enclosed document, please contact either of us at (513) 489-2255 or by e-mail at dcc@paynefirm.com or ddw@paynefirm.com.

Sincerely,

The Payne Firm, Inc.

David C. Contant, L.G.
Senior Project Manager

Daniel D. Weed, C.P.G.
Principal

cc: Mr. Doug Fisher - Vernay Laboratories, Inc.
Mr. Joseph Lonardo - Vorys, Sater, Seymour & Pease
Mr. Rob Hillard - Village of Yellow Springs
Ms. Connie Collett - Yellow Springs Community Library
Mr. David Back
Mr. Mark Nielsen - Battelle Memorial Institute

RESOURCE CONSERVATION AND RECOVERY ACT
CA750 ENVIRONMENTAL INDICATORS REPORT

VERNAY LABORATORIES, INC.
PLANT 2/3 FACILITY
875 Dayton Street
Yellow Springs, Ohio

OHD 004 243 002

Project No. 0292.11.44

September 15, 2006

Prepared For

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Yellow Springs, Ohio

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1.0 EXECUTIVE SUMMARY

The Vernay Laboratories, Inc. ("Vernay") Facility (the "Facility") is located at 875 Dayton Street in the Village of Yellow Springs, Ohio. The Facility is comprised of approximately ten acres and includes two former manufacturing buildings which are currently unoccupied (Plant 2 and Plant 3), a storage building located south of Plant 2, a fireline pump building, various asphalt driveways and parking lots, and a grass field located along the western portion of the property. The Facility is bounded by Dayton Street to the north, East Enon Road to the west, commercial, agricultural, and residential properties to the east; and residential properties to the south. Land use to the north of the Facility consists of residential properties and the Antioch Publishing Company. The area to the west consists of residential and agricultural land and the Yellow Springs High School. Volatile organic compounds (VOCs), mainly perchloroethene (PCE) and trichloroethane (TCE), have been detected in a carbonate bedrock aquifer located beneath the property and in an area east of the property.

This Resource Conservation and Recovery Act (RCRA) Migration of Contaminated Ground Water Under Control Environmental Indicators (EI) Report was prepared to fulfill the requirements under Paragraph 16 of the Administrative Order on Consent (Corrective Action Order) for the Vernay Facility. The Corrective Action Order, effective September 27, 2002, includes goals for determining that current human exposures (CA725) were under control by June 30, 2004, and the migration of contaminated ground water (CA750) is under control 180 days following the approval of the Phase II RCRA Facility Investigation (RFI) report. Approval of the CA725 was provided by the United States Environmental Protection Agency (U.S. EPA) on September 29, 2004. Approval of the Phase II RFI report (Revision 1) was provided by the U.S. EPA on December 13, 2005. To fulfill the requirements agreed to under the Corrective Action Order, Vernay prepared a draft CA750 report at the request of U.S. EPA. On April 11, 2006, Vernay submitted the draft CA750 EI for U.S. EPA review 60 days prior to the required date according to the provisions of the Corrective Action Order. Vernay has prepared this CA750 EI report based on comments received during teleconference meetings with the U.S. EPA on July 20 and 21, 2006 relating to the draft CA750 report submitted on April 11, 2006.

This EI Report evaluates and discusses information that was relied on to support the RCRA CA750 determination. Based on this information and no evidence of an expanding area of contamination based on perimeter monitoring well results, it is determined that the migration of contaminated ground water is under control on and off of the property.

2.0 INTRODUCTION

2.1 Purpose

This RCRA CA750 Migration of Contaminated Ground Water Under Control EI Report was prepared to fulfill requirements agreed to under Paragraph 16 U.S. EPA of the Administrative Order on Consent (Corrective Action Order) for the Vernay Laboratories, Inc. (Vernay) Plant 2/3 Facility (Facility) located at 875 Dayton Street in the Village of Yellow Springs, Ohio (see Figure 1). The Corrective Action Order, effective September 27, 2002, is a streamlined RCRA order in which Vernay agrees to take corrective remedial measures necessary to protect human health and the environment from all current and future unacceptable risks due to releases of hazardous waste or hazardous constituents at or from the Facility.

In addition to the voluntary site investigations conducted prior to the Corrective Action Order[1], Vernay conducted a Corrective Action RCRA Facility Investigation (RFI) to identify the nature and extent of any releases of hazardous wastes and hazardous constituents at or from the Facility that may pose an unacceptable risk to human health and the environment. Vernay conducted the RFI in two phases:

- Phase I of the RFI was completed between October 2002 and June 2004 and addressed characterization of the Cedarville Aquifer and sewer lines beneath and adjacent to the Vernay Facility. The Phase I RFI also included the investigation of the nature and extent of soil contamination in and around identified Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs), an evaluation of the extent of surface water and sediment contamination in an unnamed creek located east of the Facility, an air exposure assessment at the Facility, and a water well survey of properties within a designated area around the Facility. The results of the Phase I RFI are presented in a RCRA Facility Investigation Report (Phase I RFI Report) prepared by the Payne Firm (Payne Firm et al., 2004).

- Phase II of the RFI focused on completing the characterization of the nature and extent of contamination in soil, assessing the fate and transport of contaminants detected in the Cedarville Aquifer, and assessing the potential site-related human health and the environment risks associated with current and reasonably likely exposures to contaminated media. In addition, potential exposures

[1] Prior to the Corrective Action Order, Vernay voluntarily conducted environmental investigation and remediation activities between 1991 and 2002. The historical data was accepted by the U.S. EPA (2004) for the purposes of establishing trend analysis in ground water and incorporation into environmental indicator determinations since sufficient data were being collected during the Phase I and Phase II RFI to meet the needs of the Corrective Action Order (U.S. EPA, 2004).

to off-Facility residents via vapor intrusion from ground water and subsurface water to indoor air was evaluated indicating that current off-Facility concentrations do not present an unacceptable risk via this pathway. The results of the Phase II RFI are presented in a RCRA Facility Investigation Report (Phase II RFI Report; Payne Firm et al., 2005).

The Corrective Action Order also included requirements for determining that current human exposures (CA725) were under control by June 30, 2004, and determining that the migration of contaminated ground water (CA750) is under control 180 days following the approval of the Phase II Facility Investigation Report. Final approval of the CA725 EI was provided by the U.S. EPA on September 29, 2004. Final approval of the Phase II RFI report was provided by the U.S. EPA on December 13, 2005. With the completion of the RFI, the post-RFI corrective action process consists of the corrective measures evaluation. As specified in the Corrective Action Order, once the CA750 has been reviewed and approved by U.S. EPA, Vernay will have six months to submit a final corrective measures proposal to the U.S. EPA. Vernay will then be responsible for implementing the corrective measures, as specified by U.S. EPA.

This EI report evaluates and discusses information that is pertinent to the RCRA CA750 determination, and includes data collected during pre-RFI investigations ("historical data"), the Phase I and Phase II Facility Investigation, and from post-RFI ground water monitoring.

Based on these data, current migration of contaminated ground water is determined to be under control. The evaluation and discussion in this CA750 EI report are organized to follow U.S. EPA's CA750 Migration of Contaminated Ground Water Under Control form (U.S. EPA Interim Final Guidance, February 5, 1999). A completed CA750 form that is based on the discussion in this report is provided in Appendix A.

2.2 Facility Description

A comprehensive summary of the environmental setting of the Facility and the surrounding area was presented in the Phase I RFI report. The Facility is located at 875 Dayton Street in the Village of Yellow Springs, Ohio. Yellow Springs is located in the north-central portion of Greene County (Miami Township), which is located in the southwestern portion of Ohio. The Facility is located in a mixed industrial, commercial and residential area (Figure 1). The Facility is comprised of approximately ten acres and is bound by Dayton Street to the north; East Enon Road to the west; commercial, agricultural, and residential properties to the east; and residential properties to the south.

The primary features at the Facility include: Plant 2 and Plant 3 buildings, a storage building located south of Plant 2, a fireline pump building, various asphalt driveways and parking lots, and a grass field located along the western portion of the Facility. Approximately two-thirds of the Facility is covered by Plant 2 and Plant 3 and parking lots, with the remaining area being the grass field. The features of the

Facility, as they currently exist[2], are shown on Figure 2. Plant 2 was used for the manufacturing of specialty small-scale rubber components, primarily for the medical industry, and covers approximately 9,000 square feet. Plant 3, which is approximately 100,000 square feet in area, was used in the past for rubber manufacturing operations and maintenance activities. A detailed description of the manufacturing areas and processes conducted by Vernay in Plants 2 and 3 prior to the discontinuation of manufacturing operations are discussed in the Final Preliminary Assessment/Visual Site Inspection Report (Techlaw, 2001), which was included in the Current Conditions Report ("CCR"; Payne Firm, 2002).

Surface water drainage at the Facility flows to several on-property storm sewer drains and lines, which are connected to a 54-inch Village of Yellow Springs storm sewer located beneath Dayton Street (Figure 2). The connection to the 54-inch Village of Yellow Springs storm sewer is located near the northeast corner of the Facility. No surface bodies of water are located on the Facility. The storm sewer located beneath Dayton Street discharges to a small unnamed creek situated on the north side of Dayton Street approximately 0.3 miles east of the Facility (Figure 3). The unnamed creek travels approximately one mile to the north-northeast where it discharges to the Yellow Spring Creek near the intersection of Yellow Springs Creek and Polecat Road. Yellow Springs Creek is a tributary of the Little Miami River located approximately 2.5 miles south of the Property.

2.3 Information Reviewed

The following documents were used to support the determination that the migration of contaminated ground water is under control. These documents present the Facility historical operations (including SWMUs/AOCs), hydrogeology, and the distribution, fate, and transport of constituents of concern (COCs) in soil and ground water beneath the Facility and surrounding area:

- Current Conditions Report (Payne Firm, 2002)
- Fourth Quarter 2002 Progress Report (Payne Firm, 2003)
- Quality Assurance Project Plan (Payne Firm, 2003)
- 2003 Quarterly Progress Reports (Payne Firm, 2003)
- Soil Interim Measure Report (Payne Firm, 2003)
- RCRA Corrective Action Technical Memorandum No. 1 Facility Investigation Sampling List (Payne Firm, 2003)
- RCRA Corrective Action Technical Memorandum No. 2 Historic Data Usage (Payne Firm, 2003)
- RCRA Corrective Action Technical Memorandum No. 3 Ground Water Monitoring (Payne Firm, 2003)
- RCRA Corrective Action Technical Memorandum No. 4 Soil Confirmation (Payne Firm, 2004)
- 2004 Quarterly Progress Reports (Payne Firm, 2004)

[2] The areal photographs displayed on figures in this report were obtained from the Greene County Auditors Office dated 2003.

- Ground Water Modeling Report for the Cedarville Aquifer (Back and Payne Firm, 2004)
- RCRA Corrective Action Water Well Identification and Sampling Report (Payne Firm and ENVIRON, 2004)
- RCRA Phase I Facility Investigation Report (Payne Firm et al., 2004)
- CA725 Environmental Indicators Report (ENVIRON and Payne Firm, 2004)
- Fate and Transport Modeling Report (Back and Payne Firm, 2004)
- RCRA Phase II Facility Investigation Report, Revision 1 (Payne Firm et al., 2005)
- RCRA Corrective Action Annual Water Well Survey Report (Payne Firm and ENVIRON, 2005)
- 2005 Quarterly Progress Reports (Payne Firm, 2006)
- 2006 Quarterly Progress Reports (Payne Firm, 2006)

3.0 HYDROGEOLOGIC CONDITIONS

This section summarizes the hydrogeologic conditions beneath the Facility and surrounding area. A detailed conceptual site hydrogeological model was presented in the RFI Phase I report to characterize the physical environments in and around the Facility and to assist in the determination of the nature, extent and migration of contamination. Detailed information on the subsurface geology and hydrogeology is documented in the Phase I and Phase II RFI reports. The hydrogeology is characterized by heterogeneous glacial materials, subsurface conduits, porous and fractured carbonate bedrock, and two operating ground water extraction wells installed by Vernay as an interim measure to prevent the migration of contaminated ground water downgradient of the Facility.

3.1 Ground Water Occurrence

The vadose zone beneath the facility consists of glacial clay till. Within the clay till deposits, discontinuous silty sand seams and sewer lines with granular backfill may be present in the upper ten feet. Perched water may or may not be present in the discontinuous sand seams or sewer backfill, and is not useable because of its extremely low-yielding nature and poor water quality. As defined in the RFI, water found in discontinuous sand seams or sewer backfill has been defined as “subsurface water” and is not considered ground water for the purposes of this CA750 EI determination. In the approved RFI documents (CA725, Phase I, and Phase II), the nature and extent of VOCs in subsurface water was adequately defined to demonstrate constituent concentrations in subsurface water do not pose a significant risk and no further investigation was warranted.

Beneath the vadose zone is a carbonate bedrock aquifer, the Cedarville Aquifer. Useable ground water is present in the Cedarville Aquifer.

3.2 Cedarville Aquifer Hydrogeology

An understanding of the characteristics of the Cedarville Aquifer were determined during the RFI with the use of physical geologic samples, borehole geophysical logging, pumping tests, and the support of calibrated ground water flow and transport numerical models. Detailed descriptions of the Cedarville Aquifer geology and hydrogeology were presented in the Phase I RFI report. The following descriptions provide a general summary of the Cedarville Aquifer characteristics pertinent to this CA750 EI determination.

Geology of the Cedarville Aquifer

The Cedarville Aquifer is the uppermost aquifer beneath the Facility and the surrounding area, and includes discontinuous sand lenses at the base of the vadose zone (Unconsolidated Unit) together with the Silurian-aged carbonate bedrock units (dolomite and some shale). As shown on Figure 4, the three rock formations (youngest to oldest) comprising the Cedarville Aquifer are the Cedarville Dolomite, the Springfield Dolomite and the Euphemia Dolomite. The depth to the top of the of the Cedarville Aquifer ranges from 11 to 26 feet below the surface. The Cedarville Aquifer is approximately 74 to 89 feet thick beneath the Facility and vicinity. The localized dip of the bedrock surface is approximately one foot in elevation per 50 feet in distance to the northeast, which is consistent with the reported dip for the region (Evers, 1991).

Hydrogeology of the Cedarville Aquifer

As presented in the Phase I and Phase II RFI reports, the Cedarville Aquifer can be represented as an equivalent porous medium at the scale of the Facility and vicinity (opposed to a discrete fracture flow medium) supported by the following evidence:

1. Aquifer pumping test results show little evidence of anisotropy or delayed yield characteristics typical of discrete fracture systems.
2. There is very little vertical hydraulic head difference in wells screened in the upper, middle and lower portions of the aquifer.
3. The potentiometric surfaces of the upper, middle and lower portions of the Cedarville Aquifer exhibit a smooth and continuous surface without areas of rapidly changing or anomalous hydraulic head values.
4. The measurement of natural ground water geochemical parameters such as temperature, pH, and specific conductivity are relatively constant as documented from measurements collected on a quarterly basis.
5. Site-specific geophysical and rock core inspection indicates that ground water flow is predominantly controlled by a dense network of small-scale horizontal bedding plane partings, as opposed to a random network of non-horizontal fractures.

Vernay has installed a total of 65 monitoring wells, extraction wells and remediation wells into the upper, middle and lower portions of the Cedarville Aquifer. Additionally, 111 temporary Geoprobe direct-push borings were installed into the upper portion of the aquifer during the facility investigations to assist in the optimum placement of permanent wells on- and off-Facility, as well as to assist in determining the nature and extent of ground water contamination. Cedarville Aquifer sampling locations are shown on Sheet 1. The Cedarville Aquifer is fully saturated and confined beneath the Facility. Regionally, the Cedarville Aquifer is at least partially confined by the overlying glacial till. Water stored in the aquifer occurs within intergranular and vugular pore spaces and along joints and bedding plane partings. Ground water predominately flows horizontally to the east-northeast of the Facility based on field measurements. A slight upward hydraulic gradient has been measured consistently over time in the Cedarville Aquifer.

The approximate ground water yield from the Cedarville Aquifer is about 7 to 10 gallons per minute (gpm). Site-specific ground water flow numerical modeling was completed to support the RFI. Ground water flow velocity is directly dependent on hydraulic conductivity, aquifer porosity, and hydraulic gradient. Based on an estimated effective porosity of 20 to 25 percent, average flow velocity in the Cedarville Aquifer ranges between 80 to 125 feet per year. The estimated value for the effective porosity accounts for the interaction between the matrix and the fracture porosities. Hydraulic conductivity is a measure of the capacity of a porous medium to transmit water. The calibrated hydraulic conductivities of the Cedarville Aquifer range between 60 to 5,500 feet per year. The higher hydraulic conductivities (Figure 5) are generally greater than 1,000 feet per year, and form a northeast trending zone downgradient of the Facility. This northeast trend (or preferential pathway) produced by higher zones of hydraulic conductivity is not only consistent with the northeast trending hydraulic gradients measured from the well network, but is also aligned with the general shape of the existing area of VOC contamination described in Section 4.0.

3.3 Existing Ground Water Interim Measure

As indicated above, there are two extraction wells operating at the Facility to prevent the off-Facility migration of contaminated ground water. Data are routinely collected from the Facility monitoring well network including water level measurements and water samples to verify the effectiveness of the ground water extraction system. The continued efficacy of the ground water extraction wells was evaluated and presented in the approved Phase II RFI report. The on-going monitoring of the extraction wells is important because it assists in demonstrating that the area of contamination off-Facility is not getting larger and has stabilized as discussed in detail in Section 4.0. Below is a summary of the efficacy evaluation of the existing ground water extraction wells operating on the Facility.

Ground Water Capture Treatment System (Extraction Wells)

Currently, Vernay operates two extraction wells (CW01-01 and CW01-02) to prevent VOCs from migrating off of Vernay's Facility (Payne Firm et al., 2005). As described in the RFI Phase I report, the ground water extraction system is referred to as the Ground Water Capture Treatment System (GWCTS).

The GWCTS consists of two individual six-inch diameter stainless steel extraction wells (CW01-01 and CW01-02) located near the southeastern and northeastern property boundary of the Facility, respectively (Figure 2). CW01-01 was installed in 2000, and CW01-02 in 2003. The captured ground water is treated with activated carbon before it is discharged to the Village of Yellow Springs Publicly Owned Treatment Works (POTW) under an Ohio EPA issued indirect discharge permit. Currently, over 7,000,000 gallons of water are treated yearly by the GWCTS at the Facility. A summary of the ground water treatment system performance is provided in Appendix VI, including a table and graphs of monthly gallons of contaminated ground water and chlorinated solvents removed and treated.

Ground Water Flow Model

During the Phase I RFI, a numerical ground water flow model was developed and calibrated to assist in characterizing the hydrogeology and contaminant migration pathways beneath the Facility and the surrounding area. A properly calibrated numerical model that simulates ground water flow provides investigators a means to predict the aquifer's response to natural and manmade stresses placed upon the system. The use of the model is in conjunction with ground water monitoring to ensure ground water flow is occurring as predicted. The results of the ground water flow modeling indicated that the model is well calibrated when compared with actual measurement data (Back and Payne Firm, 2004a). Once a flow-system model is calibrated so that the simulated head distribution approximates the measured field values, the probable flow paths and time of travel can be modeled. A detailed description of the ground water flow model was presented in Back and Payne Firm (2004a), Appendix VII of the RFI Phase I report.

3.4 Current Ground Water Flow Conditions

This section describes the current ground water flow conditions beneath the Facility and the surrounding area. The conditions are significantly affected by the two operating extraction wells described above.

Prior to the operation of the two extraction wells in 2000, the regional ground water flow direction was measured in the Cedarville Aquifer. Based on the calibrated ground water flow model, a particle of ground water from the Plant 2/3 source area trended to the southeast (towards Omar Circle) then followed a northeasterly direction (Figure 6). These pre-pumping conditions are consistent with the preferential zone of hydraulic conductivity mapped during the RFI as described in Section 3.2 and shown on Figure 5. Due to continuous pumping of the confined aquifer since early 2000, the hydrogeologic system in the vicinity is near steady state conditions for ground water flow. A depiction of the potentiometric surface measured during current pumping conditions is presented on Figure 6 showing the localized area of ground water capture on-Facility and zone of influence that has been active since pumping began. The capture zone and zone of influence are described below.

Capture Zone and Zone of Influence

As presented in the RFI, the capture zone is the area through which water recharges the operating extraction wells, primarily from the upgradient portions of the Facility west of the extraction wells. The zone of influence is the area affected by the extraction wells and extends outward in three-dimensions to the point of negligible drawdown. In confined systems, the saturated thickness is generally not reduced during pumping. Hydrostatic pressure, however, is reduced in the aquifer (Driscoll, 1986). As opposed to an unconfined system with increased permeability and a smaller zone of influence, the Cedarville Aquifer is a confined carbonate bedrock system where a change in pressure that is observed in wells has a greater effect on the extent of zone of influence caused by pumping (Reilly et al., 1987).

There is a regional sloping potentiometric surface away from the Facility (Back and Payne Firm, 2004a). Currently, ground water flow on-Facility is toward the pumping centers (Figure 6). The zone of influence is the entire area in which piezometric heads have declined because of pumping. The capture zone is anywhere a particle of water originates within the zone of influence that ends up in the extraction well, even if it is a downgradient point under nonstressed conditions (U.S. EPA, 1991). The stagnant flow areas are on the fringe of the capture zone, within the zone of influence (e.g., between MW02-03 and MW02-13 on Omar Circle). Likewise, if pumping does not sufficiently lower the heads enough to reverse the natural hydraulic gradient in monitoring wells off-Facility, ground water will flow away from the extraction well (e.g., MW02-06 and MW02-06CD on Wright Street) even though these wells are within the zone of influence. As depicted on Figure 6, the capture zone (estimated by particle tracking) includes a radius of at least 500 feet to the west and east of the pumping centers. Specific wells included within the estimated capture zone are listed below.

Upper Cedarville Aquifer Wells within the Capture Zone on- and off-Facility

- MW01-01, MW01-02, MW01-03, MW01-04, MW01-05, MW01-06, MW01-09, MW01-10, MW01-11, MW01-14, MW02-02, MW02-03, MW02-08, MW02-11, and MW02-17

Middle Cedarville Aquifer Wells within the Capture Zone on- and off-Facility

- MW01-02CD, MW01-03CD, MW01-04CD, MW01-05CD, MW02-03CD, MW02-08CD, and MW02-17CD

Lower Cedarville Aquifer Wells within the Capture Zone on- and off-Facility

- MW01-02SE, MW01-04SE, MW02-08SE, and MW02-11SE

3.4.1 Efficacy Evaluation of the Extraction Wells

The measured water levels in conjunction with the known pumping rates were used to verify the capture zones with the numerical model (Back and Payne Firm, 2004a). The three dimensional area of the model is divided into a series of blocks or model elements. The two extraction wells that are continuously pumping are ideal for predicting aquifer parameters since the wells have been pumping for a number of years (opposed to 24-48 hours for a typical pumping test). Based on the aquifer properties and measured water levels, a velocity vector for each model element is calculated to predict ground water flow direction.

Capture Zone Verification

Using the ground water flow model, particle tracks were superimposed on the predicted flow field to depict the extent of the capture zone on-Facility. These hypothetical particles were placed north-south on-Facility directly upgradient of the known source areas to simulate flow paths contaminants may follow as ground water travels toward the Facility boundary. As shown on Figure 6, particle flow paths are tracked and verified to be within the capture zone when each particle terminates at the extraction wells. In addition, analytical data collected monthly from the two extraction wells indicate contaminant mass removal has been occurring since the extraction wells began operating. Since April 2000, the extraction wells have pumped approximately 40 million gallons of ground water and an estimated 17 gallons of chlorinated solvents have been recovered by the remedial system from the Cedarville Aquifer. Decreasing contaminant trends over time are presented for the extraction wells in Appendix II and a summary of the ground water treatment systems is provided in Appendix VI.

Based on the results of the calibrated ground water flow model and particle tracking analysis completed quarterly and the monthly ground water analytical results, the capture zone of the two extraction wells extends to the base of the Cedarville Aquifer along the eastern boundary beneath the Facility (Back and Payne Firm, 2004a). Therefore, the GWCTS is continuing to meet its objective, which is to control and prevent the migration of contaminated ground water from leaving the Facility in the upper, middle, and lower portions of the Cedarville Aquifer. This efficacy evaluation is being verified quarterly during the post-RFI corrective measures study as presented in the quarterly progress reports submitted to the U.S. EPA since January 2003 (www.epa.gov/region5/sites/vernay). Depictions presented in the quarterly reports indicate that the dimensions of the capture zone and zone of influence created by the two extraction wells are very consistent through time.

Utility Tunnel Sump Water Treatment System

Vernay is also operating a Utility Tunnel Sump Water Treatment System (UTSWTS) using a sump located at the northeast corner of Plant 2 (Figure 2). As described in the RFI Phase I report, the sump collects water from the Unconsolidated Unit that accumulates inside the concrete underground tunnel that connects utility lines between Plants 2 and 3. The UTSWTS treats collected water with activated carbon before it is discharged to the Yellow Springs POTW. Approximately 200,000 gallons of water is treated annually by the UTSWTS at the Facility. Contaminant mass removal is also evident from the graphs and tables presented in Appendix VI from samples collected on a monthly basis.

3.5 Ground Water Use

This section describes the current uses of ground water in the vicinity of the Facility. Information from the RFI indicated that some private water wells are located near the Facility. As demonstrated during the RFI and documented in the CA725 EI Report (ENVIRON and Payne Firm, 2004), no unacceptable exposures to contaminated ground water released from the Facility currently exist. The following description is a summary of Cedarville Aquifer ground water use as it pertains to the CA750 EI determination.

Since the 1960s, The Village of Yellow Springs has obtained its potable water from a well field located 2.5 miles south of the Facility. As shown on Figure 3, the municipal well field is located within buried valley unconsolidated deposits of the Little Miami River, which is beyond the stratigraphic limits of the carbonate bedrock Cedarville Aquifer. The Village does not derive its public water supply from the lower yielding Cedarville Aquifer located beneath the Facility. A detailed description of the municipal water use in the Village was described in the Phase I RFI report.

Most properties in the Village of Yellow Springs are connected to the municipal water supply. A few properties in a defined survey area have private wells that use the Cedarville Aquifer for potable and/or non-potable purposes. Some of the identified private wells are not currently being used for any purpose. As part of the RFI, annual water well surveys (including sampling of used water wells) were completed in 2004 and 2005 in the vicinity of the Facility to identify private water wells that are being used, or could be used. The 2004 and 2005 water well surveys were presented in appendices included with the Phase I RFI report and the Fourth Quarter 2005 progress report, respectively. The current locations and uses of the identified water wells in the survey area are presented on Figure 7.

Vernay is continuing to conduct annual well surveys and sampling in the defined well survey area to verify current water well use. The following conclusions were presented in the annual water well survey reports:

- Three properties identified during the surveys that had water wells in the Cedarville Aquifer being used for potable purposes were abandoned by Vernay. Nine water wells were confirmed to no longer be in operation. There are three potable water wells that could not be abandoned by Vernay. These three wells have been sampled by Vernay to determine if the wells may have been impacted above U.S. EPA Maximum Contaminant Levels (MCLs). None of these remaining properties with active potable water wells contain VOCs above MCLs or even above the laboratory reporting limit. In addition, four water wells used for non-potable purposes in the survey area were also sampled and do not contain VOCs at concentrations above acceptable risk-based levels (as defined in the Phase II RFI Report).

- Beneath the Facility, the Cedarville Aquifer is not used as a source of potable or non-potable ground water. An un-used well set in the middle portion of the Cedarville Aquifer exists in Plant 2 which is currently unoccupied.

4.0 CURRENT MIGRATION OF CONTAMINATED GROUND WATER UNDER CONTROL

4.1 Areas of Interest for Environmental Indicator Determination

Two ground water Areas of Interest (AOIs) were defined for the RFI risk assessment, as detailed in the Phase II RFI report: AOI 5A – On-Facility Cedarville Aquifer Ground Water, and AOI 5B – Off-Facility Cedarville Aquifer Ground Water. Ground water samples were collected on a quarterly basis during the RFI and continue to be collected quarterly during the post-RFI corrective measures study. A comprehensive summary of analytical laboratory results from monitoring wells in the Cedarville Aquifer is presented on Sheet 1 and Table 1.

4.1.1 AOI 5A – Cedarville Aquifer Ground Water Beneath the Facility

AOI 5A is defined as the Cedarville Aquifer ground water beneath the Facility. Within the limits of AOI 5A, Vernay collected 36 direct push water samples from the upper portion of the Cedarville Aquifer beneath the Facility to focus the installation of permanent wells. Vernay has installed a total of 18 monitoring wells, two extraction wells (used for hydraulic control and VOC mass removal) and five remediation wells (installed for treatability studies) within the upper, middle and lower portions of the aquifer. Ground water samples on-Facility have been analyzed for VOCs, SVOCs, pesticides/PCBs, herbicides, metals and natural attenuation parameters.

4.1.2 AOI 5B – Cedarville Aquifer Ground Water off the Facility

AOI 5B is defined as the Cedarville Aquifer ground water beneath areas off of the property within the limits of the survey area identified during the RFI (Figure 7). The survey area downgradient of the Facility covers approximately 110 acres. Within AOI 5B, Vernay collected 81 direct push water samples from the upper portion of the Cedarville Aquifer to focus the installation of permanent monitoring wells. Vernay has installed a total of 32 monitoring wells within the upper, middle and lower portions of the aquifer off-Facility. Ground water samples from direct push sampling, monitoring wells and private water wells off-Facility have been analyzed for VOCs, SVOCs, metals, and natural attenuation parameters.

4.2 Presence of Ground Water Contamination

Question 2 of the CA750 form asks whether, "…ground water is known or reasonably suspected to be "contaminated" above appropriately protective "levels" from releases subject to RCRA corrective action, anywhere at, or from, the Facility." According to the CA750 form:

> ***"Contamination"*** *and* ***"contaminated"*** *describes media containing contaminants (in any form, NAPL and/or dissolved, vapors, or solids, that are subject to RCRA) in concentrations in excess of appropriate* ***"levels"*** *(appropriate for the protection of the ground water resource and its beneficial uses).*

The identification of "contamination" in the Cedarville Aquifer in AOI 5A and AOI 5B is based on levels that exceed Ohio or federal Maximum Contaminant Levels (MCLs) for drinking water, or in the absence of an MCL, equivalent drinking water levels (EDWLs[3]). The rationale for using these protective levels was discussed in detail in the risk assessment section of the Phase II RFI report, as summarized below.

As described in Section 3.5, the Cedarville Aquifer ground water is not a source of water at the Facility. The Facility obtains its water from the Village of Yellow Springs. In addition, on-Facility direct contact exposure to constituents in Cedarville Aquifer ground water is not reasonably expected under current conditions due to the depth to ground water and the confined nature of the aquifer. Under a current scenario, the RFI risk assessment identified that potential on-Facility exposure to contaminated ground water is limited to non-drinking water exposures (i.e., vapor migration into on-site buildings). Nonetheless, as indicated above, the identification of on-Facility contamination for the purposes of this EI determination is based on a comparison to criteria for drinking water even though ground water is not currently used. Currently off-Facility, the Cedarville Aquifer is being used by some properties in or nearby the area of contamination for potable or non-potable purposes (Figure 7) and, therefore, identification of "contamination" in off-Facility ground water is also based on MCLs for drinking water. Under a current scenario, the RFI determined that none of the off-Facility potable wells have concentrations indicative of "contamination."

A site-specific sampling list of chemicals was developed for the RFI to investigate a number of medium and high release potential solid waste management units (SWMUs) and areas of concern (AOCs) at the Facility identified by the U.S. EPA (TechLaw, 2001; Payne Firm, 2003). During the RFI, the U.S. EPA agreed that SVOCs, pesticides/PCBs, herbicides and metals could be eliminated from consideration, leaving VOCs as the primary constituents of concern in the Cedarville Aquifer.

As identified by the most recent sampling event, concentrations of five VOC constituents [PCE, TCE, cis-1,2-Dichloroethene (cis-1,2-DCE), vinyl chloride, and 1,2-Dichloropropane (1,2-DCP)] in AOI 5A on-Facility and PCE/TCE in AOI 5B off-Facility are detected at concentrations that exceed drinking water criteria. These constituents are summarized in the following table:

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[3] The equivalent drinking water concentrations are generic risk-based drinking water limits calculated using conservative standard default exposure factors for estimating high-end exposures via daily drinking water consumption (U.S. EPA, 1991), and target cancer risk and target HQ of 10^{-5} and 1, respectively.

Cedarville Aquifer VOCs	Drinking Water Criteria (µg/L)	AOI 5A On-Facility Maximum Concentration (µg/L)	AOI 5B Off-Facility Maximum Concentration (µg/L)
PCE	5	5,000 (RW01-05)	23 (MW02-06)
TCE	5	330 (RW01-05)	7.6 (MW02-09)
cis-1,2-DCE	70	270 (MW01-10)	2 (MW02-09)
Vinyl chloride	2	74 (MW01-10)	Not Detected Above Reporting Limit
1,2-DCP	5	1,700 (MW01-02)	1.3 (MW02-17)

The concentrations of these five VOCs define the existing area of contamination in the Cedarville Aquifer, as discussed in the following sections.

4.2.1 Existing Area of Ground Water VOC Contamination

The existing area of VOC contamination has been adequately defined horizontally and vertically to concentrations that are below drinking water criteria on- and off-Facility. In fact, during the RFI, VOC contamination has also been defined to the laboratory's reporting limits or the Estimated Quantitation Limit (EQL) on- and off-Facility. The reporting limit (or EQL) is defined as the level to which the laboratory reports data results to a specific degree of confidence, accuracy and precision that can be quantitatively measured. According to the CA750 form:

> ***"existing area of contaminated ground water"*** *is an area (with horizontal and vertical dimensions) that has been verifiably demonstrated to contain all relevant ground water contamination for this determination, and is defined by designated (monitoring) locations proximate to the outer perimeter of "contamination" that can and will be sampled/tested in the future to physically verify that all "contaminated" ground water remains within this area, and that the further migration of "contaminated" ground water is not occurring.*

The "existing area of contamination" in the Cedarville Aquifer downgradient of the Facility consists of VOCs in ground water that are detected above drinking water criteria. Contaminated ground water exists primarily in the upper and middle portions of the Cedarville Aquifer and is limited to only the upper portion of the aquifer at the outer perimeter locations. No VOCs are detected above a reporting limit in wells screened at the base of the Cedarville Aquifer.

Evidence Defining Area of Contamination

Monitoring well results summarized in the table below define the vertical and horizontal outer perimeter of the area of contamination. This area of contamination is also shown on Sheet 1 for the five VOCs above an MCL.

Cedarville Aquifer VOCs	Drinking Water Criteria Level of Concern (µg/L)	Plume Interior Centerline Wells (On- to Off-Facility)	"Clean Wells" at Front and Base of Plume Outer Perimeter
PCE	5	MW01-02 = <56 ug/l RW01-05 = 5,000 ug/l MW01-04 = 95 ug/l †MW01-04CD = 190 ug/l MW02-08 = 14 ug/l †MW02-08CD = 14 ug/l MW02-06 = 23 ug/l MW02-09 = 17 ug/l	MW02-07 = <1 ug/l MW02-15 = <1 ug/l *MW02-10 = 2.3 ug/l †MW01-04SE = <1 ug/l †MW02-08SE = <1 ug/l †MW02-06CD = 1.1 ug/l
TCE	5	MW01-02 = <56 ug/l RW01-05 = 330 ug/l MW01-04 = 22 ug/l †MW01-04CD = 12 ug/l MW02-08 = 4.2 ug/l †MW02-08CD = 7.3 ug/l MW02-06 = 5.8 ug/l MW02-09 = 7.6 ug/l	MW02-07 = <1 ug/l MW02-15 = <1 ug/l MW02-10 = <1 ug/l †MW01-04SE = <1 ug/l †MW02-08SE = <1 ug/l †MW02-06CD = <1 ug/l
cis-1,2-DCE	70	MW01-02 = 21J ug/l RW01-05 = <83 ug/l MW01-10 = 270 ug/l †MW01-04CD = 1.8J ug/l MW02-08 = 1.1 ug/l †MW02-08CD = 1.9 ug/l MW02-06 = 1.8 ug/l MW02-09 = 2 ug/l	MW02-07 = <0.5 ug/l MW02-15 = <0.5 ug/l MW02-10 = <0.5 ug/l †MW01-04SE = <0.5 ug/l †MW02-08SE = <0.5 ug/l †MW02-06CD = <0.5 ug/l
Vinyl chloride	2	MW01-02 = <56 ug/l RW01-05 = <170 ug/l MW01-10 = 74 ug/l †MW01-04CD = <8 ug/l MW02-08 = <2 ug/l †MW02-08CD = <1 ug/l MW02-06 = <1.7 ug/l MW02-09 = <1 ug/l	MW02-07 = <1 ug/l MW02-15 = <1 ug/l MW02-10 = <1 ug/l †MW01-04SE = <1 ug/l †MW02-08SE = <1ug/l †MW02-06CD = <1 ug/l
1,2-DCP	5	MW01-02 = 1,700 ug/l MW01-01 = <1 ug/l †MW01-05CD = <1 ug/l MW02-17 = 1.3 ug/l †MW02-08CD = <1 ug/l MW02-06 = <1.7 ug/l MW02-09 = <1 ug/l	MW02-07 = <1 ug/l MW02-15 = <1 ug/l MW02-10 = <1 ug/l †MW01-04SE = <1 ug/l †MW02-08SE = <1ug/l †MW02-06CD = <1 ug/l

†Monitoring wells designated as "CD" and "SE" show results from the middle and lower portion of the Cedarville Aquifer, respectively.

*PCE detected in MW02-10 has been below a level of concern since sampling was initiated in September 2003. In addition, Geoprobe water samples (GP02-56 and GP02-57) were collected approximately 200 feet downgradient of MW02-10 and were non-detect for VOCs.

As presented in the table above, the current monitoring well network has been verifiably demonstrated to contain all relevant ground water contamination for this EI determination, and is defined by designated monitoring locations proximate to the outer perimeter of "contamination" as shown on Sheet 1 and Figure 9.

Horizontal Limits of Contamination

In a horizontal direction, the concentrations in the furthest downgradient monitoring well with VOC detections (MW02-09 on Suncrest Drive) are only slightly above the levels of concern (5 µg/L) at 17 µg/L for PCE and 7.6 µg/L for TCE. Furthermore, the concentrations of VOCs in each of the 14 "clean" wells (MW02-01, MW02-02, MW02-03, MW02-04, MW02-05, MW02-07, MW02-10, MW02-11, MW02-13, MW02-14, MW02-15, MW02-16, MW02-17, and MW02-18) were below the levels of concern. In particular, concentrations downgradient of MW02-09 (i.e., at MW02-15 on Green Street) are below drinking water criteria.

Vertical Limits of Contamination

Vertically in the Cedarville Aquifer, VOC concentrations above a level of concern (5 µg/L) are limited to only two wells in the middle portion of the aquifer located along the centerline of the plume on- and off-Facility (MW01-04CD on-Facility and MW02-08CD off-Facility), although these two wells are located within the capture zone of the extraction wells. No detections above a level of concern are currently present in the middle portion of the Cedarville Aquifer at the vertical outer perimeter, or in any lower Cedarville Aquifer wells as demonstrated by the following 18 "clean" wells (MW01-02CD, MW01-02SE, MW01-03CD, MW01-04SE, MW01-05CD, MW02-03CD, MW02-03SE, MW02-04CD, MW02-05CD, MW02-06CD, MW02-08SE, MW02-10CD, MW02-11SE, MW02-14CD, MW02-15CD, MW02-16CD, MW02-17CD, and MW02-18CD).

The vertical extent of contamination from the most recent monitoring event is plotted for each well on the geologic cross sections from two traverses through the area of contamination (Appendix IV.) The first cross section is located from the western most clean wells upgradient on the Facility to the eastern most clean wells downgradient off-Facility and is aligned with the approximate centerline of the area of contamination. A second cross section is located north-south along the Facility's eastern boundary, which is perpendicular to flow showing the effect of the two extraction wells. Similarly, the horizontal extent of contamination is plotted on Sheet 1. The three-dimensional existing area of contamination in the Cedarville Aquifer on- and off-Facility has been verified as illustrated on Figure 9 and discussed below:

PCE and TCE Area of Contamination

The horizontal and vertical extent of PCE and TCE in the Cedarville Aquifer has been defined to below drinking water MCLs (5 µg/L) on- and off-Facility by the existing monitoring well network (Sheet 1).

- On-Facility, PCE and TCE originate from known source areas identified during the RFI at the western portion of the property and the Plant 2/3 area located within the capture zone of the extraction wells as shown on Figure 6. PCE and TCE are not detected above a level of concern in wells screened in the upper, middle or lower portions of the Cedarville Aquifer at the three-dimensional outer perimeter areas of contamination on-Facility (e.g., MW01-07, MW01-08, MW01-01, MW01-03 in the upper; MW01-03CD and MW01-05CD in the middle; MW01-02SE and MW01-04SE in the lower).

- In the pre-pumping downgradient direction along the plume centerline, PCE and TCE concentrations sharply decrease (one order of magnitude) beyond the two extraction wells (e.g., MW02-08, MW02-06, MW02-09, and MW02-15).
- Beyond the zone of influence exerted by the extraction wells east and southeast of the Facility, two areas of PCE and TCE are currently present: 1) east of the Facility, a remnant lobe is oriented northeast beyond Wright Street; and, 2) southeast of the Facility, another remnant lobe exists between the southeast side of Omar Circle and West South College Street. These remnant lobes are aligned with the pre-pumping ground water flow direction (Sheet 1). PCE and TCE are not detected above a level of concern in wells downgradient of these remnant lobes (e.g., MW02-07, MW02-15/CD, MW02-10/CD to the northeast and MW02-03/CD/SE, MW02-13, and MW02-14/CD to the southeast).

cis-1,2-DCE and Vinyl Chloride Area of Contamination

- Plume degradation (i.e., destructive natural attenuation process), within the capture zone directly upgradient of the extraction wells, is indicated by the presence of concentrations of cis-1,2-DCE and vinyl chloride in addition to PCE and TCE, and is most evident in the vicinity of Plant 3 (Sheet 1).
- The horizontal and vertical extent of vinyl chloride in the Cedarville Aquifer has been defined to below the drinking water MCL (2 µg/L) on- and off-Facility. Currently, no vinyl chloride is detected above a reporting limit (1 µg/L) off-Facility.
- Similarly, the horizontal and vertical extent of cis-1,2-DCE in the Cedarville Aquifer has been defined to below the drinking water MCL (70 µg/L) on- and off-Facility. Off-Facility where PCE and TCE degradation is occurring, cis-1,2-DCE is detected above a reporting limit at some locations (0.5 µg/L) but below the MCL.

1,2-DCP Area of Contamination

- The areal distribution of 1,2-DCP in ground water (Sheet 1) is different than the four other chlorinated VOC contaminants as a result of the limited source areas on the western end of the Facility and the southwest corner of Plant 3 identified during the RFI.
- The horizontal and vertical extent of 1,2-DCP in the Cedarville Aquifer has been defined to below the drinking water MCL (5 µg/L) on- and off-Facility.
- The concentration gradient of the 1,2-DCP plume sharply decreases (one order of magnitude) in the downgradient direction towards the extraction wells at the Facility's eastern property boundary. For example, 1,2-DCP detections at MW01-02 decrease from 1,700 µg/L (adjacent to the source area within the capture zone) to below reporting limits near the extraction wells. Beyond the Facility, approximately 300 feet east of CW01-02, a remnant lobe of 1,2-DCP remains within the capture zone at MW02-17, currently detected at 1.3 µg/L in the upper portion of the aquifer (Sheet 1). Non-detect

direct-push ground water samples collected east of MW02-17 during the RFI indicated 1,2-DCP is not present beyond MW02-17 in a horizontal direction and the deeper screened interval at MW02-17CD has been non-detect since first sampled in March 2004. All other wells screened in the upper, middle and lower portions of the Cedarville Aquifer are currently non-detect for 1,2-DCP.

- MW01-02 is located near a localized source area of 1,2-DCP in soil and ground water at the western portion of the Facility. The 1,2-DCP concentration trend over time is shown on the graph for MW01-02 provided in Appendix II. When first sampled in 1998 through 2001, a decreasing concentration trend from 510 ug/l to 28 ug/L was observed. As noted on the graph, the second extraction well (CW01-02) began pumping in January 2003. VOC sampling resumed at MW01-02 in February 2003 throughout the RFI and post-RFI periods where an increase in concentrations have been observed ranging from 120 ug/L to 1,800 ug/L in February 2006. Since the location of MW01-02 is near the 1,2-DCP source area, upgradient of the second extraction well (CW01-02) and within the capture zone (Figure 6), there is a direct correlation between the increased concentrations and the increase in ground water flow velocity exerted by the second extraction well installed in 2003.
- As depicted on Figure 6, stability is maintained for any well located within the capture zone since the flow path will ultimately lead to the treatment system of the extraction wells.
- Since the maximum concentration of 1,2-DCP was 1,800 µg/L, 1,2-DCP is not expected to be present in a separate mobile phase given the maximum concentration in ground water is less than one percent of the single component solubility (2,700,000 µg/L for 1,2-DCP). In addition, the middle and lower screened intervals at the MW01-02 location have been non-detect for all VOCs since first sampled in 1999.

Fate and Transport Modeling

During the Phase II RFI, solute fate and transport modeling was completed that focused on using the results of the calibrated ground water flow model (Back and Payne Firm, 2004a) to form the basis of a contaminant transport model. The transport model was subsequently used to better understand the temporal behavior of the PCE and TCE, determine the effect of the two ground water extraction wells and to determine the adequacy of the existing monitoring well network. A detailed description of the fate and transport modeling conducted during the Phase II RFI, including the modeling objectives, conceptual model, computer code selection, model construction, model calibration, and model conclusions was presented in a separate report (Back and Payne Firm, 2004b) as Appendix V to the Phase II RFI report (Payne Firm et al., 2005f).

The results of the solute transport analyses provided an independent verification that the existing area of contamination is contained within the existing three-dimensional monitoring well network, as confirmed by the quarterly monitoring data from the RFI. The most recent quarterly monitoring data analyzed for this EI determination match the initial calibration results from the solute transport model, supporting the evidence defining the existing area of contamination (Sheet 1).

4.2.2 Effects of Pumping on Existing Area of Contamination

As discussed above and presented on Sheet 1, the area where Cedarville Aquifer ground water is impacted covers approximately two-thirds of the Facility and a downgradient, off-Facility area approximately 2,000 feet to the northeast and 500 feet to the southeast in the upper portion of the Cedarville Aquifer. VOC-contamination also exists to a lesser extent in the middle portion of the aquifer on-Facility to approximately 500 feet off-Facility. VOCs are not detected in wells screened at the base of the Cedarville Aquifer.

VOC data are available for most monitoring well locations on the Facility property since 1998 (i.e., before the two extraction wells were installed); off-property data are available at some locations prior to the start of the extraction well interim measures, but at most locations only after one or both of the extraction wells began pumping (Table 1). Ongoing ground water pumping effectively divides the area of contamination into source area and off-property components as described previously in Section 4.2.1. The area of contamination is currently hydraulically controlled by the extraction wells, which includes a capture zone on- and off-Facility and a zone of influence downgradient of the capture zone is exerted on ground water flow, contaminant migration, and ground water chemistry off-Facility (Figure 6).

Ground water reducing-oxidation (redox) conditions change from reducing conditions at the source areas to generally oxidizing conditions at the pumping centers. Reducing conditions are generally transitional to oxidizing in the immediate off-Facility area. Farther off-Facility, downgradient of the capture zone, ground water flow is less affected by pumping and is currently being monitored for natural attenuation parameters. Natural attenuation consists of the various naturally-occurring processes that reduce the mass, toxicity, mobility, volume, and concentration of contaminants, especially in scenarios where contaminants are prevented from migrating from a source area of higher concentrations, which is the current situation at Vernay.

The capture zone area was described in Section 3.4. As depicted on Figure 6, the capture zone (estimated by particle tracking) includes a radius of at least 500 feet to the west and east of the pumping centers. Specific wells included within the estimated capture zone are listed below.

<u>Upper Cedarville Aquifer Wells within the Capture Zone on- and off-Facility</u>

- MW01-01, MW01-02, MW01-03, MW01-04, MW01-05, MW01-06, MW01-09, MW01-10, MW01-11, MW01-14, MW02-02, MW02-03, MW02-08, MW02-11, and MW02-17

<u>Middle Cedarville Aquifer Wells within the Capture Zone on- and off-Facility</u>

- MW01-02CD, MW01-03CD, MW01-04CD, MW01-05CD, MW02-03CD, MW02-08CD, and MW02-17CD

Lower Cedarville Aquifer Wells within the Capture Zone on- and off-Facility

- MW01-02SE, MW01-04SE, MW02-08SE, and MW02-11SE

As the area of contamination is controlled by the extraction wells, concentrations of VOCs may change in any particular well, depending on its proximity to the ground water pumping (Figure 6). As predicted in the Ground Water Technical Memorandum (“TM-3”; Payne Firm, 2003), some monitoring wells within or near the capture zone have exhibited a significant decrease in VOC concentrations since pumping commenced at the Facility. Graphs of the five VOCs constituents that have been detected above a drinking water criteria for each monitoring well and extraction well are plotted with time in Appendix II.

The following conclusions regarding the influence of the two extraction wells on the existing area of contamination are summarized below:

- VOC concentrations in several monitoring wells screened in the upper portion of the Cedarville Aquifer show decreasing concentration of VOCs over time. The most significant decreasing trends are shown for PCE at RW01-05 (44,000 µg/L to 5,500 µg/L) near the Plant 2/3 source area and MW01-04 (4,600 µg/L to 160 µg/L) located at the southeast portion of the Facility.
- Overall decreasing trends of VOCs are also observed in monitoring wells screened in the middle portion of the Cedarville Aquifer (e.g., MW01-04CD and MW01-05CD on-Facility and MW02-03CD off-Facility).
- As predicted in TM-3 (Payne Firm, 2003), although the overall trend is decreasing, some monitoring wells within or near the capture zone of influence have exhibited increases in VOCs since pumping commenced at the Facility. As the ground water extraction wells are operating, VOCs in the ground water are drawn toward the extraction wells due to a change in the ground water flow paths from nonstressed conditions to pumping conditions, and concentrations of VOCs may temporarily increase in wells located in close proximity to the extraction wells. This was evident following the startup of CW01-01 in 2000, the addition of CW01-02 in 2003 followed by an increase in pumping rates in the third quarter 2004; these changes are noted on the VOC graphs in Appendix II. As shown on Sheet 1, the monitoring wells proximate to the capture zone exhibited an increase of VOCs during the fourth quarter 2004 sampling event, followed by expected steady-state conditions by the next quarterly sampling (see Table 1). These trends are also evident in the graphs included in Appendix II for on-Facility wells MW01-06, MW01-04, MW01-04CD, MW01-09, MW01-10, MW01-14 and the off-Facility wells MW02-03, MW02-06, MW02-08, MW02-08CD, and MW02-17.
- The control of source area VOCs along the eastern property boundary of the Facility has resulted in a reduction of chemical flux to the aquifer downgradient of the Facility. As a result, concentrations of VOCs have stabilized (i.e., are not increasing) at wells that are located near the three-dimensional outer perimeter of the plume (e.g., see graphs in Appendix II for wells MW02-01, MW02-02, MW02-03, MW02-03CD, MW02-03SE, MW02-04, MW02-04CD, MW02-05, MW02-05CD, MW02-06CD, MW02-07, MW02-10, MW02-11, MW02-11SE, MW02-13, MW02-14,

MW02-14CD, MW02-15, MW02-15CD, MW02-16, MW02-16CD, MW02-17, MW02-17CD, MW02-18, and MW02-18CD).

4.3 Ground Water Contaminant Migration Under Control

Question 3 of the CA750 form asks whether, "…the migration of contaminated ground water has stabilized (such that contaminated ground water is expected to remain within "existing area of contaminated ground water" as defined by the monitoring locations designated at the time of this determination)?"

VOC ground water contamination is stabilized and expected to remain within the horizontal and vertical dimensions of the "existing area of ground water contamination" on and off of the Facility. The current ground water contaminant migration is under control based on the physical evidence and understanding of the environmental setting determined from the RFI.

- The primary physical evidence that ground water contamination is under control is based on laboratory analytical results and monitoring data presented in Section 4.2.1.
- Additional evidence supporting the stability demonstration is provided by a statistical analysis performed on the plume outer perimeter wells and plume interior centerline wells (Section 4.3.2 below and Appendix V).

4.3.1 Primary Physical Evidence and Rationale for Migration Under Control

The following discussion demonstrates that the migration of ground water contamination can be reasonably expected to remain within the horizontal and vertical dimensions of the "existing area of ground water contamination."

Evidence for Stability at Outer Perimeter of Contaminant Plume

The evidence that the VOC plume is stable is supported by the fact that the perimeter "clean" wells have been monitored since the beginning of 2004 to April 2006 (>790 days), which is sufficient to detect a migrating plume using the following examples:

<u>Upper Zone of the Cedarville Aquifer</u>

An effective porosity of 20-25% has been estimated from site-specific measurements, resulting in a ground water flow velocity between 80 to 125 feet per year. If the contaminant with the furthest horizontal extent (PCE contoured to the level of concern of 5 µg/L) were moving at a rate similar to the ground water flow velocity *(0.22 to 0.34 ft/day x 796 days = 175 to 271 feet)* and the outer perimeter of the plume and the "clean" well MW02-15 are only 110 feet apart (Figure 8), then ample monitoring time has elapsed to observe an unstable plume above a level of concern. As of the most recent quarterly sampling event, VOCs have not been detected above a level of concern since MW02-15 was first sampled in February 2004 (796 days since first monitored).

Middle Zone of the Cedarville Aquifer

The same travel-time solution provides evidence of plume stability along the furthest plume extent in the middle zone of the Cedarville Aquifer. The distance between the furthest contaminant extent (PCE contoured to the level of concern of 5 µg/L) and the "clean well" (MW02-06CD) are only 100 feet apart (Figure 8). Using a ground water flow velocity of 80 to 125 feet per year, *(0.22 to 0.34 ft/day x 818 days = 180 to 278 feet*), then enough monitoring time has elapsed to observe a migrating plume in the middle portion of the Cedarville Aquifer above a level of concern. As of the most recent quarterly sampling event, VOCs have not been detected above a level of concern since MW02-06CD was first sampled in January 2004 (818 days since first monitored).

Lower Zone of the Cedarville Aquifer

As discussed in Section 4.2.1, VOCs are not currently detected on- or off-Facility in monitoring wells screened in the lower Cedarville Aquifer even though MW01-04SE is located in the pre-pumping downgradient flow path on-Facility (Figure 6). Likewise, the off-Facility lower Cedaville Aquifer monitoring wells (MW02-03SE, MW02-08SE, and MW02-11SE) are positioned in all pre-pumping downgradient flow paths approximately 500 feet east of the Facility boundary. These three off-Facility wells are also screened at the base of the Cedarville Aquifer down-dip of the Facility source areas where the indication of past contaminant migration would have been apparent. As of the most recent quarterly sampling event, VOCs have not been detected above a reporting limit since the SE wells were first sampled in September 2003. Upgradient of the Facility source areas, MW01-02SE has been non-detect for VOCs since first sampled in May 1999.

4.3.2 VOC Concentrations Over Time

In addition to the physical evidence for the migration under control demonstration presented above, a statistical analysis was performed to evaluate contaminant plume stability by quantitatively analyzing changes in concentrations in individual wells over time. The complete supporting documentation for the statistical analysis completed by RCJ Consulting (2006) is included in Appendix V. The statistical analysis included the five VOCs detected above drinking water criteria: PCE, TCE, cis-1,2-DCE, vinyl chloride, and 1,2-DCP. The analysis was performed on a subset of wells within the horizontal and vertical limits of contamination. As shown on Sheet 1, these wells are located on- and off-Facility either upgradient or downgradient of the two extraction wells and focused on the following 16 wells that have had detections in the plume centerline or plume outer three-dimensional perimeter:

- Plume centerline wells upgradient of extraction wells include: MW01-02, RW01-05, MW01-11, MW01-06, MW01-04, and MW01-04CD.

- Plume centerline wells downgradient of extraction wells include: MW02-09, MW02-06, MW02-08, and MW02-08CD.
- Plume outer perimeter wells downgradient of extraction wells include: MW02-10, MW02-13, MW02-03CD, and MW02-17. A statistical analysis was not performed on wells beyond the outer perimeter of the area of contamination since these wells have been non-detect for VOCs (e.g., MW02-01, MW02-02, MW02-03SE, MW02-04/04CD, MW02-05/05CD, MW02-06CD, MW02-07, MW02-08SE, MW02-10, MW02-11/11CD, MW02-14/14CD, MW02-15/15CD, MW02-16/16CD, MW02-17CD, and MW02-18/18CD).

Statistical Methodology

To provide an interpretation of whether there is a statistically significant trend in monitoring wells, the methodology included the parametric and non-parametric tests ANOVA and the Wilcoxon rank sum. These tests compare two independent samples against one another to determine if there is a statistical difference. In addition, the Students t-test for individual well pairs and the Tukey-Kramer test for multiple well comparisons were also applied to evaluate statistical differences between wells. Following the determination of whether individual wells were statistically different, the next step was to evaluate the best fit of the data trends with the use of regression analysis. The use of regression analysis determined whether the “best fit” was statistically different from the mean and whether a statistically significant trend would need further evaluation.

Results of VOC Trend Evaluation

The statistical results for TCE and PCE are presented in Appendix V-Figures 1 and 2, respectively. These results illustrate that from the *between well comparisons* for TCE and PCE, the outer perimeter wells are not statistically different. For example, wells MW02-10 and MW02-17 have the same mean and the wells MW02-03CD and MW02-13 have the same mean for TCE. The *means comparisons* tests were used to illustrate those wells that are statistically different as well as those wells that statistically have the same mean. These results are displayed for wells at the horizontal and vertical outer perimeter (MW02-10, MW02-13, MW02-03CD, and MW02-17) and wells in the three-dimensional downgradient plume centerline (MW02-09, MW02-06, MW02-08, and MW02-08CD).

Three of the plume centerline wells (MW02-06, MW02-08, and MW02-08CD) did exhibit indications of statistically significant changes over time. As a direct result of pumping effects described in Section 4.2.2, the magnitude of the concentration difference in MW01-04 and MW01-04CD (in the capture zone of CW01-01 extraction well) and the downgradient plume centerline wells in the zone of influence (MW02-06, MW02-08, and MW02-08CD) produces the appearance of trends (increasing or decreasing) over short time periods. These trends were further evaluated and the results of the PCE and TCE bivariate regression analysis in Appendix V illustrates that the variability in the observed concentrations is not statistically different from the mean value, indicating that these wells are not increasing over time. The variability of VOCs in these wells is primarily due to the effects caused by the extraction wells.

Integration of statistical test results shows that observed trends are decreasing on an overall basis. No vertical or horizontal outer perimeter wells exhibited indications of statistically significant increasing trends, indicating there is statistical evidence to support a determination that the plume is not expanding.

4.4 Ground Water Discharge into Surface Water

Question 4 of the CA750 form asks, "…whether contaminated ground water discharges into surface water bodies?" There is no evidence identified during the RFI which would indicate that the Cedarville Aquifer ground water is in hydraulic communication with surface water bodies within the study area. Therefore, ground water discharge to surface water is not reasonably expected.

4.5 Ground Water Stability Verification Monitoring

Question 7 of the CA750 form asks whether, "…ground water monitoring/measurement data (and surface water/sediment/ecological data, as necessary) will be collected in the future to verify that contaminated ground water has remained within the horizontal (or vertical, as necessary) dimensions of the "existing area of contaminated ground water?"

With the completion of the RFI, the post-RFI corrective action process consists of the corrective measures evaluation. Post-RFI ground water monitoring data will continue to be collected to further support the assessment of the need for additional corrective action tasks. The Phase II RFI identified four ground water data needs during this post-RFI period, including:

1. Monitor plume stability for the CA750 demonstration.
2. Monitor the effectiveness of the existing ground water interim measures.
3. Monitor to support the calibration of the contaminant fate and transport ground water model.
4. Monitor to support the conclusion of the risk assessment and the CA725.

The sampling locations, data quality objectives and sampling frequency is listed on Table 2 and each monitoring location for the upper, middle, and lower zones of the Cedarville Aquifer is shown on Figure 9. Vernay re-evaluates the sampling frequency and number of locations following each sampling event. The sampling frequency (monthly, quarterly, semi-annual or annual) and rationale are described below:

Semi-Annual Monitoring

In order to meet these post-RFI ground water monitoring data needs, the RFI Phase II stated future ground water monitoring events will occur on a semi-annual basis until the final corrective action is determined by the U.S. EPA. This frequency is appropriate because the potentiometric surface beneath the Facility and vicinity has a semi-annual seasonal cyclic pattern (seasonal high in the spring and low in the fall), and the quarterly ground water analytical data do not exhibit seasonal effects on the concentrations detected in the monitoring wells. VOC trends over time are graphically presented in Appendix II and hydrographs over time are presented in Appendix III.

To verify that VOCs in ground water on the outer perimeter of the area of "contamination" are not moving beyond the three-dimensional extent of the plumes, especially at well locations that are critical for monitoring future ground water contaminant migration described in Section 4.3.1, a sufficient number monitoring wells are being sampled on a semi-annual frequency. Monitoring wells to be sampled on a semi-annual basis are also sufficient to verify the calibration of the contaminant fate and transport ground water model.

These 26 semi-annual monitoring wells include:

- MW01-01, MW01-02CD, MW01-02SE, MW01-03, MW01-03CD, MW01-04SE, MW02-05CD, MW01-07, MW02-02, MW02-03, MW02-03CD, MW02-03SE, MW02-04, MW02-05, MW02-05CD, MW02-06CD, MW02-07, MW02-08SE, MW02-10, MW02-11, MW02-11SE, MW02-13, MW02-14, MW02-15, MW02-17, and MW02-17CD.

To monitor the effectiveness of the existing ground water interim measure important to understanding concentrations of contaminants over time and to assist in determining if any additional ground water interim measures are necessary, the following seven monitoring wells are being sampled on a semi-annual basis:

- MW01-02, MW01-04, MW01-04CD, MW02-08, MW02-08CD, MW02-06, and MW02-09.
- The two extraction wells (CW01-01 and CW01-02) are sampled monthly as part of the routine maintenance of the ground water treatment system.
- In addition to ground water samples, one surface water sample is collected from the storm sewer outfall location to the unnamed creek on a semi-annual basis to verify the CA725 determination.

Quarterly Monitoring

Based on the U.S. EPA approval with comments to the revised RFI Phase II Report (U.S. EPA, 2005), the U.S. EPA included an enclosure with a list of monitoring wells to be sampled quarterly for the purposes of "time-dependency and area coverage in mind" which include the following 19 monitoring wells:

- MW01-02, MW01-04, MW01-04CD, MW01-10, MW01-13 (sewer backfill), RW01-05, MW02-03, MW02-03CD, MW02-03SE, MW02-06, MW02-06CD, MW02-08, MW02-08CD, MW02-08SE, MW02-09, MW02-10, MW02-11, MW02-11SE, and MW02-13.

In order to evaluate certain remedial treatment options for the development of proposed corrective measures on and off the Facility, Vernay is collecting a suite of ground water monitoring data from six monitoring wells quarterly:

- MW02-06, MW02-06CD, MW02-08, MW02-08CD, MW02-09, and MW02-10.

Annual Monitoring

To support the verification of the CA725 determination and the RFI risk assessment conclusions, Vernay is following up annually with the property owners having water wells identified in the water well survey area. In addition, during the corrective measures study, Vernay is resampling those water wells annually that are identified as currently being used for potable or non-potable purposes within the defined survey area downgradient from the Facility. The five private water wells verified as being used in 2005 included:

- 545 Dayton Street (non-potable)
- 850 Dayton Street (potable)
- 860 Dayton Street (non-potable)
- 780 Dayton Street (potable)
- 690 Wright Street (non-potable)

4.6 Conclusion

Ongoing ground water pumping effectively divides the area of contamination into source area and off-property components. The source area of contamination on-Facility is currently hydraulically controlled by the extraction wells, which includes a capture zone which covers on- and off-Facility areas. Due to the effects from constant pumping, a larger zone of influence downgradient of the capture zone is exerted on ground water flow, contaminant migration, and ground water chemistry off-Facility.

As demonstrated by the most recent Cedarville Aquifer ground water sampling event in April 2006, concentrations of the following constituents are considered to meet the CA750 definition of "contaminated" when the highest constituent concentrations are compared with the drinking water criteria.

<u>Cedarville Aquifer Ground Water On-Facility</u>

- Tetrachloroethene (PCE)
- Trichloroethene (TCE)
- cis-1,2-Dichloroethene (cis-1,2-DCE)
- Vinyl Chloride
- 1,2-Dichloropropane (1,2-DCP)

Cedarville Aquifer Ground Water Off-Facility

- Tetrachloroethene (PCE)
- Trichloroethene (TCE)

These VOCs are detected in the upper or middle portions of the Cedarville Aquifer only; no VOCs are detected above a reporting limit in the lower portion of the Cedarville Aquifer on- or off-Facility. The current monitoring well network has been demonstrated to contain all relevant ground water contamination for this EI determination, and is defined by designated monitoring locations proximate to the horizontal and vertical outer perimeter of "contamination."

For the purposes of this EI determination, the area of contamination can be reasonably expected to remain within its horizontal and vertical dimensions. Based on monitoring completed on- and off-Facility since 1998, the area of contamination is stable, including the following observations and lines of evidence:

1. Graphs of VOCs in perimeter and centerline wells do not show steadily increasing concentration trends over time that would indicate an expanding area of contamination (see Appendix II). In fact, VOC concentrations decrease progressively from the Facility to the farthest downgradient monitoring wells where VOCs are not detected vertically or horizontally in the aquifer. Furthermore, given some variability in concentrations, results from statistical analyses show that observed trends are decreasing on an overall basis. No vertical or horizontal outer perimeter wells exhibited indications of statistically significant increasing trends, indicating there is also statistical evidence to support a determination that the area of contamination is not expanding.
2. Concentrations are relatively stable in wells near the Facility source areas indicating infiltration through the vadose zone soils and residual contaminants in the fractured carbonate bedrock matrix provide a constant source to ground water beneath portions of the Facility. This source area ground water is being captured by the extraction wells and treated by the current interim measures.
3. Two ground water extraction wells have been operating near the source area for the last three to six years. The capture of VOCs along the Facility's eastern property boundary has resulted in a reduction of chemical flux in the aquifer downgradient of the Facility thereby reducing the mass of VOCs contributing to the outer three-dimensional perimeter of the area of contamination both on- and off-Facility. Concentrations of VOCs are not increasing at wells that are located at the outer perimeter of the area of contamination.
4. VOC concentrations decrease from the upper to the lower portion of the aquifer. The lack of a downward hydraulic gradient is likely contributing to decreasing VOC concentrations with depth in the Cedarville Aquifer.
5. There has been ample time for the area of contamination to reach a state near equilibrium given the age of the release (at least 40 years for PCE). The dissolved plume is only 2,000 feet long, compared with the estimated ground water travel distance from the source area estimated to be approximately

3,000 to 5,000 feet for the same time period (0.22 to 0.34 feet/day x 14,600 days). As of April 2006, VOCs have not been detected above a level of concern from monitoring wells located less than 300 feet beyond the area of contamination.

Current ground water contaminant migration is under control according to the provisions of CA750 based on the physical evidence defined by monitoring locations designated at the time of this demonstration. Additional monitoring will be conducted to continuously verify the accuracy of this determination until the selection of the final corrective measure (see Figure 9 and Table 2).

There is no evidence identified during the RFI that would indicate that the Cedarville Aquifer ground water is in hydraulic communication to surface water bodies within the study area.

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