STATEMENT OF BASIS
for Groundwater

Chevron Cincinnati Facility
Hooven, Ohio
EPA ID No. OHD 004 254 132

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I. INTRODUCTION

This Statement of Basis (SB) explains the proposed remedy for contaminated groundwater at the former Chevron Refinery Facility (Chevron facility) in Hooven, Ohio. This is the final proposed remedy for the site under the current Administrative Order on Consent (AOC) from 1993. This proposed remedy addresses groundwater contamination's impact on soil vapor, surface water, river bank soil, and current and future groundwater use. In addition, the SB includes summaries of corrective measure alternatives, pertaining to contaminated groundwater, prepared by Chevron and evaluated by the United States Environmental Protection Agency (U.S. EPA). U.S. EPA will select a final remedy for contaminated groundwater at the Chevron facility only after the public comment period has ended and the information provided by the public has been reviewed and public comments considered. This SB to address groundwater contamination is being issued separately from the soils remedy to expedite implementation of the soils remedy. The Final Decision for Sludges and Contaminated Soils was issued by U.S. EPA in January 2004. A Performance Agreement to implement the Sludges and Contaminated Soils between U.S. EPA and Chevron was signed in March 2004 and is currently being implemented by Chevron with U.S. EPA oversight.

This SB is being issued by U.S. EPA as part of its public participation responsibilities under the Resource Conservation and Recovery Act (RCRA). The document summarizes information that can be found in greater detail in the final RCRA Facility Investigation (RFI), Corrective Measure Study (CMS) for Groundwater, Conceptual Groundwater Remedy Report, and other pertinent documents contained in the Administrative Record. U.S. EPA encourages the public to review these documents in order to gain a more comprehensive understanding of the Chevron facility and the RCRA activities that have been conducted.

U.S. EPA may modify the proposed remedy or select another remedy based on new information or public comments. Therefore, the public is encouraged to review and comment on the SB. The public is involved in the remedy selection process by reviewing the SB, submitting written comments, and attending the public hearing scheduled for May 9, 2006, at the Whitewater Senior Center and Township Hall, 6125 Dry Fork Road, Whitewater Township, Ohio. The meeting is also an opportunity to hear a summary of the proposed groundwater remedy and to provide verbal comment on the SB.

II. PROPOSED REMEDY

U.S. EPA is proposing the following remedy to address groundwater contamination from Chevron facility:

The Proposed Remedy will consist of the following remedial components:

- Periodic source removal of Light Non-Aqueous Phase Liquids (LNAPL) from the subsurface through a high grade pumping scheme;
- Monitor containment of Light Non-Aqueous Phase Liquids (LNAPL) and dissolved contaminant plume. Gradually shut down hydraulic control wells and restore natural gradients;
- Contingencies: if performance measures are not met, the pumps will be turned back on, and other alternative technologies will be analyzed and chosen to remediate the plume (for example SVE, IAS, SEAR);
- Engineered controls to stabilize the bank of the Great Miami River at both the Refinery and Gulf Park, and continued monitoring of the Great Miami River bank for releases;
- Monitored Natural Attenuation (MNA) of dissolved contaminant plume and LNAPL plume with associated sampling and 5 year review of the progress of the natural attenuation with the performance measure of complete aquifer restoration to below Safe Drinking Water Act Maximum Contaminant Levels (MCLs) in 30 years;
- Institutional controls to include prohibitions on potable groundwater use and basement construction on the refinery site;
- Point of compliance (POC) and other performance monitoring;
- Continued source removal of volatile petroleum constituent from the LNAPL smear zone beneath the town of Hooven through soil vapor extraction (SVE) during periods of high grade pumping;
- Continued monitoring of soil vapor wells in Hooven.
- Financial Assurance for implementation of the remedy

A more detail discussion of the proposed remedy is in Section VII - Scope of Proposed Remedy.

III. FACILITY BACKGROUND

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 600 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 (Figure 1). The Chevron facility also includes a Land Treatment Unit (or Landfarm) located on a ridge northwest of the main portion of the refinery area. Two islands (Number 1 and Number 2) in the Great Miami River are also considered part of the Chevron facility because underground pipelines pass beneath the islands. The pipeline also runs below portions of Gulf Park (where contamination has been detected), and leads to a former loading dock for Chevron's refinery products on the Ohio River.

The manufacturing and refinery portion of the Chevron facility was operated from 1931 until 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 are classified as hazardous wastes, were also generated during manufacturing operations. A majority of the refinery structures have been demolished. The remaining facility structures include an office building, a security building, a maintenance shed, and various structures associated with ongoing interim measures and 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. Petroleum hydrocarbon recovery systems were installed by Chevron, and a larger network of recovery and extraction wells have been installed and operated since 1985. Currently, the Chevron facility pumps and treats four to five million gallons of groundwater on a seasonal basis. Analysis of the hydrocarbon waste in groundwater indicated it was primarily refined leaded gasoline and a smaller part diesel fuel.

Chevron has been pumping large amounts of groundwater for over 20 years, and has recovered significant amounts of petroleum hydrocarbons. The term Light Non Aqueous Phase Liquid (LNAPL) is used to describe the pure petroleum hydrocarbons in liquid form that are not dissolved in water. At the facility, the LNAPL includes primarily refined gasoline and a lesser amount of diesel fuel. The quantity that originally leaked form the facility is estimated to have been 5 million gallons in total. About 2.5 million gallons were recovered within the first three years after pumping was initiated, and about one million gallons were recovered over the next 18 years. The Chevron facility has recovered between 10,000 to 200,000 gallons of LNAPL per year since 1988. Over the years, pumping and treating has gradually become less and less efficient in recovering LNAPL. The amount of LNAPL that is still remaining underground today is adhering to the soil particles at a depth of 10 feet below ground surface (bgs) to approximately 30 feet bgs. This is known as the smear zone.

On May 13, 1993, Chevron entered into an Administrative Order on Consent (Consent Order) with U.S. EPA that required Chevron to conduct the necessary investigations (i.e., RFI) to fully identify the nature and extent of contamination at the facility, to evaluate the long-term corrective measures (i.e., CMS) necessary to protect human health and the environment, to conduct interim measures which involved closure of many of the higher priority Solid Waste Management Units (SWMUs) and Areas of Concerns (AOCs) at the facility, and to continue groundwater pump and treat with recovery of petroleum hydrocarbons from the groundwater. Separate CMSs were subsequently performed for soils and sludges and for groundwater, resulting in two reports entitled *Chevron Cincinnati Facility Soils and Sludges Corrective Measures Study* (URS 2001a) and *Chevron Cincinnati Facility Groundwater Corrective Measures Study* (URS 2001b). A remedy was proposed for the soils and sludges by U.S. EPA in a *Statement of Basis for Sludges and Contaminated Soils* that was issued in June 2003. The final remedy for sludges and contaminated soils was subsequently selected by U.S. EPA in January 2004. The remedy selected for soils and sludges was excavation and removal with domestic off-site disposal. This remedy was put into a Performance Agreement on March 4, 2004 between Chevron and U.S. EPA and is currently being implemented by Chevron using the approved June 2004 Work Plan to perform the soils cleanup. The remedy for groundwater contamination is now being proposed in this SB.

Since completion of the RFI and CMS, there have been continued efforts to further define the nature and extent of the LNAPL and dissolved plume. Additional investigations have been conducted for this purpose. Chevron submitted a *Conceptual Groundwater Remedy Report* (Chevron, 2003) to U.S. EPA that provided further analysis and optimization of the remedial option recommended in the groundwater CMS. This document was reviewed extensively by U.S. EPA, which resulted in several remaining questions on the groundwater remedy. These remaining questions have been the main focus of several studies at the facility, beginning in late 2004 up to the present.

Most recently, there have been a series of long-term, high grade LNAPL recovery tests and a shutdown test at the facility to assess the feasibility of the proposed corrective measures contained in the groundwater CMS. The implementation of these tests was outlined in two work plans submitted to U.S. EPA by Chevron: the *Work Plan for Long-Term High-Grade LNAPL Recovery Test, Additional Assessment Activities to Support Groundwater Remedy* (Chevron 2005a), and the *Work Plan for Extended Non-Pumping Aquifer Evaluation, Additional Assessment Activities to Support Groundwater Remedy* (Chevron 2005b). The goal of the long-term high grade pumping test was to determine if LNAPL recovery, under concentrated pumping during occasional periods of naturally occurring low water table (referred to as high grade pumping), was a viable option for LNAPL removal. The long-term high grade LNAPL recovery test was performed during the seasonal low groundwater table. The shutdown test was performed to verify the effects of shutting down the production wells at the outer edges of the plume and to evaluate the stability of the plume under natural hydraulic gradients.

A. Site Hydrogeology

The Chevron facility lies in a glacial valley cut into Ordovician-age shale and partially filled with glacial outwash gravel and fluvial deposits of the Great Miami River. The steep-walled valley is approximately one-half mile wide and 100 feet deep. The bedrock shale is consolidated and has a low hydraulic conductivity, but is locally fractured and jointed and interbedded with thin layers of limestone. Overbank silt and sand deposits derived from floods of the Great Miami River generally overlie coarser-grained sand and gravel derived from glacial outwash.

The hydrogeology of the Great Miami River buried valley aquifer is characterized by high hydraulic conductivity, textural heterogeneity, and rapid water level changes driven by river stage. Investigations at the site confirm that discontinuous surficial flood plain deposits and fill cover most of the refinery site and are up to 15 feet thick. Below this are highly conductive sands and gravels up to 100 feet thick, which form the productive part of the aquifer. High transmissivity and significant textural heterogeneity characterize these aquifer materials. This aquifer has been designated a sole-source aquifer by the U.S. EPA, and is the principal source of drinking water for the area and commonly yields more than 1,000 gallons per minute.

Groundwater and the river are both controlled by the bedrock structure of the system. Groundwater and the Great Miami River are in direct hydraulic communication, and groundwater flows in the same direction as the river (i.e., south/southwest) in the site vicinity. The water table is affected mainly by the river stage, which is typically high during the spring and declines over the summer into the fall. However, the river stage can change abruptly in response to storms. Groundwater flow is from north to south, generally parallel to the river when pumping is not taking place. Groundwater velocities are typically in the range of two to four feet/day.

The depth to the water table beneath the former refinery portion of the facility ranges from approximately 15 to 40 feet below ground surface (bgs). The elevation of the water table varies seasonally, generally reaching its seasonally lowest elevation in autumn and its seasonally highest elevation in spring. The aquifer beneath the facility has a maximum saturated thickness of approximately 65 to 80 feet.

B. Groundwater Contamination

Both LNAPL and dissolved-phase contamination occur at the Chevron facility. The two types of contamination are closely related, with LNAPL being the primary source of the dissolved-phase groundwater contamination. Both the LNAPL and dissolved phase plumes have been extensively studied.

While the refinery was in operation, refined petroleum products were released to the surface and subsurface. The petroleum products moved downward through the soil, leaving residual hydrocarbons in the subsurface. Where enough product was released, a layer of petroleum product or LNAPL accumulated in the water table zone. These petroleum products did not readily migrate deeper into the aquifer because they tend to float on the water table. However, as the product layer thickens, LNAPL also tends to spread laterally on the water table. Thus, as the result of the releases at the facility, the LNAPL plume spread, ultimately resulting in an approximately 250-acre footprint of LNAPL and dissolved-phase contamination on the groundwater. The LNAPL plume covers much of the facility and has spread under the southern portion of Hooven and into the commercial area to the southwest of the facility referred to as the Southwest Quadrant.

As LNAPL accumulates, thicker layers of LNAPL form and depress the water table. This layer of LNAPL at the water table tends to move up and down with the water table. As the water table moves up and down, LNAPL is retained as residual LNAPL in subsurface materials by capillary forces, creating a smear zone around the water table. Water table fluctuations over the years and the history of LNAPL release and movement resulted in a relatively thick hydrocarbon smear zone in the central areas of the plume, but there is only a thin smear zone in the lateral and distal portions of the plume in areas along the Great Miami River and in areas such as Hooven and the Southwest Quadrant. The LNAPL smear zone extends from a depth of 10 feet bgs to a maximum depth of approximately 30 feet bgs in the central area of the plume.

Although estimates are available for the amount of LNAPL released, the time and amount of the LNAPL releases on site are uncertain. The petroleum product releases that caused the LNAPL plume may have occurred at any time during the facility's 55-year operational history (1931 - 1986). Although details of the releases are unknown, LNAPL chemistry data, product history, and production runs suggest that much of the LNAPL was released in the 1950s and 1960s. Sampling of the LNAPL plume indicates that the LNAPL is a mixture of approximately 80 percent leaded gasoline and 20 percent diesel fuel. The LNAPL can be divided into two types based on physical properties: a low viscosity, low density LNAPL and a higher viscosity, higher density LNAPL. The latter LNAPL type is limited to a small area in the eastern portion of the site.

The dissolved groundwater contamination observed at the Chevron facility consists primarily of constituents derived from the petroleum products released at the site, although some contamination may have been derived from the sludges formerly disposed on site. These sludges are now being removed as part of the contaminated soil and sludges remedy. The sludges are wastes from the refinery process and generally contain metals, semi-volatile organic compounds (SVOCs), and volatile organic compounds (VOCs). The dissolved petroleum constituents observed on site include benzene, ethylbenzene, and naphthalene. Benzene is the most widespread contaminant, with concentrations as high as 5,000 micrograms per liter (µg/l) in groundwater beneath the facility. The Maximum Contaminant Level (MCL) for benzene under the Safe Drinking Water Act is 5 micrograms per liter (µg/l). Groundwater monitoring indicates that the distribution of dissolved benzene is primarily limited to the shallow portions of the saturated zone of the aquifer, within and beneath the LNAPL smear zone. However, benzene is observed in deep groundwater in the vicinity of the groundwater production wells used to control plume migration. In these areas, the pumping has increased vertical gradients, drawing some dissolved-phase hydrocarbons deeper into the aquifer. Dissolved benzene generally is not detected outside the area containing residual LNAPL because of the inward gradient maintained by the groundwater production wells. The source of the dissolved benzene currently observed in groundwater is primarily the LNAPL in the subsurface, which contains benzene and related petroleum constituents. These constituents dissolve out of the LNAPL and into the groundwater as it flows through the LNAPL smear zone.

C. Interim Remedial Measures

In early 1985, in a response to a LNAPL sheen emanating from the river bank adjacent to the then Gulf Oil refinery, focused groundwater and initial LNAPL recovery was initiated by Chevron to contain and recover the LNAPL, as well as the dissolved-phased plumes. This extraction well system has expanded over the years at the site to include 16 high-volume groundwater production wells. These wells are installed at various locations throughout the property. The number of wells in use has varied depending on containment and LNAPL recovery needs. These production wells have been operated to create an inward hydraulic gradient that captures LNAPL and prevents further lateral expansion of the LNAPL plume. The inward hydraulic gradient also inhibits the migration of dissolved hydrocarbons from the site.

Approximately 3.5 million gallons of LNAPL have been recovered to date. The exact amount of hydrocarbon remaining in the aquifer is uncertain and difficult to determine. However, based on the historical recovery curves, more than half of the hydrocarbon has already been removed. Seventy-three percent of the cumulative LNAPL recovery occurred during the first three years of pumping at just two to three recovery wells, with the remaining 27 percent coming in the last 17 years from these, and several additional wells.

The LNAPL recovery rate has diminished over time, indicating that the recoverable fraction remaining is relatively small and that the inherent mobility of the LNAPL plume has been greatly reduced. Recovery rates over the last few years are only a fraction of the initial recovery rates and are strongly linked to seasonal low water tables or periodic drought conditions that expose the lower portion of the smear zone. These conditions allow LNAPL to drain to recovery locations under increased gradient created by pumping large volumes of groundwater. As a result, in recent years LNAPL recovery operations have been carried out mainly during the fall low water-table season. During these times, partially penetrating wells (partially penetrating into the zone of LNAPL contamination) are brought on line; these wells create cones of groundwater depression that capture floating LNAPL. In these cones of depression, LNAPL is recovered by skimming it from recovery wells located within or adjacent to the production wells. The recovered LNAPL is pumped through metered lines for storage in above-ground tanks prior to off-site shipment.

At other times, the water levels raise enough to trap and immobilize most of the LNAPL in soil pores. The LNAPL becomes less mobile and the plume becomes more stable during these periods. Regardless, the productions wells are pumped year round at sufficient rates to ensure hydraulic containment of both the dissolved and LNAPL plumes. Typical high water table groundwater pumping rates are approximately 2.5 million gallons per day (mgd), while low water table groundwater pumping rates are up to 5 mgd. The effectiveness of the hydraulic containment system to control hydraulic gradients is evaluated by gauging an extensive network of monitoring wells (more than 115 wells) and two river measuring points six times per year for water level and LNAPL thickness.

Natural processes within LNAPL plumes tend to limit their spread. These natural processes include the retention of residual LNAPL in soils and the dissipation of the pressure within the LNAPL plume as the plume thins due to spreading. If LNAPL releases are stopped, the spread of the resulting LNAPL normally stabilizes over time. The recovery of LNAPL further enhances the stabilization of LNAPL. Due to the large amounts of LNAPL that have already been recovered to date, the LNAPL plume may be approaching stability under natural hydraulic gradients. A Shutdown test conducted from November 2005 to February 2006 demonstrated plume stability in that period of time, and no measurable expansion of the LNAPL or dissolved plume occurred.

In addition to the groundwater extraction program designed to recover and contain LNAPL and dissolved plumes, horizontal soil vapor extraction (HSVE) was implemented beneath the community of Hooven in 1999 to ensure that unacceptable vapor exposure was not occurring. The HSVE system also serves as an additional measure for petroleum hydrocarbon removal. Like the LNAPL recovery program, the HSVE system has experienced strongly diminishing returns as the available vapor has been removed. Currently, only seasonal vapor recovery is possible when the water table is low and the smear zone beneath Hooven is exposed.

D. Land Use

A conceptual future land use plan for the former Chevron facility (Figure 2) has been developed with input from citizens and through Chevron’s Community Advisory Panel. Future land reuse option for the site is a mixed use scenario that includes potential industrial/commercial, open space, and recreational uses. Due to the fact that the facility is located in the Great Miami River floodplain, residential and institutional reuses are not viable; however portions are being considered for recreational development. The area being considered for industrial/commercial reuse is located inside the 100-year flood protection berm.

IV. SUMMARY OF CONTAMINATION RISKS

A. Risk Assessment History and Review

A conceptual land use plan was prepared to guide risk assessment, remediation, and potential redevelopment of the facility. The current land use plan is a mixed-use scenario, including potential industrial/commercial, open space, and recreational uses (Figure 2). Assessment of risk at the site was addressed in the *Chevron Cincinnati Facility Phase II Facility-Wide Human Health and Ecological Risk Assessment* (E&E 2000a). Additional assessment of risk to human health in the town of Hooven and in the Southwest Quadrant was addressed in the *Human Health Risk Assessment of Potential Exposure to Volatile Compounds, Hooven, Ohio, Revision 2* (E&E 2000b), *Human Health Assessment for Potential Offsite Volatiles Exposure at the Southwest Quadrant* (E&E 2002), and most recently *Subsurface Investigation and Field Activities Report and Human Health Risk Assessment*, *Chevron Cincinnati Facility*, *Hooven , Ohio* (Trihydro, 2005). The sample results from the RFI and off-site vapor investigations were used as input parameters in the risk assessments. The results were screened using risk values that relate to the proposed reuse of the area (i.e., industrial, recreational). The human health screening values used were the U.S. EPA Region 9 Preliminary Remediation Goals (PRGs). The results relating to ecological areas were screened using the U.S. EPA Region 5 Ecological Data Quality Levels (EDQLs). Using these screening methods, contaminants of potential concern (COPCs) were identified. These COPCs were used in the conceptual site model (CSM) that summarized the relationship between the sources and the receptors.

Using the CSM, contaminated media were identified as surface soils, subsurface soils, sediment, groundwater, and surface water. The pathways of exposure for human health are dermal (skin) contact, inhalation of vapors, inhalation of soil particles, and ingestion. The receptors for human health pathways are future industrial workers, future recreational users, construction workers, remediation workers, and residents of Hooven. The ecological receptors are terrestrial, wetland, and aquatic plants and animals.

The risks associated with the sources of contamination in surface soils, subsurface soils, and sediment were addressed and summarized in the *Statement of Basis for Sludges and Contaminated Soils* (U.S. EPA 2003); therefore, these risks are not addressed in this SB. On March 4, 2004 U.S. EPA signed a remedy for the sludges and contaminated soils, and Chevron is performing the cleanup of the selected soils remedy.

B. Contaminants of Potential Concern (COPCs)

1. Groundwater COPCs
    a. Facility property: The COPCs for human health in groundwater from refinery operations at the Chevron facility are benzene, ethylbenzene, 1,4-dichlorobenzene, acetophenone, bis(2-ethylhexyl)phthalate, naphthalene, pyrene, dissolved lead, and total arsenic.

b. Hooven: The COPCs for human health in groundwater at Hooven are benzene, ethylbenzene, naphthalene, 1,2,4 trimethyl benzene, 1,3,5 trimethyl benzene,n-propyl benzene, isopropyl benzene, n-Hexane, acetone, toluene and xylene.

c. Southwest Quadrant: The COPCs for human health in groundwater in the Southwest Quadrant are benzene, ethylbenzene, naphthalene, 1,2,4 trimethyl benzene, 1,3,5 trimethyl benzene,n-propyl benzene, isopropyl benzene, n-Hexane, acetone, toluene and xylene.

2. Vapor COPCs
   a. Facility property: COPCs for human health in groundwater vapor at the Chevron facility are acetone, benzene, chlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, naphthalene, and trichloroethene.
   b. Hooven: The COPCs for human health in groundwater at Hooven are benzene, ethylbenzene, naphthalene, 1,2,4 trimethyl benzene, 1,3,5 trimethyl benzene,n-propyl benzene, isopropyl benzene, n-Hexane, acetone, toluene and xylene.
   c. Southwest Quadrant: COPCs for human health in the groundwater vapor in the town of Hooven are acetone, benzene, chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 1,1-dichloroethylene, ethlybenzene, methylene chloride, naphthalene, toluene, 1,1,2-trichloroethane, m- and p-xylene, and o-xylene.

C. Human Health Risk Characterization

The human health risk characterization makes a quantitative estimate of risks at the Chevron facility. The characterization uses the COPCs, the CSM, an assessment of the toxicity, and an assessment of the exposure to calculate the risks. Calculations for risk characterization used two different methods, the reasonable maximum exposure (RME), and the central tendency (CT) method.

The noncarcinogenic risk characterization looks at all noncarcinogenic COPCs and arrives at a hazard index (HI) for these contaminants. U.S. EPA specifies that an HI equal to, or less than one, is considered acceptable, and an HI greater than one indicates an unacceptable risk to human health. The noncarcinogenic risk exceeded the HI of one for the commercial/industrial receptor in basement indoor air. This risk is addressed in this proposed remedy with institutional controls through prohibition of basement construction on the facility.

1. Noncarncinogenic Risks in Recreational Reuse Area
   a. Future Adolescent Recreator Calculations indicate negligible noncarcinogenic inhalation hazards for outdoor inhalation of vapors based upon the RME and CT assumptions. The HI for RME (0.029) and CT (0.014) methods were well below one. 1,3-dichlorobenzene was the primary contributor to the hazard values.

b. Future Construction/Remediation Worker Calculations indicate negligible noncarcinogenic inhalation hazards for outdoor inhalation of vapors based upon the RME assumption. The HI for the RME (0.032) method was well below one.

2. Noncarcinogenic Risks in Industrial Reuse Area
   a. Future Industrial/Commercial Worker Calculations indicate negligible noncarcinogenic inhalation hazards for inhalation of vapors in a basement based upon the RME and CT assumptions. The HI for RME (0.035) and CT (0.19) methods were well below one. 1,3-Dichlorobenzene was the primary contributor to the hazard value.
      i. *Basement Scenario* (Working in basements) Calculations indicate unacceptable noncarcinogenic inhalation hazards for inhalation of indoor vapors based upon the RME assumption. The HI for the RME (1.4) method was slightly above one. Toluene and ethylbenzene were the primary contributors to the hazard values.
   b. Future Construction.Remediation Worker Calculations indicate negligible noncarcinogenic inhalation hazards for inhalation of outdoor vapors based upon the RME assumption. The HI for the RME (0.32) method was well below one.

3. Noncarcinogenic Risks in the Southwest Quadrant
   a. Commercial Worker
      i. *Basement Scenario* Calculations indicate unacceptable or significant noncarcinogenic inhalation hazards for indoor chemicals in a basement, based upon the RME assumptions. The HI for basement vapor inhalation (2.0) exposure using the RME methods was greater than one. Benzene was the primary contributor to the hazard value.

The risk characterization then looks at all carcinogenic COPCs and arrives at an estimated carcinogenic risk. USEPA's range of acceptable risk is 1×10^{-4} to 1×10^{-6}. This risk is equivalent to one additional person in 10,000 to one additional person in 1,000,000 contracting cancer from a lifetime exposure to these contaminants.

4. Carcinogenic Risks in Recreational Reuse Area
   a. Future Adolescent Recreator Calculations indicate negligible carcinogenic risk for a future adolescent due to inhalation of outdoor vapors. The total carcinogenic risk for the vapor inhalation exposure pathway was calculated to be 1.8×10^{-7} using the RME method and 6.9×10^{-8} using the CT method. This risk falls below the U.S. EPA acceptable risk range. A subgroup of SVOCs, the polynuclear aromatic hydrocarbons (PAHs), was the major source of carcinogenic risk in the Recreational Reuse Area.
   b. Future Construction/Remediation Worker Calculations indicate negligible carcinogenic risk for a future construction/remediation worker due to inhalation of outdoor vapors. The total carcinogenic risk for the vapor inhalation exposure pathway was calculated to be 1.7×10^{-7} using the RME method. This risk falls below the U.S. EPA acceptable risk range.

5. Carcinogenic Risks in Industrial Reuse Area
    a. Future Industrial/Commercial Worker Calculations indicate negligible carcinogenic risk for a future industrial/commercial worker due to inhalation of outdoor vapors. The total carcinogenic risk was calculated to be 1.5×10^{-5} using the RME method and 2.0×10^{-6} using the CT method. The calculated risks fall within the U.S. EPA acceptable risk range.
        i. *Basement Scenario* Calculations indicate significant carcinogenic risk for a future industrial/commercial worker due to inhalation of vapors in a basement. The total carcinogenic risk was calculated to be 1.7×10^{-2} using the RME method. This risk is greater than the U.S. EPA acceptable risk range. The only contributor to this risk was benzene. This value was derived following the assumption that a commercial/industrial worker inhales the vapor in the basement for 8 hours day, 5 days a week for 25 years.
    b. Future Construction/Remediation Worker Calculations indicate negligible carcinogenic risk for a inhalation of outdoor vapors. The total carcinogenic risk was calculated to be 4.1×10^{-6} using the RME method. This risk is within the U.S. EPA acceptable risk range.

6. Carcinogenic Risks for the Southwest Quadrant
    a. Commercial Worker
        i. *Basement Scenario* Calculations indicate negligible carcinogenic risk for basement vapor inhalation exposures. The total carcinogenic risk across all exposure pathways was calculated to be 5.1×10^{-5} for the RME method. This risk is within the U.S. EPA acceptable risk range. Benzene is the only contributor to this risk.

Risk to Subpopulations in Hooven

The assessment of risk to human health in May 2000, indicated a noncarcinogenic inhalation hazard of 3.0 as well as a carcinogenic inhalation risk of 8.0×10^{-5} for indoor chemicals for the basement scenario in the town of Hooven. These values were derived following the assumption that a resident lives in the basement for 24 hours a day, 350 days a year for 30 years. A follow-up study was completed in June 2005 to update the human health risk assessment and to reevaluate the crack ratio assumptions used in the subsurface vapor intrusion model in the risk assessment report with the revised toxicity data currently available for some of the COPCs under study. The analytical data from the recent study on the vertically nested wells showed that petroleum hydrocarbon COPCs detected in vapor samples immediately above the LNAPL and dissolved plume attenuate within a short distance above the groundwater table. The attenuation is attributed to active biodegradation confirmed through oxygen and carbon dioxide profiles in the plume area. Further, the soil gas concentrations of constituents identified in the LNAPL/dissolved plume are below the generic screening levels at depths shallower than 30 ft. below ground surface in all the nested wells inside the plume. As a result of these observations and in accordance with U.S. EPA's Office of Solid Waste and Emergency Response (OSWER) draft vapor intrusion guidance, the vapor migration pathway from LNAPL or dissolved plume to indoor air in the residents of Hooven is considered incomplete. Thus under current conditions, carcinogenic risk and/or non-carcinogenic hazard from groundwater contamination is assumed to be insignificant to Hooven residents as well as the school children and faculty as a result of this incomplete pathway.

D. Ecological Risks

The ecological risk characterization looks at receptors classified into terrestrial, wetlands, and Great Miami River components. The ecological risk characterization associated with the terrestrial and wetland receptors was addressed in the *Statement of Basis for Sludges and Contaminated Soils* (U.S. EPA 2003).

1. Aquatic Life Risk Analysis
   The Great Miami River, which is adjacent to the facility on the north, east, and south, was investigated. Surface water samples were taken to determine whether petroleum contamination has been released to the river. No site-related petroleum contamination was detected in surface water. Riverbank soil samples were also collected to evaluate potential ecological receptors of riverbank contamination. Residual PAH contamination from a release of hydrocarbon seepage to the river that was discovered on January 21, 1985, affects a small area of the riverbank along the southern extent of the refinery property. Riverbank and surface water samples indicate that the impacts of this contamination on aquatic life are expected to be minimal.

   On May 16, 2005, oil releases the size of quarters were noticed in the Great Miami River near Monitoring Well 85 along the western shore. A boom was placed in the river in the area of the release, and initial erosion control measures were put in place. Investigations revealed the impacted soil along the bank was eroding into the river and releasing petroleum hydrocarbons. A similar situation arose on July 13, 2005 in Gulf Park on the eastern bank of the Great Miami River where localized small releases of hydrocarbons were observed. Surface water, river sediment and groundwater were sampled near these releases and initial results show no exceedances of Ohio EPA regulatory standards. Anticipated shoreline erosion controls in areas along the Great Miami River are expected to prevent contaminated soil from eroding into the river, these controls are detailed in the Scope of the Proposed Remedy (Section VII).

   Groundwater pumping has occurred since 1985 to prevent discharges to the river. Currently, preliminary modeling regarding potential flow to the river under natural gradients is being developed. Groundwater monitoring wells are being installed and sampled adjacent to the river to further develop the preliminary models and determine the extent of contamination and the surface water groundwater interaction near the Great Miami River.

V. SUMMARY OF ALTERNATIVES

The corrective measure alternatives analyzed to clean up contaminated groundwater at and from the Chevron facility are presented below.

- **Alternative 1**: No-Action
- **Alternative 2:** High Grade Pumping, Containment of plume, MNA, Institutional Controls, Stabilization of Riverbank, Hooven SVE, and Vapor Well Monitoring.
- **Alternative 3**: Sitewide Soil Vapor Extraction (SVE), Containment of plume, MNA, Institutional Controls, Stabilization of Riverbank, Hooven SVE, and Vapor Well Monitoring.
- **Alternative 4**: Sitewide SVE and In-Situ Air Sparging (IAS), Containment of plume, MNA, Institutional Controls, Stabilization of Riverbank, Hooven SVE, and Vapor Well Monitoring.
- **Alternative 5**: Sitewide Surfactant Enhanced Aquifer Remediation (SEAR), Containment of plume, MNA, Institutional Controls, Stabilization of Riverbank, Hooven SVE, and Vapor Well Monitoring.

Alternative 1: No-Action

The no-action alternative provides a baseline for comparing the benefits and costs of other alternatives. This alternative assumes that no additional actions will occur at the facility to remediate groundwater beyond what has already been completed.

Alternative 2: High Grade Pumping, Containment, MNA, and Institutional Controls

This alternative includes source removal (recovery of LNAPL); containment of the dissolved phase and LNAPL plumes to prevent further migration of contamination; and natural attenuation of both LNAPL and dissolved contaminants to ultimately achieve concentration levels of dissolved contaminants in the ground water at or below Federal drinking water standards (Safe Drinking Water Act Maximum Contaminant Levels (MCLs) in 30 years. Alternative 2, as well as Alternatives 3, 4 and 5 also require implementation of institutional (non-engineering) controls (e.g., deed restrictions, equitable servitude) to restrict certain land and ground water uses on the facility. These institutional controls will prevent exposure to the LNAPL and groundwater plumes throughout the on-site and off-site areas. See the more detailed discussion of the land and water uses to be restricted in Section VII: Scope of the Proposed Remedy—Alternative 2. Recovery of LNAPL will be achieved through a high grade pumping scheme in the area of high concentration (Figure 3) designed to remove LNAPL during periods of low water table elevations. Containment will be achieved through LNAPL plume stabilization supplemented with hydraulic control if necessary. MNA will reduce the concentrations of dissolved contaminants in down gradient areas of the plume. In addition to controlling down gradient dissolved contaminants, MNA will be relied on, in part, to further deplete benzene and other petroleum constituents from the LNAPL. The Hooven Soil Vapor Extraction (HSVE) system will continue to be used to control vapors volatilizing from the LNAPL and further deplete volatile constituents in the LNAPL plume beneath the town of Hooven. In addition, sampling of vapor monitoring wells will be conducted in Hooven. This alternative also includes stabilization of the bank at the refinery and Gulf Park along the Great Miami River, where releases were previously observed. The company would have to provide an assurance that adequate financial resources are available for implementation of the remedy. Analyses of mass loss on specific contaminants at the site conducted by Chevron suggest that MCLs can be reached within 30 years.

Alternative 2 serves as the basis for the remaining three alternatives. These additional alternatives differ from the Alternative 2 only in the additional technologies employed to enhance the removal of LNAPL.

Alternative 3: Sitewide SVE, Containment, MNA, and Institutional Controls

This alternative would feature a sitewide SVE system in addition to the corrective measures described in Alternative 2. The SVE system would be implemented via a network of mostly parallel, horizontal wells underlying the entire site. These wells would be drilled from existing north-south site roads and would be spaced approximately 300 feet apart. The system would be composed of approximately 17 horizontal wells on site and three or four additional wells off site, south of Hooven. The SVE system would be used to remove volatile contaminants, including benzene, from the unsaturated zone. The system should increase the natural depletion of volatile constituents from the upper portions of the LNAPL smear zone and thus reduce the time to achieve the cleanup of the entire plume to MCLs. The system would be operated as long as it continued to be effective in removing volatile constituents in the subsurface, which is estimated to be a period of five to ten years. This is not the overall time frame, i.e., the time estimated to reach MCLs.

Alternative 4: Sitewide SVE & IAS, Containment, MNA, and Institutional Controls

This alternative would feature an IAS system in addition to the corrective measures described in Alternative 3. The IAS system would involve the injection of air below the LNAPL smear zone via a network of vertical wells laid out in an orthogonal grid. Like SVE, the IAS system would strip volatile components from the subsurface and facilitate biodegradation through aeration of the subsurface. The IAS wells would be installed on 50-foot centers which would result in approximately 3,500 wells for the two-acre plume area. The SVE system would operate concurrently with the IAS system and capture the volatile constituents stripped from the subsurface by the IAS system. Like the SVE system, the IAS system would be operated as long as it continued to be effective in removing volatile constituents in the subsurface, which is estimated to be a period of five to ten years. This is not the overall time frame, i.e., the time estimated to reach MCLs.

Alternative 5: Sitewide SEAR & SVE, Containment, MNA and Institutional Controls

Alternative 5 would feature SEAR in addition to the corrective measures described in Alternative 3. This alternative differs from Alternative 4 only by replacing SEAR for IAS as a means for removing LNAPL from beneath the water table. Under this alternative, SEAR would be used to flush most of the LNAPL from the saturated zone and remove the free phase, while SVE would attack the vadose zone. SEAR would be implemented during periods of low water table to take advantage of the natural vertical drainage of LNAPL under such conditions. The implementation of SEAR during periods of low water table elevation would help to minimize the volume of aquifer to be treated, and thus, the volume and cost of surfactant to be used. SEAR is different from the other technologies considered because it would be implemented in small blocks referred to as panels. A panel would be treated in a few weeks, after which time the operation would move to the next down gradient panel. This process would extend over several low water seasons, progressing down gradient until the entire site is treated. The surfactant mix would be injected through a row of injection wells spaced 10 to 15 feet apart and extracted through a parallel row of wells 50 feet from the injection row. Under these assumptions, approximately 17,000 wells would be drilled.

VI. EVALUATION OF ALTERNATIVES

A. Evaluation Criteria

This section presents the process used to evaluate the five cleanup alternatives and the results of the evaluation for contaminated groundwater. The evaluation criteria used are described in the May 1, 1996, Advance Notice of Proposed Rulemaking (ANPR) for Corrective Action at Hazardous Waste Management Facilities 61 Federal Register 19432. Although the rule was never published as a final rule, it is used by U.S. EPA as guidance for selecting corrective measures at RCRA corrective action facilities. The ANPR criteria are applied in a two-phased evaluation: Proposed remedies are screened to see if they meet the four threshold criteria. The remedies that meet the threshold criteria are then evaluated using five balancing criteria to identify the remedy that provides the best relative combination of attributes.

The threshold criteria require that all remedies: (1) be protective of human health and the environment; (2) attain media cleanup standards (concentration levels of hazardous constituents identified by U.S. EPA as protective of human health and the environment); (3) control the source(s) of releases of hazardous waste (including hazardous constituents) that pose threats to human health and the environment; and (4) comply with applicable standards for waste management. The cleanup standards for the contaminated groundwater at the Facility are Safe Drinking Water Act Maximum Contaminant Levels (MCLs). The balancing criteria are: (1) long-term reliability and effectiveness; (2) reduction of toxicity, mobility, or volume of wastes; (3) short-term effectiveness; (4) implementability; and (5) cost.

B. Selection of the Proposed Remedy

U.S. EPA conducted a review of the corrective measure alternative in Chevron's October 2001 groundwater CMS. The threshold criteria have been evaluated by U.S. EPA for all the proposed remedies. Alternative 1, the no action alternative, does not meet all of the threshold criteria and is not considered for evaluation by the balancing criteria. Alternative 1 does not protect human health and the environment, control the source, attain any cleanup standards, or propose any waste management. U.S. EPA determined alternatives 2, 3, 4, and 5 meet the threshold criteria and are evaluated relative to the balancing criteria.

1. Long-Term Reliability
   While the pumping and wastewater treatment systems involved in Alternative 2 will require some maintenance, this alternative has been shown to be reliable in short term tests and has been proven reliable in the long term. Alternatives 3 and 4 are not routinely operated at the scale envisioned at the Chevron site and can be considered less reliable in the long term than Alternative 2. Alternative 5 is developmental and has been conducted at the bench scale (laboratory test) only and is considered the least reliable in the long term of all the alternatives considered.

2. Reduction of Toxicity, Mobility or Volume of Wastes
   All of the proposed alternatives would reduce the toxicity of the residual LNAPL by depletion of benzene and related compounds or through direct removal of LNAPL from the subsurface. Recent tests have shown the mobility of LNAPL is not significant at the Chevron site, and appears to be stable. Consequently, none of the alternatives offers any significant advantages relative to reductions in mobility. With their more aggressive approach to removal of LNAPL from the subsurface, Alternatives3, 4 and 5 appear to offer advantages, as compared with alternative 2, with regard to the reduction in the volume of residual LNAPL and the time frame for achieving MCLs. Alternative 2, relying in large part on natural degradation, would generate less waste than the other alternatives. Alternative 5 with its SEAR technology would result in the greatest reductions in residual LNAPL volumes although it may increase mobility in the process.

3. Short-Term Effectiveness
   The high grade pumping scheme in Alternative 2 is only operational and effective during extended periods of low rainfall when groundwater levels expose the smear zone.

Consequently, the short-term effectiveness of this alternative is dependent on weather patterns. Alternative 2 also relies heavily on the volatilization of benzene into soil vapor and the dissolution of benzene into groundwater to deplete the benzene and related contaminants contained within the LNAPL. This reliance on natural attenuation mechanisms adversely impacts the short-term effectiveness of Alternative 2. Although somewhat more effective than Alternative 2, the short-term effectiveness of Alternative 3 is limited by the fact that SVE only addresses the contaminants in the unsaturated zone and does not address the large amounts of LNAPL held below the water table in the LNAPL smear zone. While the effectiveness of SVE in Alternative 3 would be enhanced during low water table conditions, this alternative would then be subject to the same limitations imposed on the high grade pumping by weather conditions. The addition of IAS to Alternative 4 would help to more rapidly address the LNAPL below the water table and would likely improve the short-term effectiveness of the remedy. The SEAR technology in Alternative 5 is most effective at low water tables which are present only at certain times of the year. SEAR would overall remove the most LNAPL, and consequently would likely provide the greatest short-term effectiveness.

4. Implementability
Alternative 2 is readily implementable. The equipment necessary to implement the high grade pumping scheme in Alternative 2 is already largely in place and the treatment system has been in operation at the site. Although high grade pumping would require low water table conditions, such conditions may be sufficiently frequent so as not to adversely impact the implementability and therefore effectiveness of Alternative 2. Alternatives 3 and 4 require the installation of large networks of SVE and IAS (Alternative 4) wells. While these technologies have been used on a lesser scale at many other sites, the scale that would be involved in implementing these technologies at the Chevron site is very large and reliability of the performance is unclear. Thus, Alternative 3 and 4 may be considered less implementable than Alternative 2. The added complexity of the IAS system in Alternative 4 and the major drilling effort required makes Alternative 4 less implementable than Alternative 3. The implementation of the SEAR technology on this scale in Alternative 5 would be unprecedented and would have to be considered developmental. The extensive injection and recovery well system required for the SEAR technology combined with the complexities of this technology clearly make Alternative 5, as described, the least implementable of all the alternatives. In addition, both the IAS and SEAR technologies may increase dissolved concentrations of contaminants thereby spreading the plumes in groundwater and require additional containment measures, also making Alternatives 4 and 5 less implementable. The high grade pumping scheme in Alternative 2 has the advantage of having significant reach in the subsurface including beneath portions of Hooven. Alternative 2 is the most readily implementable remedy.

5. Costs
The estimated costs for each Alternative in 2006 dollars are presented in Table 1 below. The total cost figures here differ from the cost figures in the 2000 Groundwater CMS

because the 2000 cost estimate included the cost of continued site wide pumping through the life of the remedy. The 2006 estimates presumes that the hydraulic control wells will gradually be shut down within a few years after the remedy is implemented.

Table 1. Present Worth of All Costs Associated with Alternatives 2 through 5

Alternative	Initial Source Removal Technology	Present Worth ($ millions)			
		Initial Source Removal		Duration (years)	Total
		Capital	O&M		
2	High Grade Pumping	$11,292,499	$14,514,433	30	$25,806,932
3	SVE	$20,690,474	$26,250,945	12	$46,941,419
4	IAS + SVE	$27,359,122	$35,417,392	10	$62,776,514
5	SEAR + SVE	$99,102,293	$18,163,889	8	$117,266,181

C. Summary

Alternative 2 appears to be the most easily implemented and most reliable in the long tem of all the remedial alternatives considered. Alternative 2 is not the most effective in the short term nor in reducing mobility, toxicity or volume of wastes. While considered less implementable and reliable, Alternative 3 provides only modest improvement in the remedial time frame over Alternative 2. Alternative 4 and particularly Alternative 5 have shown the potential for significant reduction of residual LNAPL and significant improvements in the timeframe of the remedy. The advantages of short-term effectiveness and reduction in volume of LNAPL in Alternatives 3, 4 and 5 are balanced with the disadvantages regarding their implementability and long-term reliability. The last balancing criteria U.S. EPA has to consider is costs, Alternatives 3, 4, and 5 are progressively more costly than Alternative 2. When all the balancing criteria are weighed against the four alternatives, Alternative 2 outweighs Alternative 3, 4 and 5. Consequently, Alternative 2 (*Advantage*-implementable, long-term reliability, and costs/*Disadvantag*e-short-term effectiveness; reduction in mobility, toxicity or volume of wastes) is recommended as the proposed groundwater remedy at the Chevron facility.

VII. SCOPE OF PROPOSED REMEDY - ALTERNATIVE 2

The proposed remedy, Alternative 2, has been designed to be protective of human health and the environment. The details of this proposed remedy are laid out in this section. The long-term corrective action objective is to restore groundwater to its maximum beneficial uses by achieving drinking water MCLs throughout the area of contaminated groundwater. Based on mass loss estimates for contaminants at the facility, U.S. EPA expects that MCLs will be achieved throughout the plume within 30 years. Thus the proposed remedy includes the long-term performance standard of restoring the ground water to MCLs by 2036. However, because achieving this long-term objective will take many years, a series of interim corrective action objectives have been developed for the Chevron groundwater plume. These interim objectives have been designed to ensure that human health and the environment are protected until the long-term corrective action objective is achieved.

As indicated in the Summary of Facility Risks (Section IV) the principal contaminant of concern in groundwater is benzene, although benzene, toluene, ethylbenzene, and xylene (BTEX) compounds are found in groundwater above MCLs. Benzene poses a risk to human health through ingestion via drinking water and inhalation. The discharge of BTEX compounds and other contaminants to the Great Miami River also pose potential risks to ecological receptors.

The following interim remedial objectives have been identified:

- 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 riverbank to prevent erosion

These interim remedial objectives are interrelated and are to be achieved through the various components of the proposed remedy.

A key component of the proposed remedy is the containment and stabilization of the LNAPL and dissolved contaminant plumes. The LNAPL and dissolved contaminant plumes are currently contained by the ongoing interim measure consisting of the operation of a recovery well system that hydraulically controls the plumes. However, studies have indicated that the LNAPL plume may be stable under natural gradients. Consequently, operation of the site-wide recovery system may not be necessary to contain the LNAPL plume. In addition, the benzene and related petroleum compounds that emanate from the LNAPL source are generally biodegradable in groundwater. On-site monitoring has suggested that natural attenuation stabilizes the dissolved plume emanating from the LNAPL plume. Consequently, hydraulic control may not be necessary to contain the dissolved plume.

During the early phases of the remedy, hydraulic control of the plume will be gradually eased and the migration of the plumes monitored carefully to verify that the LNAPL and dissolved plumes are stable under natural groundwater gradients. The remedy includes an extensive ongoing program of monitoring both the LNAPL and dissolved plumes to verify that both plumes are stable.

For the dissolved plume, a network of monitoring wells establishes a “Containment Point of Compliance” (“POC”), beyond which the LNAPL plume or dissolved contaminants above MCLs will not be allowed to migrate. These monitoring wells are located at the approximate down-gradient boundary of the current plume, and additional wells may be added to completely monitor the down-gradient boundary (Figure 4). Sampling of these wells will be conducted semiannually for the first five years, annually for the next five years (staggered to account for seasonality), biennially for the next ten years, and every five years thereafter. Should the performance monitoring indicate that MCLs have been exceeded at or beyond the Containment POC, operation of the extraction well system will be resumed. If necessary, Chevron will analyze and implement additional remedial measures in order to ensure containment of the dissolved plume. Alternatives evaluated and Chevron's recommended alternative will be submitted to U.S. EPA for review. Whenever new wells are installed, Chevron will develop an initial data set for the new wells by sampling quarterly for the first two years.

To ensure containment of the LNAPL plume, the ROST wells and groundwater monitoring wells outside the smear zone will be tested for the appearance of LNAPLs (Figure 4 & 5). These monitoring wells will be sampled semiannually for the first five years, annually for the next five years (staggered to account for seasonality), biennially for the next ten years and every five years thereafter. The contingency, if LNAPL is seen migrating, is to resume year round pumping. In addition, Chevron will analyze alternate LNAPL recovery mechanisms (including focused aggressive source removal technologies such as air sparging and solvent flushing (SEAR)) and propose a recommended alternative for U.S. EPA review. Chevron shall implement additional remedial measures to ensure containment of the LNAPL plume.

The ongoing performance monitoring program will include close monitoring of the LNAPL and dissolved plumes along the Great Miami River to ensure that discharges to the river do not occur. Should this monitoring indicate that the LNAPL plume is not stable in the area adjacent to the river, special engineered barriers to LNAPL migration will be implemented along the river. Residual (immobile) LNAPL has been observed along the river bank. This residual has been observed to be released to the river during periods of high river flow due to bank scour and sloughing of contaminated soils along the river bank at the refinery and in Gulf Park. To eliminate such releases, the proposed remedy may require the installation of engineered structures along contaminated portions of the bank to stabilize the bank and prevent sloughing of contaminated soil into the Great Miami River.

Since the LNAPL plume, more specifically the benzene and related volatile compounds contained in the LNAPL, are the source of contaminants in the dissolved plume, the proposed remedy includes measures to remove as much LNAPL from the subsurface as is practical. The LNAPL recovery operations conducted to date as an interim measure have demonstrated diminishing returns. The remaining LNAPL is held in the LNAPL smear zone located above and below the water table. Most of this LNAPL is contained below the normal water table elevation and is only available for recovery during periods of low water table elevations, typically early fall to mid-winter. The proposed remedy includes a scheme of pumping during periods of naturally occurring low water table to further lower the water table in order to exploit this LNAPL behavior. This scheme has been termed high grade pumping. High grade pumping involves concentrated pumping during periods of naturally occurring low water table elevation to further lower the water table in a localized area and enhance the recovery of LNAPL in that area. High grade pumping will be operated in areas where significant quantities of potentially recoverable LNAPL are known to exist starting in the northwest corner of the facility near Hooven and the Southwest Quadrant and progressing eventually to other areas more centrally located in the facility. LNAPL recovery operations during periods of normal and high water table elevations will be suspended since recovery of reasonable amounts of LNAPL is no longer possible during these periods. At the time of the 5 year review, we will evaluate the high grade LNAPL recovery systems' performance to make sure we have controlled the sources of releases so as to reduce or eliminate, to the extent practicable, further releases of hazardous waste (including hazardous constituents) that might pose threats to human health and the environment. The high grade pumping program will continue to recover LNAPL from the subsurface until this approach is no longer capable of efficiently recovering further LNAPL.

Depletion of benzene and related volatile compounds in the LNAPL is necessary to meet the long-term corrective action goal of returning groundwater to its most beneficial use and meeting MCLs. This depletion is expected to occur through a number of processes in addition to biodegradation. Benzene is removed from the LNAPL by dissolving into groundwater passing through the smear zone. Benzene also continues to volatilize from the shallow portion of the smear zone into the air contained in the vadose zone overlying the water table. Operation of the SVE system beneath Hooven during periods of high grade pumping is included in the remedy to further accelerate volatilization during these periods. The recovery of LNAPL through the high grade pumping program is also intended to directly remove source material. Modeling and other analysis have resulted in predictions that these mechanisms should remove sufficient benzene and related compounds from the LNAPL to achieve the long-term performance measure of attaining MCLs in groundwater within 30 years. In order to verify that these predictions are correct, the performance monitoring component of the remedy includes periodic investigation of the LNAPL extent and composition, combined with appropriate analysis of these data, to confirm the timely achievement of the long-term performance measure. MNA parameters should be collected and analyzed on a 5 year interval to properly gauge progress of predicted attenuation of the hydrocarbons in the subsurface, Appendix 1 contains the *U.S. EPA Region 5 Framework for Natural Attenuation Decisions for Groundwater* which lays out a flowchart for decision making and indicator parameters to test for in the field. Should this performance monitoring indicate that MCLs will not be achieved in a timely manner, i.e., within thirty years, additional removal of LNAPL must be implemented by Chevron. Chevron will evaluate alternatives and submit its recommended alternative to U.S. EPA for its review.

The remedy includes a number of institutional and engineering controls to address any potential exposures that may occur during the interim remedial period. The institutional controls shall be established in a manner to be legally enforceable against existing and future property owners, and shall include the following use restrictions:

1) Land use restrictions on the facility property which are consistent with the soil cleanup standards and anticipated future land uses;
2) Prohibitions on construction of basements or other sub-grade areas for human occupancy on the facility;
3) Prohibitions on potable use of ground water on the facility; and
4) Notice to existing and future owners of off-site properties situated above the plume emanating from the Chevron facility of prohibitions on well installation contained in Ohio Revised Code Sections 3745-09-04.

The restrictions in 1) through 3) above will be in the form of restrictive covenants that run with the land in conformance with the Ohio Universal Environmental Covenants Act, Ohio Revised Code Section 5301.80 to 5301.92.

The remedial activities described in this section, including the land use controls, are designed to allow for redevelopment of the refinery property during site remediation before final remedial goals have been met.

The company will have to provide an assurance that adequate financial resources are available for implementation of the remedy. The performance measures of the proposed remedy can be viewed in terms of the receptors potentially impacted by the LNAPL and groundwater plumes. These receptors can be grouped into the following categories based on location: 1) human receptors in Hooven, 2) human receptors in the Southwest Quadrant, 3) the Great Miami River, 4) groundwater at and beyond the POC, and 5) on-site receptors. The strategy of the proposed remedy for protecting each of these potential receptor groups is discussed below.

<u>Human Receptors in Hooven</u>: The LNAPL and dissolved groundwater plumes lie beneath a portion of Hooven. The principal potential exposure pathway to human receptors in Hooven is inhalation of constituents volatilized from the LNAPL and migrating through soil vapor to the surface. The performance measures for Hooven are (1) to ensure that no constituents from the Chevron plume exceed risk based residential standards in soil vapor at the ground surface (these standards are identified in U.S. EPA Office of Solid Waste and Emergency Response (OSWER) Draft Vapor Intrusion (VI) Guidance, 2002); (2) to remove as much LNAPL and associated volatile constituents from the LNAPL plume beneath Hooven, as is practical; and (3) to stabilize the LNAPL plume beneath Hooven under natural gradient conditions.

Recent investigations have demonstrated that the vapor inhalation pathway is incomplete. Investigation of contaminant concentrations in subsurface vapor have demonstrated that benzene quickly attenuates through biodegradation. To ensure that this pathway does not pose any unexpected risks in the future, the proposed remedy includes ongoing soil vapor monitoring beneath Hooven. The vapor monitoring wells that will be tested are nested vapor wells 93, 96, 99 and 129. These wells will be sampled at 5, and 10 feet below ground surface and at 10 foot intervals to the groundwater table. These nested vapor wells will be tested once per year for the first five years, then every three years thereafter. If conditions permit, the samples will be collected when the water table altitude is at or below 463.5 ft-elevation for one week or longer, and before the HSVE system is operated. In addition, the SVE system installed beneath Hooven will continue to operate during periods of low water table when the high grade pumping is performed. The operation of the SVE system at this time will serve both to capture any volatile constituents vaporizing from the smear zone and to further deplete these constituents from the upper portion of the LNAPL smear zone beneath Hooven, thus reducing the future source of benzene vapor beneath Hooven. If vapor samples show that there is a complete pathway from groundwater to the surface in concentrations exceeding the risk-based levels, Chevron shall implement measures to prevent the vapors from intruding into homes in Hooven. Such measures may include year-round groundwater pumping, operation of SVE, and/or other engineered control(s), and installing vapor vents or other engineered controls in foundations.

The high grade pumping program during periods of low water table will similarly remove LNAPL from beneath Hooven, further reducing the source of benzene and stabilizing the LNAPL plume beneath Hooven. The monitoring wells outside the smear zone will be tested to insure no new LNAPL appearance. The monitoring wells to insure LNAPL stability will be sampled semiannually for the first five years, annually for the next five years, staggered (to account for seasonality) biennially for the next ten years, and every five years thereafter. The contingency, if LNAPL is seen migrating, is to resume year-round pumping and re-evaluate alternate NAPL recovery techniques, which may include focused aggressive source removal (e.g. air sparging, solvent flushing etc.).

Human Receptors in the Southwest Quadrant: The LNAPL and dissolved groundwater plumes also lie beneath the western portion of the Southwest Quadrant. The principal potential exposure pathways to the human receptors in the Southwest Quadrant include the extraction and use of contaminated groundwater and inhalation of benzene through vapor migration of benzene to the ground surface. The performance standards in the southwest quadrant are to protect human receptors from exposure to contaminants in groundwater and to stabilize the LNAPL and groundwater plumes in this area. The proposed remedy includes engineering and land use controls addressing the potential human exposures in the Southwest Quadrant. These controls include the installation of vapor barriers in buildings in these areas, and a statutory prohibition on groundwater use on the installation of wells where known contaminants will be conducted to a well. The high grade pumping scheme is designed to remove LNAPL from beneath the Southwest Quadrant and further stabilize the LNAPL plume in this area. Monitoring of the LNAPL in the Southwest Quadrant will be accomplished using Rapid Optical Scanning Technology (ROST) wells in three or four transects. These will be located outside the smear zone and monitored semiannually for first five years, annually for next five years, staggered (to account for seasonality) biennially for next ten years, every five years thereafter. If LNAPL is detected at these ROST wells then Chevron must resume year-round pumping until compliance is restored, and re-evaluate alternate LNAPL recovery techniques. The contingencies could include focused aggressive source removal (e.g. air sparging, solvent flushing etc.)

Great Miami River: The performance standards for the Great Miami River are to (1) prevent any NAPL migration to the river and (2) to prevent the development of a NAPL sheen in the river. The performance standards for the Great Miami River also include (3) the prevention of any discharge of dissolved constituents to the river above appropriate Ohio EPA surface water standards. While preliminary studies appear to indicate that the LNAPL plume will be stable under natural gradients in the vicinity of the river, the proposed remedy requires engineered or hydraulic barriers to contain the LNAPL plume should performance monitoring fail to demonstrate that the LNAPL plume is stable in the area near the river. The monitoring program includes surface and groundwater monitor locations along the Great Miami River, with "early" warning components and monitoring locations at the river bank/smear zone interface. Monitoring includes piezometers and monitoring wells near the river and wells to sample pore space in river sediment. The frequency and locations of sampling are to be determined depending on river study findings. Locations known today where sampling and stabilization are needed are at the refinery and Gulf Park. If OEPA surface water standards are exceeded or sheens appear on the Great Miami River, then the contingency is to resume year-round groundwater pumping until compliance with the standard is restored. In addition, Chevron will evaluate contingency alternatives, including perimeter treatment system (e.g. sparge curtain, funnel/gate etc.), aggressive source removal (e.g. air sparging, SVE, solvent flushing (SEAR) etc.), and implement additional corrective measures if necessary to meet the performance standard of allowing no migration of LNAPL or dissolved constituents into the river above OEPA surface water standards. Chevron shall analyze alternatives and submit its recommended alternative to U.S. EPA for its review.

Groundwater at and Beyond the Point of Compliance (POC): The performance standard for the proposed remedy in the downgradient area of the plume is to prevent the migration of LNAPL or dissolved constituents above appropriate regulatory levels (i.e., MCLs) beyond the POC. This POC will be established at the approximate boundaries of the current plume. Thus, the proposed remedy is designed to prevent any further expansion of either the LNAPL or dissolved phase plumes. It is expected that expansion of the LNAPL plume will be prevented by the natural stabilization of the plume. The benzene and related petroleum compounds that emanate from the LNAPL source are generally biodegradable in groundwater. On-site monitoring has confirmed that natural attenuation stabilizes the dissolved plume emanating from the LNAPL plume. Consequently, it is expected that the migration of the dissolved plume will be controlled by MNA. Monitoring of the plume is key; therefore sampling will be conducted semiannually for the first five years, annually for the next five years, (staggered to account for seasonality) biennially for the next ten years, and every five years thereafter. This performance monitoring will confirm if MCLs for groundwater will be exceeded at six monitoring wells near the POC and no LNAPL detections in the three or four transects of ROST wells mentioned above. However, should either plume prove not to be stable, Chevron will resume year-round pumping until compliance is restored. In addition, Chevron will evaluate contingency alternatives, including perimeter treatment system (e.g. sparge curtain, funnel/gate etc.), aggressive source removal (e.g. air sparging, SVE, solvent flushing etc.), and implement additional corrective measures if necessary to meet the performance standards of allowing no migration of LNAPL or dissolved constituents above MCLs beyond the POC. Chevron will evaluate alternatives and submit its recommended alternative to U.S. EPA for its review.

On-Site Receptors: The performance standards for protecting people who will be working on-site in the future are (1) to prevent exposures to vapor constituents, (2) prevent exposure to soil containing residual contamination, and to (3) prevent groundwater use. These standards are to be met, in part, by implementing engineering controls (e.g., vapor barriers) in buildings during the redevelopment of the property. In addition, institutional controls that prevent exposure to groundwater and residual contamination in soils will be implemented in an expeditious fashion. See the discussion of appropriate land and groundwater use restrictions to be implemented in Section VII. Scope of Proposed Remedy - Alternative 2.

VIII. PUBLIC PARTICIPATION

U.S. EPA solicits input from the community on the corrective measures proposed for clean up of contaminated groundwater. The public is also invited to provide comment on corrective measure alternatives not addressed in this SB. U.S. EPA has set a public comment period from April 12, 2006 through May 30, 2006, to encourage public participation in the selection process. The comment period will include a public hearing where U.S. EPA will present the investigation results and the proposed remedy, answer pertinent questions, and accept oral and written comments. In addition, written comments will be accepted by U.S. EPA up to the close of the comment period.

The public hearing is scheduled for May 9th, 2006, at the Whitewater Senior Center and Township Hall, 6125 Dry Fork Road, Whitewater Township, Ohio.

The Administrative Record for the Chevron Facility is available at the following locations:

Public Library of Cincinnati
Miami Township Branch
8 N. Miami Rd.
Cleves, OH 45002

U.S. EPA, Region 5
Waste, Pesticides and Toxics Division Records Center
77 West Jackson Boulevard, 7th Floor
Chicago, Illinois 60604-3590
(312) 886-0902
Hours: Mon-Fri, 8:00 a.m. - 4:00 p.m.

General information about the site is available on U.S. EPA's Web page:
epa.gov/region5/sites/chevron

After consideration of the comments received, U.S. EPA will select the remedy and document the selection in the Final Decision and Response to Comments. In addition, public comments will be summarized and U.S. EPA's response provided. The Final Decision and Response to Comments will be drafted at the conclusion of the public comment period and incorporated into the Administrative Record.

To send written comments or request technical information on the Chevron facility, please contact:

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FIGURES

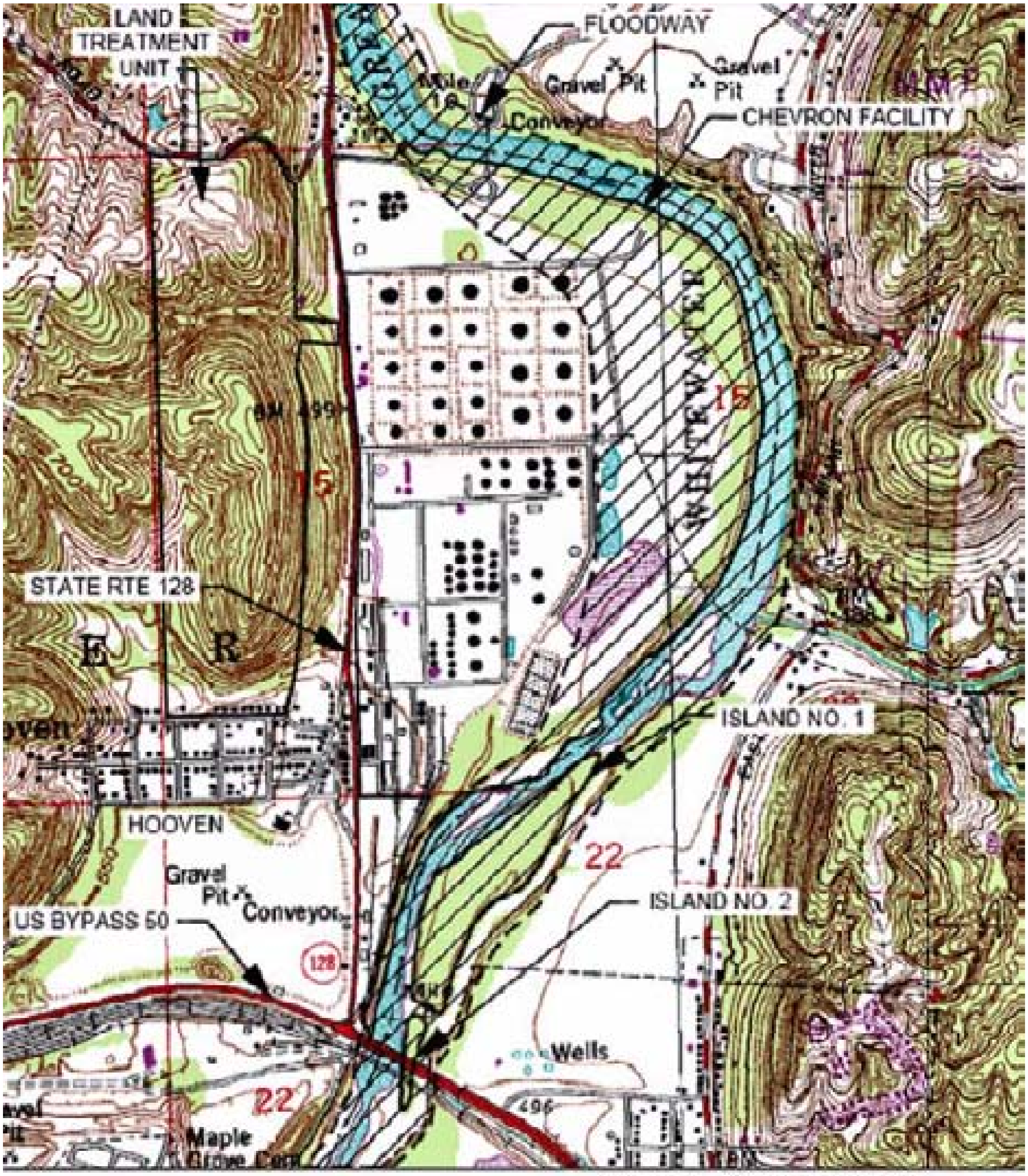

Figure 1. Site Location and Former Facility Layout Map Chevron Cincinnati Facility Site, Hooven, Ohio

Figure 2.
Future Land Use Figure:
Mixed Use Scenario

Chevron Cincinnati
Facility Site,
Hooven, Ohio

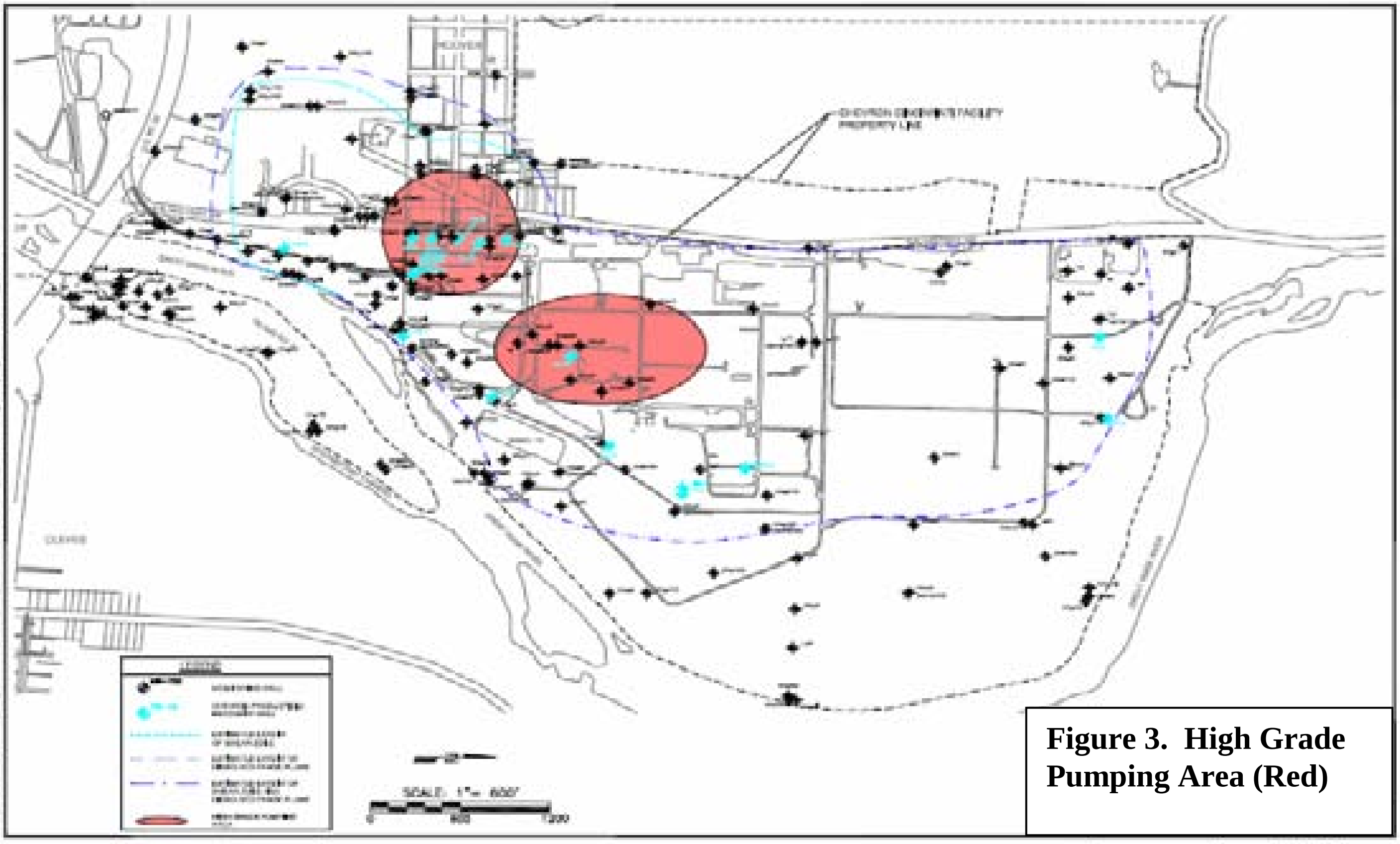

Figure 3. High Grade Pumping Area (Red)

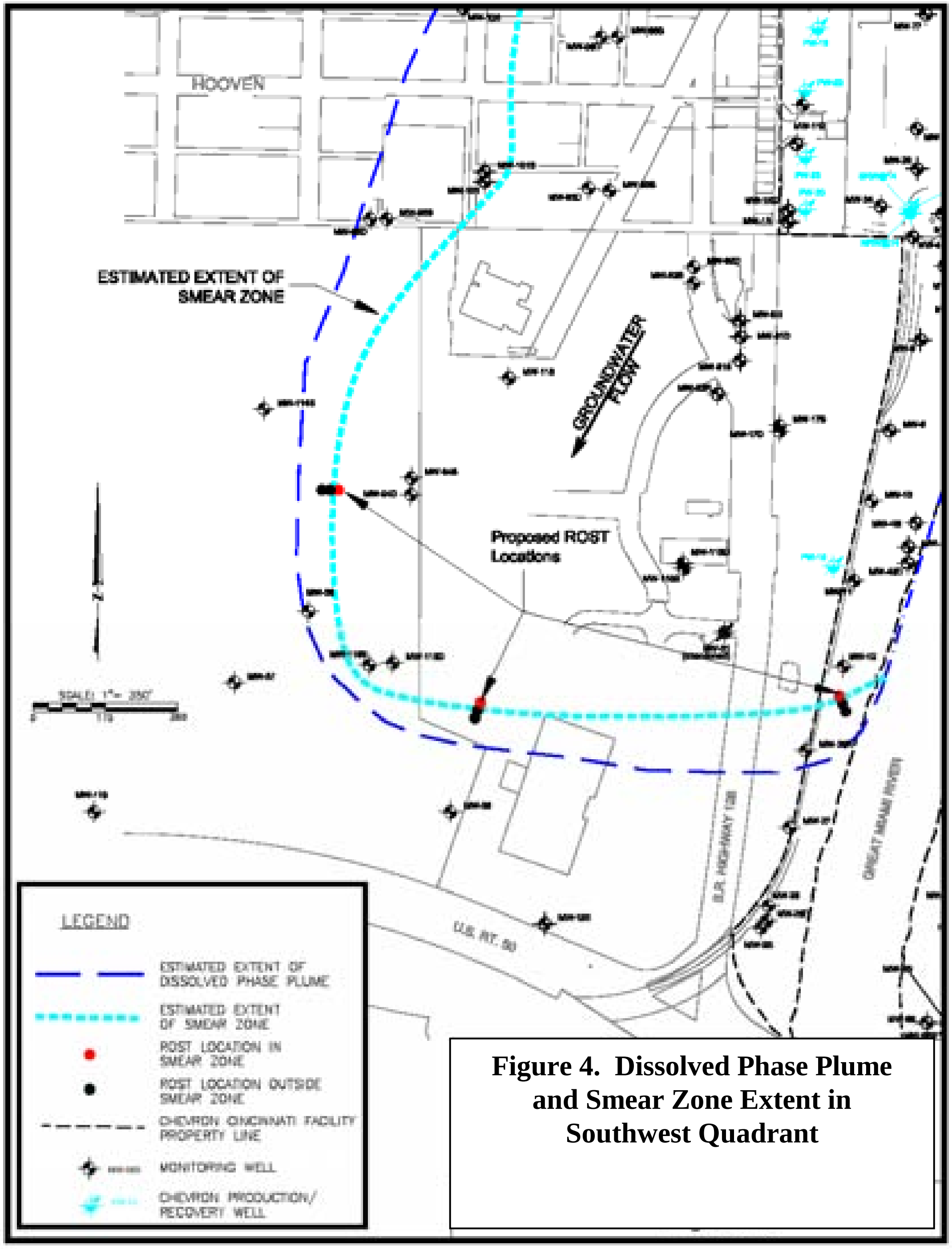

Figure 4. Dissolved Phase Plume and Smear Zone Extent in Southwest Quadrant

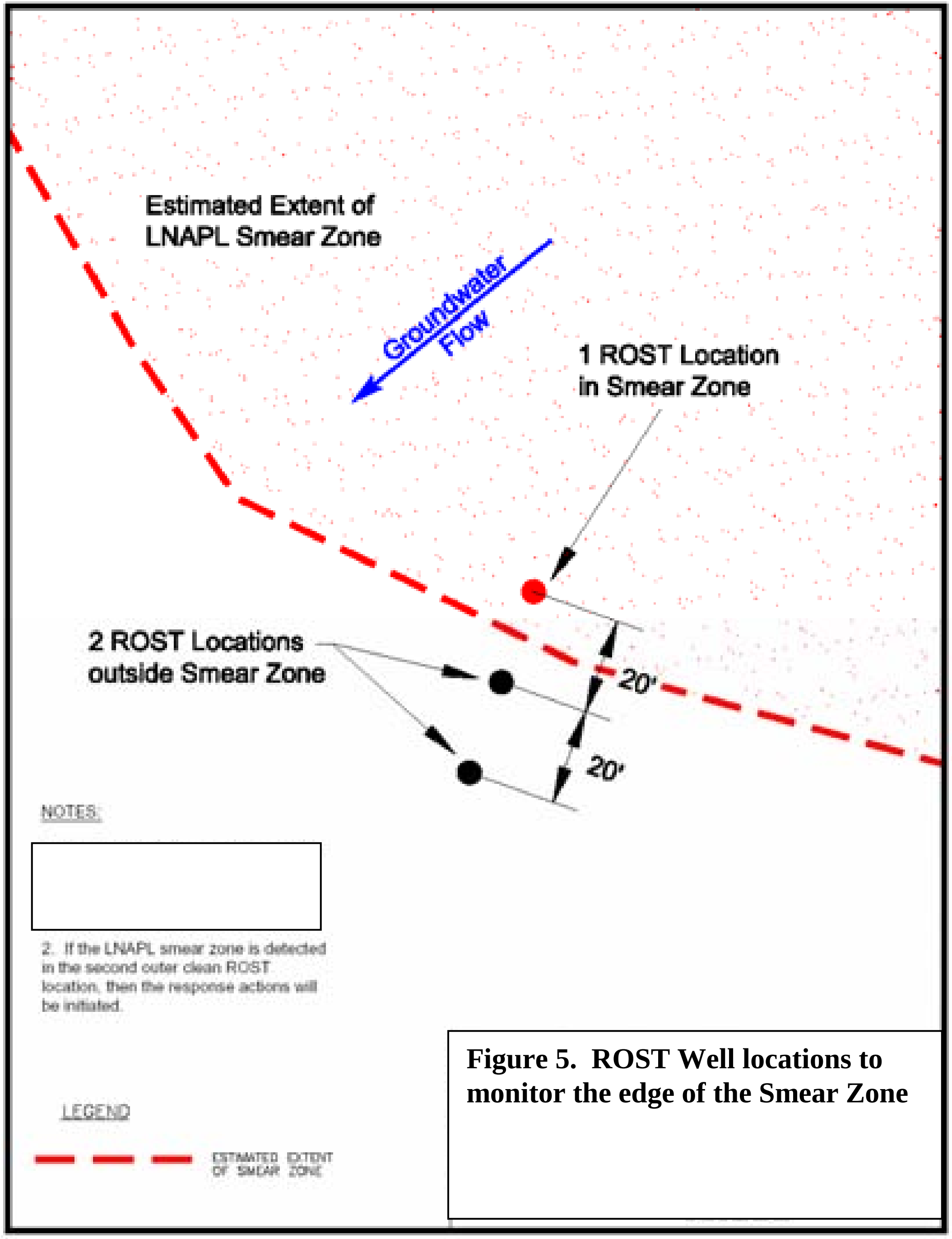

Figure 5. ROST Well locations to monitor the edge of the Smear Zone

APPENDIX 1
Region 5 Framework for Monitored Natural Attenuation Decisions for Groundwater
September, 2000