REMEDY IMPLEMENTATION PLAN FOR

FINAL GROUNDWATER REMEDY

CHEVRON CINCINNATI FACILITY

HOOVEN, OHIO

December 13, 2007

Project #: 500-018-010

SUBMITTED BY: Trihydro Corporation

1252 Commerce Drive, Laramie, WY 82070

PREPARED FOR: Chevron Environmental Management Company

Chevron Cincinnati Facility, 5000 State Route 128, Cleves, OH 45002

Trihydro
CORPORATION

ENGINEERING SOLUTIONS. ADVANCING BUSINESS.

Home Office | 1252 Commerce Drive | Laramie, WY 82070 | phone 307/745.7474 | fax 307/745.7729 | www.trihydro.com

Table of Contents

List of Tables

List of Figures

List of Appendices

1.0 INTRODUCTION

This Remedy Implementation Plan (RIP), in combination with the Operation, Maintenance, and Monitoring (OMM) Plan (Plan), details plans and schedules for long-term operation of the final groundwater remedy at the Chevron Cincinnati Facility ("Facility") in Hooven, Ohio. Chevron and the United States Environmental Protection Agency (USEPA) executed an Administrative Order on Consent for implementation of the Final Groundwater Remedy on November 1, 2006 (2006 Order). The combined RIP/OMM Plan is intended to satisfy Paragraph 11 of the 2006 Order.

This Plan describes the physical systems and infrastructure to be constructed in the short term (e.g. over the next 6-12 months) in order to accomplish the remedy. The OMM Plan details the long-term procedures that will be followed to operate, maintain, and monitor remediation systems and overall cleanup progress.

Routine operations and monitoring at the site have to date been conducted under a 1993 Order. That Order terminated with issuance of the 2006 Order, but routine monitoring and reporting have continued under the terms of the 1993 Order while the combined RIP/OMM Plan is being prepared and reviewed. Upon USEPA approval of the combined RIP/OMM Plan, work will be performed under agreements set forth therein. A transition period in remedy activities is anticipated while new monitoring systems are being constructed, during which new wells or other infrastructure will not yet be available for operation or testing. During this transition period, available infrastructure will be operated/monitored during a given remedy event, with new infrastructure being operated/monitored as soon as construction activities are completed. Construction of most of the monitoring infrastructure described herein is expected to be completed within three to six months of USEPA approval of plans.

This Work Plan was originally submitted to USEPA on February 28, 2008. This version of Work Plan reflects changes that were made to address USEPA comments to the original submittal, and reflects the Final Plan. A compilation of USEPA's comments on the draft RIP and OMM and Chevron's response is included at Appendix C of this report.

2.0 SITE BACKGROUND

2.1 HISTORY

The Chevron facility is located in Whitewater Township, Hamilton County, Ohio, just east of the town of Hooven, and west of the Great Miami River. Land use surrounding the Chevron facility is residential, commercial, and wooded to the west. The site occupies approximately 500 acres bordered on the north, east, and south by the Great Miami River. Commercial retail property is developed along State Route 128, southwest of the Chevron facility (see Figure 2-1). In accordance with the Facility Description included in the 2006 Order, the facility includes a closed, capped Land Treatment Unit (LTU) located on a ridge northwest of the main portion of the refinery property. A former loading dock on the Ohio River is included in the facility, as well as a former products pipeline corridor between the refinery and the barge terminal. Two locations of known past pipeline releases are also included in the facility, at “the Islands” located directly across the Great Miami River from the former refinery, and at an area known as Gulf Park, in the Village of Cleves, Ohio.

Although the LTU is included under the RCRA Facility Definition under the 2006 Order, post-closure care and monitoring is being conducted for that location under a post-closure care permit with the Ohio Environmental Protection Agency (OEPA). Therefore, the operations, maintenance, and monitoring for the LTU are not addressed in this Plan. Remediation at the Islands has been completed under the 1993 AOC with U.S. EPA, so they also are not addressed further in this Plan.

Remediation and monitoring systems are in place at Gulf Park, and the operation, maintenance and monitoring of those systems is addressed in this Plan. Past remedial activities have been conducted at the Barge Terminal. No remedial or monitoring activities are planned at the Barge Terminal, so it is not addressed further in this Plan.

The manufacturing and refining portion of the Chevron facility was operated between 1931 and 1986. Gulf Oil Corporation operated the facility from 1931 until 1985. Chevron acquired Gulf Oil Corporation in 1985 and assumed operation until May 1986, when refinery operations were terminated. The refinery produced gasoline, jet fuels, diesel, home-heating fuels, asphalt, and sulfur. Refinery sludges and solids, many of which were classified as hazardous wastes, were also generated during manufacturing operations. The vast majority of refinery structures have been demolished, leaving an office building, a security building, a maintenance shed, and various structures associated with ongoing remediation activities.

On January 21, 1985, a hydrocarbon sheen was observed seeping into the Great Miami River near the southern boundary of the Chevron facility. The seep indicated a hydrocarbon plume in groundwater beneath the facility. Analysis of hydrocarbon in the groundwater indicated it was primarily refined leaded gasoline, with smaller components of diesel and other refined fuels. Petroleum hydrocarbon recovery systems were subsequently installed and have been in operation since 1985.

The term Light Non Aqueous Phase Liquid (LNAPL) is used to describe petroleum hydrocarbons in liquid form that are not dissolved in water. The quantity that originally leaked from the facility is not precisely known. Chevron has since pumped large amounts of groundwater over the past 20+ years, and recovered significant amounts of petroleum hydrocarbon (LNAPL). Approximately 2.5 million gallons were recovered within the first three years after pumping was initiated, with approximately 1.4 million gallons recovered over the next 18 years and approximately 3.9 million gallons recovered to date.

Currently, the Chevron facility pumps and treats four to five million gallons of groundwater per day on a seasonal basis while recovering between 10,000 to 20,000 gallons of LNAPL in recent years and 100,000 gallons in the most recent drought year of 1999. Though pumping and treating has gradually become less efficient over the years in recovering LNAPL, the 2006 high-grade pumping season still recovered more than 14,500 gallons of LNAPL, and 2007 is on pace to recover approximately 80,000 gallons of LNAPL. LNAPL remaining underground today exists in the pore spaces between soil particles within an area just above and below the groundwater table known as the smear zone. The thickness of the smear zone generally increases from inches at the plume periphery, to as much as 20 feet in some locations at the center of the plume. The depth to the top of the smear zone varies across the site, from as little as 10 feet near the Great Miami River, to approximately 30 feet across most of the former process areas and tank farms, to about 60 feet under the town of Hooven.

Extensive assessment and remedial activities have been conducted under the now terminated May 13, 1993 Administrative Order on Consent (1993 Order). These include a RCRA Facility Investigation to identify the nature and extent of contamination at the facility, a Corrective Measures Study to evaluate long-term corrective measures, numerous interim corrective measures, and Groundwater Conceptual Remedy reports and evaluations that lead up to execution of the 2006 Order and preparation of the combined RIP/OMM Plan. Interim corrective measures have included the removal of Solid Waste Management Units (SWMUs) and Areas of Concern under a 2004 Performance Agreement, and LNAPL recovery and groundwater containment efforts that have been ongoing for the past 21 years.

Details regarding past investigations and corrective actions are available in numerous Reports and Documents which are a part of the facility record.

Recent documents that relate directly to the 2006 Order and this Plan include the USEPA's description of the proposed Final Groundwater Remedy, in the *Statement of Basis for Groundwater*, issued April 2006. Following a public meeting and comment period, USEPA issued a *Final Decision and Response to Comments* on August 30, 2006, which described the final groundwater remedy. The Statement of Basis and Final Decision are the underlying USEPA technical documents that, in conjunction with the 2006 Order, define overall remedy components and goals detailed in the combined RIP/OMM Plan.

2.2 CONCEPTUAL SITE MODEL

The nature and extent of LNAPL and dissolved phase impacts have been well defined through extensive investigation and modeling. The groundwater conceptual site model (CSM) has been refined as additional assessment and testing was completed, and will continue to evolve as data is collected under the combined RIP/OMM Plan. Formal documentation regarding the Groundwater CSM was initially provided in the Corrective Measures Study in 2001. The model was further developed in the 2003 Conceptual Groundwater Remedy Report, and then updated in a June 2005 document titled "Update to Site Conceptual Model and Summary of Remedial Decision Basis, Chevron Cincinnati Facility". In addition, the nature and extent of impacts along the Great Miami River Bank was further developed in a June 2007 report titled "Evaluation of Engineering Options along the Great Miami River, Chevron Cincinnati Facility, Hooven, Ohio".

The CSM was also discussed in the EPA's Statement of Basis (April 2006), as well as the Final Decision and Response to Comments (August 2006). Therefore, it will not be fully described again in this Plan. However, key elements of the model pertaining directly to operations described in this Plan will be discussed herein.

Foremost, it is important to recognize that extensive LNAPL characterization and dissolved-phase monitoring, as well as short-term shut-down tests, indicate that both LNAPL and dissolved phase plumes are stable, and no longer migrating. Proposed remedies and monitoring programs detailed in the OMM Plan are intended to provide further assurance of long-term plume stability. Following the removal of potential sources of LNAPL release from the site and 21 years of LNAPL recovery efforts, remaining LNAPL saturations have been reduced such that the feasibility of significant lateral LNAPL migration is not sufficient to warrant a management action even under the lowest water table conditions when separate phase LNAPL can be measured in wells within the core plume area.

Dissolved phase plume stability under pumping conditions has been consistently documented during routine semiannual monitoring events. It has also been verified during a short-term recovery pump shutdown (e.g. about two months) ambient flow conditions test, and is expected to continue over the long-term, once a steady state condition is established after permanent cessation of containment pumping as planned under the final remedy. The primary driver for dissolved phase plume stability is believed to be active biodegradation of dissolved contaminants in the oxygenated groundwater at the periphery of the plume. Qualitative estimates of relative mass loss rates and related mechanisms will be feasible based on the analysis of additional data collected in accordance with the OMM Plan.

Biodegradation is a primary driver not only for stability at the down-gradient plume margin, but also for overall contaminant mass reduction throughout the plume. Biodegradation is active not only in the dissolved groundwater phase, but also within the LNAPL source zone (e.g. smear zone), and in the soil vapor phase above the plume. In fact, the largest single source of natural mass loss from the source zone is thought to be volatilization of hydrocarbons from the top of the source zone into the overlying vadose-zone soil, where it is biodegraded in the interface where abundant atmospheric oxygen has diffused downward into the soil above the plume.

Taken as a whole, both aerobic and anaerobic biodegradation processes contribute toward LNAPL mass reduction and overall stability of the dissolved phase plume. Whenever oxygen is available, aerobic biodegradation processes tend to predominate, since oxygen as the terminal electron acceptor is a more rapid and favorable process for biodegrading microorganisms. There is existing evidence from the site that aerobic degradation processes predominate in the plume periphery, outside of the smear zone, as discussed further below.

A graphical illustration of the groundwater plume CSM, presented in Figure 2-2, shows that, as the groundwater moves from up-gradient of the smear zone to the interior of the plume and dissolved oxygen is depleted, anaerobic biodegradation processes will tend to dominate. These anaerobic processes are expected to continue throughout the entire smear zone, given the relatively consistent supply of organic constituents from the smear zone. Immediately down-gradient of the smear zone, anaerobic processes are expected to continue to some extent, as dissolved organic constituents that partitioned to groundwater within the smear zone are consumed. However, the area immediately down-gradient of the smear zone is considered to be the “transition zone,” because the supply of organic constituents for biodegradation processes is consumed in this area, in the absence of the smear zone. Within this transition zone, dissolved oxygen concentrations are expected to "rebound" as the groundwater moves down-gradient. This is an indicator that the supply of organic constituents in groundwater has been depleted and anaerobic and aerobic biodegradation are no longer occurring. Figure 2-3 is provided to illustrate supplemental information regarding the vapor profile CSM.

A natural attenuation investigation conducted in 2002 supports this conceptual model. This investigation is reported in Appendix C of Conceptual Groundwater Remedy Report, Revision 0 (Chevron Cincinnati Groundwater Task Force, July 2003). For this investigation, a collection of wells was sampled for geochemical indicators and organic compounds. These wells represented groundwater up-gradient of the site on the northern end of the facility, and in West Hooven. Wells were also sampled in the smear zone of the facility and East Hooven, in the "transition zone" immediately down-gradient of the smear zone, and down-gradient near US 50. The findings of this investigation include:

- Significant dissolved oxygen was present in shallow groundwater up-gradient of the smear zone (1.3 – 3.6 mg/L). Within the smear zone, the average dissolved oxygen concentration was less than 1 mg/L. This is evidence the groundwater is depleted of dissolved oxygen as it enters the smear zone; aerobic biodegradation processes are occurring at the periphery of the plume.

- Sulfate concentrations in groundwater decreased from up-gradient (>50 mg/L) of the smear zone to the interior (non-detect concentrations). This indicates anaerobic biodegradation processes within the interior of the smear zone.

- Nitrate concentrations generally decreased from up-gradient to within the plume, and within the transition zone. However, nitrate concentrations in the up-gradient wells at the northern edge of the facility were low, so significant biodegradation with nitrate used as the terminal electron acceptor is not likely in this area. Nitrate concentrations in the up-gradient wells in West Hooven were higher, indicating anaerobic biodegradation processes, possibly in the transition zone.

- Dissolved/ferrous iron and methane concentrations were low in the up-gradient wells, high in the smear zone, and intermediate in the transition zone. This indicates anaerobic biodegradation processes in the smear zone, with these processes active but decreasing in the transition zone due to the finite supply of organic constituents.

- The "rebound" of oxygen was observed in the transition zone.

- BTEX constituents were not detected up-gradient of the site, or in the down-gradient wells near US 50. Within the smear zone, BTEX concentrations were high, and in the transition zone, they were intermediate. This indicates that BTEX partitions from the smear zone to the groundwater and is consumed within the smear zone. In the transition zone, the supply of BTEX is finite and consumed before the groundwater reaches the down-gradient wells near US 50.

The combined components of natural source zone attenuation including dissolution, dissolved phase biodegradation, and volatilization/gas phase biodegradation, is now far greater than what can be accomplished by engineered physical mass removal except during high-grade pumping events at extreme low water table conditions. Therefore, much of the monitoring program described in the OMM Plan is targeted toward verifying and tracking the ongoing natural source zone attenuation.

The high-grade recovery component of the final remedy is intended to focus on what little additional free-phase LNAPL removal can be accomplished in the core portions of the plume where the highest remaining LNAPL saturations remain. But it is important to remember that the overall plume remediation will be accomplished primarily through natural processes that drive contaminant degradation and removal over time.

Therefore, the bulk of the monitoring program described in the OMM plan is intended to document and track the continued stability and natural attenuation of the remaining source zone. Other key monitoring components described in the plan include:

- Verification that the LNAPL and dissolved phase plume is stable and not migrating.
- Verification that LNAPL impacted soil is not being eroded into the Great Miami River, and that dissolved phase constituents in nearby impacted soil are not migrating into the Great Miami River (only a preliminary overview of the River Monitoring plans are provided with this submittal – per the 2006 Order, a detailed River Monitoring Plan will be included with the detailed designs that are currently being developed for an engineered control and bank stabilization measures along the Great Miami River).
- Documentation and tracking of the high-grade and vapor recovery efforts.

Because the natural mass loss occurs through multiple processes in different media, several different monitoring programs will be required to track it. The primary monitoring programs focus on the following three physical forms of remaining contaminant:

- Free-phase LNAPL trapped between soil pores throughout the smear zone.
- Dissolved phase contaminants in groundwater within the source zone and at the dissolved phase-only plume around the down-gradient periphery of the smear zone.
- Vapor phase volatile hydrocarbons in soil gas above the plume.

Monitoring programs will document the concentrations of constituents of concern in these media over time, as well as indicator parameters that relate to the natural attenuation of the LNAPL source zone and associated vapor and dissolved phase plume.

3.0 GROUNDWATER REMEDY APPROACH

The groundwater remedy proposed herein has been designed to be protective of human health and the environment, with the long-term objective being to restore groundwater to its maximum beneficial uses by achieving drinking water MCLs throughout the area of contaminated groundwater. The principal contaminant of concern in groundwater is benzene, although the other constituents listed in Table 3-1 have also been detected in groundwater above MCLs. Because achieving the long-term objective will take many years, the following interim objectives have been developed:

- Protect human health and the environment
- Monitor soil vapor concentrations and prevent unacceptable indoor air exposures
- Maintain plume control to prevent migration of either LNAPL or dissolved phase constituents
- Remove recoverable LNAPL to the extent practicable
- Stabilize the Great Miami River riverbank to prevent erosion of LNAPL impacted soil

These remedial objectives are interrelated and are to be achieved through implementation of the various remedy components detailed in the combined RIP/OMM Plan.

A key component of the proposed remedy is the containment and stabilization of the LNAPL and dissolved contaminant plumes. Through extensive LNAPL removal efforts over the past 21 years, most recoverable LNAPL has already been removed from the site. This is especially true in the upper and middle reaches of the smear zone, where remaining LNAPL saturations are lowest. The highest remaining LNAPL saturations persist in the lower portions of the smear zone, which is the focus area of the high-grade strategy and the cornerstone of continued aggressive engineered source removal envisioned over the next six to 12 years. Continued operation of the horizontal soil vapor extraction (HSVE) system under Hooven is also planned in conjunction with high-grade recovery efforts. The primary mechanism for overall LNAPL mass reduction, though, will continue to be through natural biodegradation and attenuation. Thus, monitored natural attenuation (MNA) will be a key focus during the next six to 12 years of aggressive source removal, as well as throughout the long-term remedy period, through 2048.

A key premise of the groundwater remedy is that the LNAPL and dissolved-phase plumes are depleted and immobile. Extensive assessment supports this conclusion, and shut-down tests during 2005 confirmed that the plume is stable over short time periods of ambient groundwater flow conditions. Therefore, upon USEPA approval of the combined RIP/OMM Plan, the continuous groundwater recovery and containment that has been ongoing for the past 21 years will be discontinued. LNAPL and dissolved phase plumes will be monitored to ensure they do not migrate under long-term, natural gradient conditions. Specifically, groundwater will be monitored for dissolved contaminants of concern (COCs) listed in Table 3-1 for compliance with Maximum Contaminant Level (MCL) standards. If the LNAPL and dissolved contaminant plumes do not remain stable under natural gradient conditions, the site-wide recovery system will be reactivated to contain the plumes and additional corrective actions will be evaluated and implemented, as appropriate and agreed to with the USEPA.

Components of the groundwater remedy to be implemented in accordance with regulatory agreements presented in Section 2.0 are as follows:

- LNAPL and Dissolved Phase Plume Monitoring
- Seasonal High-Grade Pumping
- Granular Activated Carbon (GAC) System Operation
- HSVE System Operation
- Vapor Monitoring

Details for implementation, operation, maintenance, monitoring, and measuring these remedy components, as well as corrective measure should monitoring indicate plume migration, are presented in the OMM Plan.

While the vast majority of systems and infrastructure necessary for operation, maintenance, and monitoring of the groundwater remedy is already in place, installation of additional monitoring and remedial systems is necessary to meet requirements stated in the 2006 Order. Existing, as well as proposed, systems and infrastructure are shown in Figure 2-1. While the OMM Plan is comprehensive in its discussion of remedy components, this Plan focuses on plans and schedules for installation of additional systems and infrastructure necessary to support long-term operation of the final groundwater remedy. As such, this Plan is limited to those remedy components requiring new systems, infrastructure, or modification of existing systems, which can be summarized as follows:

- New sentinel and POC monitoring wells
- New ROST transect borings
- Up-grades to existing production well(s)
- Consideration for future production wells
- River bank stabilization and engineered control measures (details to be incorporated at a later date, with development and USEPA approval of detailed River Engineered Control designs, which are currently being prepared, and which are due to USEPA by 12/ 7/07)
- New Hyporheic zone monitoring wells (details to be provided with River Engineered Control design)
- Engineering and institutional controls
- New nested vapor monitoring wells
- New nested groundwater monitoring wells
- New lysimeters

4.0 DOWN-GRADIENT MONITORING SYSTEMS

4.1 SENTINEL AND POC WELLS

As detailed in the OMM Plan, this remedy component requires that a network of monitoring wells be established at the current down-gradient boundary of the dissolved contaminant plume to constitute a monitoring system that will provide an early warning of potential down-gradient migration. This system will be comprised of both sentinel and POC monitoring wells, as listed in Table 4-1. Two proposed monitoring wells, MW-131 and MW-132, will be located as shown in Figure 4-1 to supplement existing monitoring well MW-35 to comprise the sentinel monitoring system. Sentinel wells will be installed as shown in Figure 4-2.

A Point of Compliance (POC) well will be established down-gradient from each sentinel well to define the dissolved-phase plume point of compliance. Two proposed POC monitoring wells, MW-133 and MW-134, will be located to supplement existing monitoring well MW-37 to act as the POC monitoring system, as shown in Figure 4-1. In addition, existing monitoring well MW-120 will be monitored as a POC well without a companion sentinel well because surface access limitations in the area preclude installation of a companion sentinel well. POC wells will be installed in the same fashion as sentinel wells, as shown in Figure 4-2. Sentinel and POC wells will be monitored for signs of dissolved-phase plume migration in accordance with the OMM Plan.

A key concept relating to the sentinel versus POC wells is that the sentinels are intended as an “early warning system”, which will provide an indication of the potential for dissolved phase-plume migration. Sentinel wells are targeted for placement immediately adjacent to the farthest down-gradient extent of the dissolved-phase plume. The precise location of the dissolved-phase maximum historical down-gradient extent is difficult to pinpoint, as it can vary with natural conditions including the groundwater elevation, and with physical and chemical groundwater characteristics. Therefore, the sentinel wells will be placed in a zone which may appear during installation and during most monitoring events to be “uncontaminated”, but which has at some time in the past seen low-levels of dissolved phase constituents.

The critical location for defining dissolved phase plume mobility will be at the POC wells. As described in the Order, a confirmed detection of a COC at levels above the MCL in a POC well will be cause for immediate resumption of groundwater containment pumping, and evaluation of additional corrective measures. Such a detection in a sentinel well during a subsequent re-sampling event, two months following an initial exceedance, will also be cause for immediate resumption of groundwater containment pumping and evaluation of additional corrective measures. If subsequent analysis indicates that the confirmed sentinel well exceedance was due to an anomalous low water table condition, and not to actual plume migration, Chevron will follow up with USEPA to discuss rational and seek approval to discontinue pumping.

4.2 ROST TRANSECTS

Rapid Optical Screen Tool (ROST) technology has been identified as the primary tool for monitoring the potential for LNAPL migration at the leading edge of the plume. ROST is designed to provide rapid sampling and real-time, relatively low-cost analysis of the physical and chemical characteristics of subsurface soil to distinguish contaminated (primarily petroleum fuels and coal tars) and non-contaminated areas. Three transects consisting of three ROST borings each will be installed at the periphery of the LNAPL plume, as shown on Figure 4-1. The edge of the smear zone has already been determined to within approximately 10 feet during previous ROST investigations in the Southwest Quadrant. The edge of the smear zone and the target ROST well locations will be staked at the surface at the ROST well transect locations, and the ROST monitoring wells will be installed based on those surveyed locations. Subsequently, the ROST rig will be mobilized in and utilized to confirm that the first ROST well is inside the plume, and that the second two down-gradient wells are outside the plume. If the ROST readings from the initial well locations indicate that alternate locations are necessary to achieve the target spacing across the edge of the plume, additional ROST wells will be installed using a traditional drill rig, until wells at the approximate desired locations and spacing have been established. ROST borings located outside the smear zone will be monitored for possible migration of the LNAPL plume in accordance with the OMM Plan.

Previous efforts using ROST in these areas have experienced difficulties with the tool encountering large cobbles in the subsurface, causing refusal or deflection of the ROST tool. To address this issue, this Plan proposes to install permanent ROST boring locations by augering a hole from the surface down to approximately 5 feet above the potential smear zone elevation, as shown in Figure 4-3.

ROST borings will be constructed by drilling a bore hole 4 to 6 inches in diameter to depth in the same way that a monitoring well boring is advanced. Two-inch schedule 40 or 80 steel casing (or larger, if dictated by the size of the ROST tools being used by the ROST drilling contractor at the time of the well installation) will be installed in to the bottom of the bore hole and the casing will be grouted in place, as shown on Figure 4-3. A plastic cap will be placed on the casing during grouting and when not in use to ensure that it doesn't become plugged with foreign materials. The construction details and protocol for advancement of the ROST tool across the groundwater table may need to be adjusted based on initial operational results, as there is no precedent of which we are aware, for constructing and operating a permanent ROST monitoring station.

The probe is instrumented with a variety of gauges that allow classification of soil type, stratigraphic changes, and water bearing units. The CPT equipment includes four major components:

1. Hydraulic thrusting mechanism for pushing the cone into the ground
2. Thrust reaction system
3. Electronic cones and associated push rods
4. Resistance measurement system

The cone penetrometer contains two resistance strain gauge load cells for independent measurements of tip and friction resistances. Electric signals from the load cells are transmitted through an electrical cable running inside the hollow push rods and recorded by the computer acquisition system at the surface. The cone is pushed into the ground at an approximate rate of two centimeters per second.

The ROST sensor provides real-time field screening of petroleum hydrocarbon impacts within the subsurface. ROST records in-situ distribution of petroleum hydrocarbons based upon the fluorescence response induced in the polycyclic aromatic hydrocarbon compounds. ROST has the capability of detecting hydrocarbon impacts throughout the vadose, capillary fringe, and saturated zones.

ROST makes use of a wavelength tunable ultraviolet laser source coupled with an optical detector to measure fluorescence via optical fibers. A tunable laser mounted in the CPT truck is connected via fiber optic cables to a down-hole sensor, consisting of a small diameter sapphire window mounted flush with the side of the cone penetrometer probe. The laser and associated equipment transmit 50 pulses of light per second to the sensor through a fiber optic cable. As the probe is advanced into the soil, the laser light passes through the sapphire window and is absorbed by the polycyclic aromatic hydrocarbon (PAH) compounds in contact with the window. This addition of energy (photons) to the hydrocarbons causes them to fluoresce. A portion of the fluorescence emitted from any encountered aromatic constituents is returned through the sapphire window and conveyed by a second fiber optic cable to a detection system within the CPT rig. The emission data resulting from the pulsed laser light is averaged into one reading per one second interval (approximately one reading per every two centimeters of vertical movement) and is recorded continuously.

Before arriving at the site and following completion of each boring, all down-hole drilling equipment, tools, and accessories will be decontaminated by scrubbing off surfaces with brushes in a phosphate free detergent solution, followed by a single rinse in potable water, and a final rinse in distilled water. Decontamination fluids will be containerized, transported to the Chevron Cincinnati Facility, and processed through the site wastewater treatment system.

5.0 HIGH-GRADE WELLS

5.1 PRODUCTION WELL UPGRADES

Existing production wells include production wells which would require upgrade to increase well capacity and operational capabilities to be consistent with the needs of high-grade pumping include #4, #5, #12, #14, #15, #17, and #18, as shown in Figure 2-1. While these wells may be considered for upgrade for high-grade operation, many will be eliminated from consideration for high-grade pumping based on their location within the plume. As discussed in the following section, it may be more viable to install new production wells than upgrade existing production wells.

Production well #12 (PROD_12, as shown in Figure 2-1), located in the central plume area, was upgraded to support the 2007 high-grade event. Production well PROD_12 upgrades included a high-capacity pump, necessary electrical modifications, as well as installation of larger diameter piping necessary to accommodate increased flows. As will be addressed in the semi-annual report to USEPA, a high-grade test was conducted at PROD_12 during the summer of 2007, the results of which are being used to evaluate additional production wells for potential upgrade. Fluid level data, as well as operational factors, will continue to be considered in selecting which production well will optimize LNAPL recovery during high-grade pumping. Operation of PROD_12 encountered entrained NAPL, due to the heavier nature of NAPL in this area, and evaluations are ongoing as to alternate recovery and/or wastewater treatment techniques that may facilitate more successful operation of PROD_12 or other wells in this area in the future.

In addition to upgrades to existing production wells, groundwater flow and recovery data will be used to evaluate the need for additional high-grade wells in the central are of the plume, or whether operational modifications that may improve removal efficiencies should be employed. Operation of upgraded PROD_12 yielded additional data regarding the effectiveness in reducing measurable thickness throughout the central process area, as well as operational issues encountered in recovering heavier LNAPL typical to this area of the Facility. The evaluation of high-grade data will be presented to the USEPA in future monitoring reports, or during a meeting to discuss additional proposed locations for high-grade wells placement.

5.2 FUTURE PRODUCTION WELLS

It is anticipated that within the next year, analysis will be complete regarding the possible need for additional production well(s) for source removal of LNAPL during high-grade pumping in both the southern and central areas of the LNAPL plume. In parallel with the preparation of this Plan, an additional production well (PROD_24) was installed at a location within the town of Hooven, as shown on in Figure 2-1. Ongoing analysis of drawdown and groundwater modeling will be performed to forecast the effectiveness of a production well at alternate locations.

In the meantime, multiple existing production wells will be utilized for ongoing LNAPL recovery during suitable conditions. These wells will be operated in accordance with the OMM Plan. The rationale for placement of additional high-grade wells, if any, will be provided to the USEPA along with the rationale for long-term high-grade performance and eventual permanent cessation criteria, within two years of the date of the 2006 Order, by November 1, 2008.

6.0 RIVER CONTROLS

6.1 BARRIER WALLS

A separate plan was submitted to USEPA in accordance with the Order presenting alternatives for engineered controls and recommendations necessary to stabilize the bank of the Great Miami River at the refinery to prevent LNAPL-contaminated soils from sloughing into the river. USEPA approved the alternatives analysis in a letter dated June 15, 2007, and preparation of detailed designs for construction of the proposed remedy are underway. A similar evaluation of options to stabilize the river bank adjacent to an area of hydrocarbon impacts in Gulf Park was submitted to USEPA on February 28, 2007. Upon USEPA approval of the Gulf Park engineering option analyses, detailed stabilization measure(s) for that location will also be designed and submitted for USEPA approval. Upon USEPA approval of the detailed designs, necessary permits (e.g. U.S. Army Corps of Engineers and local permits) will be obtained, and approved measures will be constructed. Long-term monitoring plans associated with river stabilization measures will be included with the Engineered Control designs, and will ultimately be incorporated into the OMM Plan.

6.2 HYPORHEIC INTERFACE ZONE WELLS

Paired river-groundwater-surface water monitoring stations will be established along the stretch or the Great Miami River where smear zone is near the River. It is anticipated that the hyporheic wells will be installed directly adjacent to the groundwater wells, on the river-ward side of the engineered control. Where practicable, the stations will be established at locations adjacent to existing dissolved-phase wells, for continuity in comparisons to historical data at those wells. However, it is anticipated that some existing wells may need to be removed during construction of the engineered control, and subsequently replaced. Well locations and installation details will be proposed pending completion of the design for riverbank stabilization measures, which are due to be submitted for USEPA review by December 7, 2007. The paired groundwater-hyporheic zone-surface water monitoring stations will establish a network for monitoring for the potential migration of groundwater COCs from the smear zone, into the River. It is anticipated that the groundwater, hyporheic zone and surface water samples will be analyzed for the COCs listed in Table 3-1, and compared to OEPA surface water standards. The OEPA surface water standards will be included with the River Monitoring Plan which will be included with the Engineered Control design, and will ultimately be incorporated into the OMM Plan, upon USEPA approval of the proposed plans.

7.0 ENGINEERING AND INSTITUTIONAL CONTROLS

7.1 ENGINEERING CONTROLS

At locations over the plume where the depth to the top of the smear zone is approximately 30 feet below ground surface or less, the incorporation of engineered controls into new building construction will be appropriate. While analysis of vapor profiles over the plume has shown that constituents which have volatilized from the plume are biodegraded within 20 to 30 feet above the plume, inclusion of engineered controls in building foundations to ensure that vapors do not enter structures will provide an extra level of protectiveness. The primary engineered control at locations where the smear zone is exposed will be placement of an impermeable membrane in the building foundation. An alternative will be the installation of a sub-slab or foundation venting/oxygen injection system where appropriate. At locations within the refinery or land farm portions of the Facility, limitations set forth in the Environmental Covenant specify that no sub-grade development shall take place. At locations outside of the refinery or land farm portions of the Facility, basements and other sub-grade structures should not be constructed over the plume where the depth to the top of the smear zone is less than approximately 30 ft-bgs without a location and structure-specific analysis of the protective measure to be employed.

In accordance with the 2006 Order, Chevron will exercise best efforts to convince the owner of any newly constructed buildings in the Southwest Quadrant to install vapor barriers at Chevron's cost to prevent human exposure to soil vapors reaching the ground surface exceeding the risk-based residential standards identified in the OMM Plan. Because development in the Southwest Quadrant began only within the past 10 years, Chevron has offered assistance and funding for incorporation of a vapor barrier in all structures built in that area to date. Nearly all businesses have accepted and installed the vapor barriers. Chevron recently purchased additional property so that it owns most of the land remaining in the Southwest Quadrant located over the plume which has not already been developed. With these actions, Chevron is in a position to control future development to ensure that engineering controls are built into future design and construction plans. Provisions for potential future expenses related to the execution of engineering controls are included in Table 16 of the financial assurance cost estimates in Appendix B.

7.2 INSTITUTIONAL CONTROLS

Institutional controls will provide for permanent restrictions regarding the use of groundwater, as well as the types of use, subsurface disturbance, and construction methodologies that can occur on portions of the property where some form of risk-based, in-place management of remaining contamination will be necessary. As previously mentioned, Chevron has offered to fund the inclusion of engineering controls in structures built over the plume in the Southwest Quadrant. In conjunction with this effort, institutional controls have also been addressed. Thus, the majority of remaining land requiring deed restrictions with regard to future subsurface disturbance and property use is the former refinery property. As noted in Paragraph 16 of the 2006 Order, the Ohio Revised Code at Sections 5301.80 to 5301.92 provides the legal mechanism for placing an enforceable, lasting use restriction on the property deed. USEPA is in the process of developing a model format and will provide approved final deed restriction language to Chevron once review has been completed. Chevron will then have 30 days to provide USEPA with draft language specific to its property. Upon USEPA approval of proposed site-specific language, Chevron will proceed to finalize the environmental covenants within 60 days. Provisions for potential future expenses related to the execution of engineering controls are included in Table 16 of the financial assurance cost estimates in Appendix B.

8.0 MONITORED NATURAL ATTENUATION COMPONENTS

8.1 NESTED VAPOR MONITORING WELLS

Nested vapor wells will be constructed at three of the four grouped media sample locations shown in Figure 2-1, corresponding to the approximate locations of existing monitoring wells MW-21, MW-18R, MW-20S, and MW-93S, which are the locations of various sampling activities discussed in the combined RIP/OMM Plan. Nested vapor wells will be constructed at grouped media sample locations Group 21, Group 18, and Group 20, as listed in Table 8-1, to supplement the existing nested vapor well VW-93 at Group 93. Nested vapor wells listed in Table 8-2 will be constructed with vapor sampling points at 5 to 10 foot intervals from five-feet below the ground surface, down to just above the groundwater table, as shown in Figure 8-1. Nested vapor wells will be constructed and sampled according to methodology described in the Report titled "Subsurface Investigation Field Activities Report and Human Health Risk Assessment, Chevron Cincinnati Facility, Hooven, Ohio, October 2005", by Trihydro and GeoSyntec.

Vapor profiles will be sampled in accordance with the schedules and protocols detailed in the OMM Plan. Results of subsequent analyses will be used to estimate the total vapor mass loss occurring from the plume over time, and may be used for planning engineering controls as appropriate relative to redevelopment at the site and as specified by the Order. The means of estimating vapor mass loss from the plume may be modified in the future, based on initial results and evolving industry methodology. Sampling locations and frequencies may be adjusted over time if interpretation of results indicates that data collected from other locations or at other frequencies will be beneficial to the overall tracking and understanding of plume attenuation over time. Efforts will be made to sample in conjunction with varying groundwater elevations to account for impacts that seasonal groundwater fluctuations may have on sample results.

8.2 NESTED GROUNDWATER MONITORING WELLS

Vertically nested groundwater monitoring wells listed in Table 8-3 will be constructed at grouped media sample locations previously referenced as vertical vapor profile sampling locations (e.g. near groundwater wells MW-21, MW-18R, MW-20S, and MW-93S), as shown in Figure 2-1. Vertical groundwater sampling intervals will be established with one to two feet long screen intervals, targeting the approximate top of the groundwater table, the middle and bottom of the current smear zone, and below the smear zone, as illustrated in Figure 8-2. Vertical spacing of sample intervals will vary across the plume, depending on the thickness of the smear zone. Smear zone and dissolved-phase profiles will be evaluated to determine optimum vertical spacing.

Vertically nested groundwater wells NW-21, NW-18, NW-20, and NW-93 will be sampled in conjunction with nearby standard monitoring wells MW-21, MW-18R, MW-20S, and MW-93S in accordance with the schedules and protocols detailed in the OMM Plan. Results of subsequent analyses will be interpreted relative to demonstrating overall plume degradation activity, including via methods described in the Lundegard, Johnson and Liu paper.

8.3 LYSIMETERS

Lysimeters will be installed at the four grouped media sample locations shown in Figure 2-1 in order to collected data regarding surface water infiltration at various locations across the plume. Previous aquifer water budget data concluded that the average infiltration potential for the site is approximately seventeen inches per year. If all of this surface water infiltrated from the ground surface to the smear zone, the volume of water would be comparable to the amount of water that entered the smear zone laterally as groundwater. While not all ground surface water infiltrates into the smear zone, previous aquifer water budget data suggests that much of the potential infiltration water does indeed infiltrate. An indication of this is that river levels don’t directly follow precipitation trends, suggesting that the amount of runoff may be relatively small.

Lysimeters will be constructed as shown in Figure 8-3. Each lysimeter will be a small diameter (approximately 2-inch) ceramic cup placed into a borehole just above the capillary fringe. The cup will be connected to a receptacle (6, 12, 24, or 36 inches tall) having two polyethylene tubes running up to the ground surface. The ceramic cup will wick soil moisture which can be pulled to the ground surface through one of the tubes by using a hand pump. Infiltrating groundwater will be sampled and analyzed for dissolved oxygen content for use in calculating natural attenuation rates. Lysimeters have not been previously installed on this site. The intent is that the data collected will assist in understanding plume attenuation.

9.0 SCHEDULE AND COST

The schedule for installation, operation, and monitoring of remedy components addressed in the combined RIP/OMM Plan is attached in Appendix A. The schedule presents the initial two and a half years of remedy implementation, beyond which schedules will continue per the operations, maintenance and monitoring frequencies described in the OMM Plan. Schedules for high-grade pumping, related GAC and HSVE operations, and Gulf Park bioventing operations are not addressed in Appendix A, as they are largely weather dependant. However, projected seasonal start-ups and durations, as well as factors affecting operation and monitoring schedules, are presented in related sections of the OMM Plan.

A cost estimate for the groundwater remedy implementation is attached in Appendix B. The exact time to complete the remedy is not known, but is estimated at a maximum of 42 years. Therefore, the maximum duration of 42 years is used in tabulating total lifecycle costs. Financial assurance for these costs will be established per the terms of the 2006 Order, within 90 days of Chevron's fiscal year end. Subsequently, financial assurance amounts will be updated each year, per Paragraph 25 of the 2006 Order.

TABLES

FIGURES

APPENDIX A

REMEDY SCHEDULE

APPENDIX B

REMEDY COST ESTIMATE

APPENDIX C

USEPA CORRESPONDENCE