

**STATEMENT OF BASIS/PROPOSED FINAL REMEDY
DECISION
Area of Concern (AOC) #1**

REGION II
VID 980536080

HOVENSA L. L. C.
Christiansted, St. Croix, USVI
February 14, 2008

Facility/Unit Type:	Active Petroleum Refinery
Contaminants:	phase-separated liquid hydrocarbons (a/k/a "free product" or oil)
Media:	AOC 1 - Areas where underground phase-separated hydrocarbon plumes are located (site-wide)
Remedy:	Total Fluid Recovery, Vacuum Enhanced Recovery, and Monitored Natural Attenuation

FACILITY DESCRIPTION

In 1999, in the renewed RCRA Part B Permit, the United States Environmental Protection Agency (EPA) designated several Areas of Concern (AOCs) for purposes of conducting corrective action for groundwater at HOVENSA. Area of Concern 1 is the designation for areas where Phase Separated Hydrocarbons (PSH) plumes are located. This Statement of Basis describes the status of the Area of Concern 1 areas at the site.

The HOVENSA refinery is situated on approximately 1,500 acres located on the south central coast of St. Croix. Oil refining, chemical processing, storage, and handling activities have been conducted at the site for over 40 years by HOVENSA and its predecessor HOVIC. During that time, process-derived wastes were managed in surface impoundments or treated in landfarms. Historic operations at the refinery, including storage and handling activities, have resulted in impacts to soil and groundwater.

St. Croix has a semi-arid tropical climate typical of Caribbean islands. The mean monthly temperature ranges from 76 to 82 degrees Fahrenheit. Annual rainfall averages 39 inches per year with a standard deviation of 13.5 inches per year. Most of the precipitation occurs during two seasonal periods, in May and June, and September through November.

In the area of the Refinery, limestone, lagoonal clay and fill compose the near surface lithologic units. In the northern portion of the facility, limestone predominates, while lagoonal clay overlain by fill material is common in the southern portion of the facility. The fill covers the majority of the site and is present as a thin layer in the northern portion of the Refinery. It occurs above the water table in most areas where the lagoonal clay is

absent. Where the fill is absent, the Kingshill limestone constitutes the surface material.

The reported depth to groundwater ranges from 6 feet to over 100 feet across the site. Groundwater beneath the site is not potable and is not utilized for drinking or domestic purposes. In particular, the Kingshill limestone is characterized by high levels of sodium and chloride. The site abuts the Caribbean Sea along the south shoreline. In this area the shoreline is primarily used for shipping and commercial purposes.

The site is located in the Southern Industrial Complex and the shoreline near the HOVENSA facility is used as an industrial park. This is in accordance with the policies of the Virgin Islands Industrial Act of 1963. Light industrial zones are adjacent to the central heavy-industry area. Presently, most of the land surrounding the industrial area is characterized by unimproved shrub thickets and grasslands. Adjacent properties include industrial/commercial land with residential areas along the perimeter to the north and northeast.

Under the 1965 Agreement between the Virgin Islands Government and HOVIC, as amended, the use of the site as an oil refinery is deemed to comply with zoning and land use law. The Legislature and the Governor confirmed the use of the refinery site again in 1998 with approval of the creation of the joint venture between HOVIC and Petr6leos de Venezuela S.A. (PDVSA) V.I. The long term use and the future of the site as a refinery are stipulated in the 1998 Amendment Agreement, which will remain in place ensuring use of the site as a refinery until year 2022.

PRIOR INVESTIGATIONS AND OTHER ACTIONS

In 1982, HOVIC discovered PSH in the subsurface below the gasoline blending area. HOVIC conducted an initial investigation and began PSH delineation and recovery operations under its Hydrocarbon Recovery Project (HRP).

Since then, HOVIC/HOVENSA, in coordination with the EPA, has implemented the Hydrocarbon Recovery Project as an Interim Corrective Measure (ICM) to mitigate the risk to the environment and human health arising from the presence of Phase Separated Hydrocarbon on the groundwater table and to prevent the associated dissolved-phase hydrocarbon plumes from migrating into Limetree Bay, Krause Lagoon, or the Caribbean Sea. The goals of the ICM/HRP program are 1) Source Identification, 2) Containment, and 3) recovery of the Phase Separated Hydrocarbon. The program was incorporated into the RCRA Part B Permit in November 1, 1999, and is ongoing.

Also, as part of the ICM, investigations and evaluations have been performed to establish hydraulic control, such that any off-site migration of the released PSH was stopped and existing PSH plumes would be contained on-site at the facility, and recovered. Further evaluations have been implemented as part of the Corrective Measures Study (CMS) required under the 1999 RCRA Permit, so as to identify all remaining areas of PSH requiring remedial measures, and determine the proposed final remedy for those areas.

A CMS has been performed for the AOCs at the site, and has been approved by EPA. The CMS identified 25 Potential Remedial Areas (PRAs) within AOC #1, which underwent further evaluation to determine if they posed an unacceptable risk to human health and/or the environment. The CMS evaluation included a tiered human health risk assessment to determine if further action for a PRA was required to mitigate risk and prevent human exposures. Final tier site-specific evaluations used the industrial value for total carcinogenic risk of 1E-04 (1 in 10,000 chance of contracting cancer) in industrial areas, 1E-06 (1 in 1,000,000 chance of contracting cancer) in residential areas, and used a Hazard Quotient of 1.0 across both residential and industrial areas. Any PRAs determined to require further action from the tiered human health risk assessment and site-specific evaluations were identified as Remedial Action Areas (RAAs). The final Corrective Measures Study report was approved by EPA on May 30, 2006. Of a total of 25 PRAs evaluated under AOC 1, results of the CMS analyses indicated that four of those should be classified as RAAs, and require further remedial measures to mitigate risk and prevent exposure.

As a part of the Corrective Measures Study, an Ecological Risk Assessment was also conducted for Constituents of Potential Ecological Concern associated with AOC #1. The Ecological Risk Assessment, completed in May 2004, determined that constituents present in the PSH on the groundwater did not pose an unacceptable risk to ecological receptors and/or the environment. The Ecological Risk Assessment was approved by EPA on June 7, 2004.

EXPOSURE PATHWAYS

Pathways for potential human exposure to the constituents within Phase Separated Hydrocarbon plumes on the groundwater underlying the site were evaluated. The potential human exposure pathways evaluated included: indoor air, outdoor air, groundwater, and tap water. However, consumption of tap water contaminated by PSH on the groundwater underlying the HOVENSA site is not considered a completed exposure point, as groundwater is not used for drinking or other domestic purposes, at the site, or down-gradient of it.

Potential human exposure receptor populations evaluated included: residents, workers, construction workers and trespassers. Trespassers are prohibited by physical access restrictions, including fencing and security. Potential exposure pathways include inhalation, ingestion, and direct/dermal contact. These pathways were considered in the site-specific human health risk assessment implemented as part of the Corrective Measures Study. Areas posing unacceptable potential human health risks were classified as the RAAs.

The Ecological Risk Assessment (ERA) completed as part of the CMS did not identify any unacceptable risk to ecological receptors and/or the environment. Although the ecological exposure pathway to freshwater aquatic organisms and habitats is considered complete, via discharge of contaminated groundwater to surface water, no concentrations of Constituents of Potential Ecological Concern were indicated in the ERA to be above generally accepted ecological benchmarks where groundwater discharges to the surface water. Potential exposure pathways to terrestrial wildlife receptors were evaluated via direct uptake and ingestion. However, since the site is industrial and most of the refinery is paved, the ERA concluded that unacceptable risks to ecological receptors by exposure to constituents present in subsurface Phase Separated Hydrocarbon via incidental ingestion of soil and/or exposure through the food web are not indicated based on current site usage conditions.

The Least Tern (*Sterna antillarum antillarum*), a locally listed endangered species, is the only endangered species indicated to inhabit the refinery property. However, other

habitats are indicated to occur in the vicinity of the facility in the off-site areas. Threatened and endangered species listed for St. Croix near HOVENSA include eleven animal and 3 plant species as federal threatened or endangered species. Among these fourteen species, four species are threatened; they are green sea turtle (*Chelonia mydas*), loggerhead sea turtle (*Caretta caretta*), the least bittern (*Lxobrychus exilis*), and the roseate tern (*Sterna dougallii dougallii*). The remaining ten species are listed as endangered species; St. Croix ground lizard (*Ameiva polops*), brown pelican (*Pelecanus occidentalis*), peregrine falcon (*Falco peregrinus*), hawksbill sea turtle (*Eretmochelys*

imbricate), leatherback sea turtle (*Dermochelys coriacea*), Caribbean monk seal (*Monachus tropicalis*), finback whale (*Balaenoptera physalus*), sperm whale (*Physeter catodon*), VI tree boa (*Epicrates monensisgranti*), and plants (specifically for St. Croix) including *Catesbaea melanocarp*, and Vahl's Boxwood (*Buxus vahlii*), and lignum vitae (*Guajacum officinale*). In addition to the federally listed plants, twelve species are locally listed for St. Croix. However, only one plant, Lignum vitae (*Guajacum officinale*) has been identified in the vicinity of HOVENSA.

CONTAMINATION DETECTED AND CLEANUP GOALS

During the Corrective Measures Study analyses, Constituents of Concern within the Phase Separated Hydrocarbon which are volatile and could exceed the site-wide action levels were identified. Constituents that were not determined to exceed the conservative threshold values in the analyses or were not volatile were not retained for further analyses and are not listed below. Constituents that exhibited like properties were considered together where feasible and conservative surrogate properties were used.

Media	Estimated ¹ volume	Contaminants	Maximum Concentration	Action Level	Cleanup Goals	Point of Compliance
PSH ("free product"/oil) floating on Groundwater	1,504,600 gallons ² (35,824 barrels) of PSH ("free product"/oil) in or on the groundwater as of June 2007	benzene, ethylbenzene, toluene, xylenes, naphthalene, C ₅ to C ₈ aliphatics, C ₉ to C ₁₂ aliphatics and C ₉ to C ₁₀ aromatics.	not applicable	PSH thickness greater than 0.2 ft (as measured in monitoring well)	PSH thickness less than 0.2 feet at AOC #1 compliance boundary and an indicated PSH velocity of less than 0.1 feet per day	less than 0.2 feet PSH at AOC #1 RAA compliance boundary; PSH velocity of less than 0.1 feet per day within RAA boundary
Air (vapor intrusion from subsurface PSH volatilization)	Not determined	benzene, ethylbenzene, toluene, xylenes, naphthalene, C ₅ to C ₈ aliphatics, C ₉ to C ₁₂ aliphatics and C ₉ to C ₁₀ aromatics.	not applicable	Unacceptable human health threat via vapor intrusions due to volatilization of subsurface PSH.	No unacceptable human health threats via vapor intrusions due to volatilization of subsurface PSH.	On-site residential Indoor and outdoor air

¹ Remaining phase separated hydrocarbon ("free product"/oil) in or on the groundwater. Through June 30, 2007, 41,707,500 gallons (993,037 barrels) of phase separated hydrocarbon ("free product"/oil) have already been recovered under the HRP/ICM. Refer to "Corrective Action Status Report, 1st Semiannual Report 2007", dated August 15, 2007.

² Refer to Appendix B of "Corrective Action Status Report, 1st Semiannual Report 2007", dated August 15, 2007.

SELECTED REMEDY

Proposed remedies were selected by the May 2006 Corrective Measures Study (CMS) Final Report to remediate Phase Separated Hydrocarbon (PSH) and remove volatile constituents from the groundwater. These proposed remedies will be implemented as described in the February 2008 Corrective Measures Implementation (CMI) work plan. PSH recovery via “Total Fluid Recovery” and Vacuum Enhanced Recovery systems has been shown to be effective as part of the on-going Hydrocarbon Recovery Project/Interim Corrective Measure.

Through active down-hole pumping, Total Fluid Recovery creates a cone of depression in the water table, which induces a gradient towards the recovery well and draws both impacted groundwater and Phase Separated Hydrocarbons towards the well. Both groundwater and Phase Separated Hydrocarbons are extracted and pumped to any onsite oil/water separation and treatment system. This technology is particularly applicable because: a) it maximizes the volume of PSH recovered; and b) produces hydraulic control and containment of both Phase Separated Hydrocarbon and associated dissolved plumes. Total Fluids Recovery is primarily effective in high permeability areas.

Vacuum Enhanced Recovery uses one pump to recover vapor, Phase Separated Hydrocarbon, and water. This method extracts Phase Separated Hydrocarbon from the water table and the associated “capillary fringe” above the water table. Vacuum Enhanced Recovery allows for removal of the Phase Separated Hydrocarbon with minimal depression of the water table. Minimizing changes in the water table also minimizes the creation of “smear zones” due to water table fluctuations. It improves remediation efficiency without extracting large quantities of groundwater. In addition, Vacuum Enhanced Recovery acts to remediate residual Phase Separated Hydrocarbon and enhance bioremediation by drawing air through the unsaturated zone. This method is less effective in low permeability soils than in high permeability soils, but is likely more effective than Total Fluids Recovery in low permeability areas.

These remedial technologies were indicated to be applicable at the site and have a proven track record of effectiveness. Total Fluid Recovery technologies are indicated to be effective in areas where fluid thicknesses are sufficient and permeability is great enough to recover total fluids. Vacuum Enhanced Recovery is effective in both low permeability zones and areas with minimal fluid availability, as well as in areas of high permeability and high fluid availability. Vacuum Enhanced Recovery may also involve the use of vacuum trucks to supplement activities in localized areas.

Monitored Natural Attenuation (MNA) encompasses all in situ processes within the aquifer that decrease dissolved concentrations. These processes may include dilution, dispersion, volatilization, biodegradation, adsorption, and chemical interaction with aquifer materials. Of these processes, biodegradation is considered the most important in the remediation of groundwater at the HOVENSA site. Monitored natural attenuation is considered a secondary remedy after cleanup goals have been reached to assure protectiveness of human health and the environment.

Currently, the remedial measures described above are being implemented at the four identified AOC #1 Remedial Action Areas (RAAs), and the groundwater at those RAAs is being monitored to demonstrate the success of the remedial measures. These activities will be maintained as proposed in the Corrective Measures Implementation workplan until clean-up criteria are satisfied. In addition, groundwater monitoring will continue at a dissolved constituent monitoring well network around the perimeter of the HOVENSA facility to confirm that should any unforeseen, future offsite migration of PSH and/or dissolved constituent plumes occur, it will be detected and addressed.

The costs to complete the corrective measures remedies associated with Areas of Concern 1, 2 & 3 at the HOVENSA Refinery is estimated to be \$28,050,000 in present day costs. It is assumed that the site will remain an industrial facility for the next 30 years, and the final corrective measures remedies will be completed within the 30 year timeframe.

It should also be noted that the Remedial Action Areas and the recommended remedies and clean-up goals discussed in this Statement of Basis are based on current site-usage as an industrial facility. If the site ceases to be utilized as a petroleum refinery, additional corrective measures may be necessary to achieve an acceptable, i.e., unrestricted site clean-up.

INNOVATIVE TECHNOLOGIES

Vacuum Enhanced Recovery

PUBLIC PARTICIPATION

A public meeting to discuss this proposed remedy decision is scheduled to be held on March 12, 2008 in St. Croix.

NEXT STEPS

Implement the February 2008 Corrective Measures Implementation Work Plan, and Continue semiannual

monitoring and reporting. Perform assessment of remedial operations at defined Remedial Action Areas on an annual basis to ensure continued progress towards remedial goals. Perform a review of the risk assessment

every five years to determine if any conditions have changed warranting that a revised risk assessment be performed.

KEY WORDS

Groundwater, Phase Separated Hydrocarbon, Inhalation, Refinery, Organics, Monitoring, Recovery, Vacuum Enhanced Recovery, Air Sparging, Volatile Organic Compounds, Area Of Concern 1, Natural Attenuation

CONTACT

Timothy Gordon
U.S. Environmental Protection Agency (EPA), Region 2
Gordon.timothy@epa.gov
(212) 637-4167