HOW CHEVRON'S SAMPLING AND ANALYSIS METHODS MINIMIZES EVIDENCE OF CONTAMINATION

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I. INTRODUCTION

This report analyzes the sampling and analysis approach used by Chevron-Texaco in its remediation in the mid-1990s and in the ongoing *Aguinda v. ChevronTexaco* litigation in Ecuador. The lawsuit has been filed by residents of the Oriente region in Ecuador against the multi-national oil company for damages related to operation of a former Texaco concession in the Amazon rainforest that Texaco operated from 1964 to 1990. This report was prepared in accordance with Article 42 of Ecuador´s Law of Environmental Management. It is based on (a) visits to several former Texaco well sites in Ecuador; (b) an analysis of technical reports submitted as part of the trial by Chevron's court-appointed experts; and (c) an analysis of Chevron's own reports summarizing its "remediation" of the former concession area.

For the reasons stated below, we conclude that Chevron has and is using a sampling and analysis approach in its remediation and in the Ecuador litigation that is based on a deeply flawed conceptual model and that yields misleading results. The results from this approach minimize or hide the existence of toxic contamination from both the court and nearby residents who live in risk of harmful exposure resulting from Texaco's practices.

II. QUALIFICATIONS

This report was prepared by Dr. Ann Maest, an aqueous geochemist; Mark Quarles, a registered professional geologist; and William Powers, a professional engineer with expertise in the petroleum field. Dr. Maest has expertise in the fate and transport of contaminants in groundwater, surface water, and sediments. Dr. Maest's research has been published in numerous peer-reviewed journals, including *Applied Geochemistry*, *Canadian Journal of Fisheries and Aquatic Sciences*, *Chemical Geology*, *Applied and Environmental Microbiology*, and *Environmental Science and Technology*. Dr. Maest has served as an expert witness for the Department of Justice in federal environmental lawsuits, as a research geochemist at the U.S. Geological Survey, and has designed, conducted, and managed numerous groundwater and surface water hydrogeochemistry studies. Mr. Quarles has more than 20 years experience conducting

environmental investigations, including designing and implementing field sampling and analysis plans and corrective actions for petroleum hydrocarbons and inorganic contaminants. In addition, he has published peer-reviewed papers on contaminant fate and transport and corrective actions for petroleum hydrocarbons and volatile organic compounds. Mr. Powers has more than two decades of experience in environmental testing with emphasis in oilfield equipment, production fields, and oil refineries. He formerly worked for the Department of Defense retrofitting combustion processes and air contaminant emission control systems, and is a member of the Air & Waste Management Association, American Society of Mechanical Engineers, and International Gas Turbine Institute. Mr. Powers developed and led major hazard pollutant emission characterization programs for oil and gas production operations in Kern County, California. He also led an oilfield emission reduction workshop for PEMEX engineers in Mexico City. In addition, Mr. Powers has extensive experience in oilfield and energy project assessment in Peru, Mexico, Venezuela, and Chile.

III. SUMMARY OF CONTAMINANTS OF CONCERN

The lawsuit in question accuses Texaco (now Chevron) of systematically dumping crude oil, drilling muds, produced water, and other toxic wastes into the rainforest environment during its more than two decades of operation in Ecuador's Amazon region. Untreated crude oil contains a variety of toxic and carcinogenic petroleum hydrocarbons, including benzene, toluene, ethylbenzene and xylene (together known as BTEX), and polynuclear aromatic hydrocarbons (PAHs). Drilling muds and produced water not only contain significant amounts of crude oil but also typically contain dangerous quantities of the variety of highly-toxic lubricants, solvents, anti-corrosion agents used in the drilling process, and metals such as chromium, barium, cadmium, and lead. Wastes containing these chemicals were disposed of at the estimated 350 well sites where Chevron drilled and/or processed petroleum. Currently, technical experts for Chevron and the affected indigenous groups and communities are collecting and analyzing soil and water samples during judicial inspections of the sites that plaintiffs allege are contaminated. The sections below present an initial assessment of Chevron's sampling and analysis approach used in the trial and in their remediation effort.

IV. HOW CHEVRON'S SOIL SAMPLING PROGRAM MINIMIZES THE EXISTENCE OF CONTAMINATION

A. Chevron's Collects Soil Samples Locations Are Selected to Avoid Contamination

In the Ecuador trial, Chevron's hired technical experts are using a sampling and analysis program that meets neither minimum U.S. EPA guidelines nor the requirements of basic common sense. In several respects, the sampling practice of

Chevron's experts appears designed specifically to avoid finding contamination that would otherwise be obvious to any neutral technical expert.

i. Chevron Collects Soil Samples from Waste Pits in the Superficial, Recently-Added Layer of Topsoil

The main contaminants of concern in the waste pits at the former well sites in Ecuador are petroleum hydrocarbons and metals, both of which are toxic and can cause grave harm to human and ecological health over time. A substantial number of the former Texaco pits that the company claims to have "remediated" were instead simply covered with a two- to three-foot layer of clean topsoil in an operation overseen by Woodward-Clyde, an American company, in the mid-1990s. This top layer of soil was placed over an open-air waste pit that contained hydrocarbon contamination that was not adequately removed.[1] Today, there is typically little visual indication of petroleum hydrocarbons in this top layer of soil, as would be expected. However, soil just below this clean layer of soil is often wet with a clear, viscous liquid that smells strongly of petroleum hydrocarbons, even in supposedly "remediated" pits. This clearly suggests that underneath the clean layer of soil the petroleum hydrocarbons remain.

At the judicial inspections in the trial, experts for the affected communities observed strong indications of the presence of petroleum hydrocarbons when sampling the soils underneath the clean top layer. In contrast, experts for Chevron generally collected samples only at superficial levels that often did not penetrate the layer of "clean" soil that the company added during its "remediation." This simple difference in choice of sampling locations explains many of the discrepancies in analytical results: experts for the affected communities routinely found high contaminant concentrations at the same sites where Chevron experts found concentrations that were below toxic thresholds and local and international standards. That said, Chevron's laboratory results still show substantial levels of toxic constituents, which at some sites are far above U.S. EPA and Ecuadorian standards. Unfortunately, the Ecuadorian court has yet to assert its authority to demand that Chevron sample at locations and depths where hydrocarbons and metals exist at high concentrations. We conclude that Chevron's sampling method -- specifically its choice of sampling depths in the pits themselves -- is designed to minimize the presence of toxic contamination at its former sites.

ii. *Chevron Selects Sampling Locations Outside of Expected Contaminant Pathways*

Chevron's sampling approach also appears to be designed to avoid sampling contaminant pathways in the environment around the pits. When scientists or engineers

[1] The inadequacy of Chevron's remedial actions prior to pit closure is evident from a comparison of Chevron's own data at the time of the remediation with the data now emerging from the trial, 10 years later. For example, one pit at the Sacha-51 site was tested by Texaco in 1995 and showed concentrations up to 22,817 ppm of TPH. Texaco claimed to have remediated the pit below 5,000 ppm, but when tested again by plaintiffs during the trial, the site revealed no less than 29,657 ppm of TPH.

are looking for the effects of contaminants on the environment, sources of contamination must be identified, and pathways from the sources to groundwater and surface water must be examined for the presence or absence of the contaminants. At the sites in the Ecuadorian jungle, the sources in many cases are the waste pits where highly toxic drilling muds, oil, and produced waters were dumped. These pits are frequently located on areas of higher ground that slope steeply downward to marshes or streams. Even without doing a more detailed investigation, it is obvious that the most likely pathway for movement of petroleum hydrocarbons and metals is downhill from the pit toward the marsh or stream. Chevron's own experts concede this point, noting that "*Although there isn't sufficient information to calculate the groundwater flow patterns, it is inferred that, in general, the groundwater flows slowly toward the section of the river (drainage) that is closest*."[2] This is common sense. Yet Chevron's sampling approach almost never includes taking downgradient samples; to the contrary, Chevron's technical experts take samples upgradient of the sources – an approach that will always fail to find the pathways for transport of contaminants in the environment and that will minimize the extent of impacts of the source materials.

The well site SSF-13 in the Shushufindi field is a case in point. At a site visit on January 14, 2006, petroleum hydrocarbon contamination was obvious, by sight and smell, a few feet below the surface of the "remediated" pit and in a stream downhill from the pit. When the judicial inspection took place at SSF-13, the experts for the affected communities sampled the obvious contaminated soils and stream bank sediment. The experts for Chevron instead sampled areas uphill from the pit and across the stream in a downhill area that was clearly not hydraulically connected to the pit. These sampling approaches used by Chevron are disingenuous and obfuscate the truth. Not surprisingly, Chevron claimed its sample results showed acceptable levels of contaminants, whereas samples collected by the plaintiffs showed contaminant concentrations that far exceeded any relevant standards.

B. Chevron's Water Sampling Program Lacks the Necessary Site-Specific Analysis

Chevron's water sampling program is particularly flawed in light of the heightened complexity and rigor required to adequately detect and calculate water contamination. Standard site investigation practices for soil, surface water and groundwater investigation require that a company take a variety of steps to determine the horizontal and vertical extent of the contamination, and sample from the areas that are expected to contain the highest concentrations of contaminants.[3] Chevron met none

[2] Report of John Conner, P.E., P.G., D.E.E., *Judicial Inspection – Sacha Central Station*, Nov. 4, 2005, p. 51.

[3] US EPA, Superfund Program Representative Sampling Guidance, Volume 1, Dec. 1995, at Pages 1-5. It is important to note that throughout this analysis we look to US EPA guidance and standards only in order to supplement areas that may not be as well-defined in Ecuadorian environmental standards. This is different from Chevron's use of US EPA norms to *displace* Ecuadorian norms, which are clearly more appropriate given that this case is Ecuadorian in every respect except the nationality of the defendant.

of these basic requirements -- although, ironically, the company appears to have developed a rudimentary understanding of site characteristics sufficient to design conceptual site models that avoid finding contamination even at highly contaminated sites. In Chevron's conceptual model, for example, contaminants and groundwater are apparently capable of defying gravity and flowing uphill, to the locations where Chevron ultimately decides to take its samples. After taking samples in inappropriate locations, Chevron concludes that their results demonstrate that site groundwater is not contaminated. However, as the legally responsible party, Chevron would have to complete a much more thorough analysis of the relevant aquifer(s), contaminant pathways, well construction elements, direction of groundwater flow, and the well location relative to the contaminated areas before making such conclusions.

C. Chevron's "Compositing" of Soil Samples Misses Hotspots and Violates U.S. EPA Guidance

Another flawed method used by Chevron to minimize contaminant concentrations is the compositing of soil samples. When soil samples are composited, multiple samples from different locations are mixed together and analyzed as a single sample. This approach contrasts with grab sampling, or the collection of individual samples from different locations that are analyzed individually. Composite sampling can serve a legitimate purpose at sites where contaminants are more homogeneously distributed. However, this type of sampling is inappropriate for sites being inspected during the judicial process, where toxic contaminants have been dumped in highly concentrated amounts into pits, streams, and rivers. Composite sampling will not find the most severe “hot spots” of contamination that are critical in evaluating the importance of sources of petroleum and metal contamination. In these types of sites, compositing will only serve to mask peak contaminant concentrations because they will provide an average concentration. According to the US EPA:

> It should be remembered that a composite sample under the best of conditions will yield an average value of contaminants within the grid. Composite samples are most appropriate where a reasonable degree of variability is anticipated, and where soil types are amenable to adequate mixing. This is normally the case when contaminants have been distributed by airborne deposition (relatively homogeneous distribution across the site). Where localized "hot spots" are present due to releases from process units, indiscriminate dumping, or the burying of wastes, a more specialized approach that takes these types of distribution into account is required. [4]

The composite sampling strategy afforded Chevron experts the opportunity to mix clean topsoil and lesser contaminated soil with the underlying contaminated soil in the

[4] US EPA, 2001. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, Region 4, 980 College Station Road, Athens, Georgia 30605. www.epa.gov/region4/sesd/eisopqam/eisopqam.html.

"remediated" pits. Mixing these samples together underestimates the maximum concentrations and can result in *apparent* compliance with standards when, in fact, the sampling approach itself is bankrupt.[5]

D. Chevron Uses an Inappropriate Laboratory Test

Chevron's use of the Toxicity Characteristic Leaching Procedure (TCLP) test for total petroleum hydrocarbons (TPH) in soils for its "remediation," and the corresponding 1,000 mg/L standard for closure is not protective of human health and the environment. First, the use of the TCLP test itself is highly suspect. The test was designed to determine if a waste is classified as a hazardous under the Resource Conservation and Recovery Act and also to simulate the leaching of constituents into groundwater under the acidic conditions found in municipal solid waste landfills.[6] Further, U.S. EPA states that:

> The TCLP might not be appropriate for analyzing oily wastes. Oil phases can be difficult to separate (e.g., it might be impossible to separate solids from oil), oily material can obstruct the filter (often resulting in an underestimation of constituents in the leachate), and oily materials can yield both oil and aqueous leachate which must be analyzed separately.

Indeed, the inappropriateness of the TCLP test for TPH is illustrated by the fact that the U.S. EPA does not even set a TCLP-based regulatory limit for TPH.[7] Rather, for oily wastes such as those left in the former concession area, U.S. EPA recommends the use of different methods, such as Method 1330 (Extraction Procedure for Oily Wastes), a procedure that measures hazardous components in oil, on soil, and in aqueous leachate.[6] Chevron has rejected this recommendation in favor of the TCLP, and its use of the TCLP test will clearly minimize the amount of contamination measured in affected soils.[8] The more appropriate test, ignored by Chevron, used by most experts and by experts for the affected communities, bypasses all of TCLP's inherent problems by directly measuring the total amount of TPH in the soil. The Ecuadorian standard for the total amount of TPH in soil is 1,000 mg/kg.

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[5] We note that Chevron has repeatedly tried to discredit the sampling and analysis approach of the technical experts for the affected communities for their *failure* to create composite samples. Sampling by experts for the affected communities at contamination "hot spots" is precisely the appropriate method in a situation like this, where contaminants are highly concentrated and are not homogenously dispersed.

[6] Guide for Industrial Waste Management: Protecting Land, Ground Water, Surface Water, Air. Chapter 2. Characterizing Waste. http://www.epa.gov/epaoswer/non-hw/industd/guide.htm.

[7] It does set TCLP-based limits for pesticides, volatile and semi-volatile organic compounds, and other chemicals for which the test is appropriate.

[8] In contrast with Method 1330, the TCLP test only measures the amount of contamination that leaches out of the soil after it is mixed with acidic water for a short time, the equivalent of pouring water over coffee grounds and then measuring the amount of caffeine in the water, rather than the total amount of caffeine in the grounds. The TCLP test thus returns a rough estimate of contamination that might be released in a single rainstorm, but it doesn't come close to estimating the cumulative environmental threat posed by the toxic source, especially when dealing with toxins like TPH and heavy metals.

E. Chevron Ignores the Importance of the Lack of Institutional Controls

Finally, decisions for proper pit closure must always include structural and institutional controls to limit human exposure to the waste that remains and to protect the environment. Such controls typically include deed and zoning restrictions to limit the use of the land for future owners, impermeable barriers to prevent human contact, and limitations on use of the localized groundwater and surface water.[9] Chevron never put such controls in place in the area in which its "remediation" took place. Many pit sites that still contain high levels of both metals and petroleum hydrocarbon contaminants are near or under homes and domestic water supply wells, and the surrounding land is used to grow crops or graze domestic animals.

Chevron's use of the TCLP test was an attempt to justify leaving contamination in the ground. However, determining an appropriate concentration of TPH in the leachate produced during the test is just a small part in an overall risk assessment. Determining an acceptable concentration is determined by also considering such conditions as the groundwater depth, the soil type, the surface water occurrence, and the use of these water sources by the local human population. Use of the 1,000 mg/L TPH value as an allowable standard is irresponsible without this type of information combined with strict institutional controls. Use of the 1,000 mg/L concentration is especially irresponsible when one considers that the TPH standard in water for Ecuador is 0.325 mg/L.

During it's remediation and during the Lago trial, Chevron never generated this type of information and did not put these structional and institutional controls in place. The allowable level to protect human health can only be determined by a site-specific analysis of the risks and exposures to human health and the environment at Chevron's former sites. This was never done by Chevron or Woodward-Clyde (the American sub-contractor for Chevron's clean-up work in Ecuador) and is not being done by Chevron's current technical experts during their site assessments.

F. Chevron Misapplies U.S. EPA Guidance And Invents Norms With No Basis In Law

Chevron's use of the US EPA Soil Screening Guidance (SSG) document (U.S. EPA 1996) to determine when a regulatory standard concentration is achieved is incorrect and increases the risk to human health in this area of Ecuador.[10] Chevron's chief lawyer stated in a letter sent to Amazon Watch that "*no sample from these remediated areas contained unsafe levels of potentially toxic metals or hydrocarbons*"

[9] US EPA, Road Map to Understanding Innovative Technology Options for Brownfields Investigations and Cleanup, Fourth Edition, Page 91. September 2005.
[10] US EPA, 1996. Soil Screening Guidance, User's Guide. Office of Solid Waste and Emergency Response, EPA/540/R-96/018, July. Second Edition.

when compared to the SSG.[11] This statement has no basis in fact because Chevron never properly applied the SSG. Proper use of the U.S. EPA's Soil Screening Level values (SSLs) would have included a step-by-step process that involves developing a conceptual site model, comparing the conceptual model to the SSL scenario, defining data collection needs, sampling and analyzing soils at the site, calculating site-specific SSLs, comparing site soil contaminant concentrations to calculated SSLs, and determining which areas of the site require further study. Chevron did not comply with any phase of this process during its "remediation" in Ecuador.

The U.S. EPA notes that different SSL values can apply for a given contaminant: 1) a numerical standard for ingestion, *and* 2) numerical standards for the migration to groundwater. As examples, Table 1-A of the SSG document provides acceptable concentrations for barium: 5,500 mg/kg for ingestion; 1,600 mg/kg for migration to groundwater for impermeable soils and deep groundwater; and 82 mg/kg for migration to groundwater in areas such as the former Texaco concession with a shallow groundwater that is used for drinking water by local people. Although Chevron used the SSL values for determining closure levels of many target contaminants, they conveniently avoided the SSL values when these values were not in their favor. For example, rather than using the SSL standards for barium, Chevron instead compared the measured barium results to the Louisiana 29-B "standard" of 40,000 mg/kg -- almost *500 times* in excess of the appropriate U.S. EPA standard and over 50 times in excess of Ecuador's own relatively lax standard.[12]

The component of Louisiana 29-B standard that Chevron used is extremely lax and is only applied under a narrow set of circumstances where the threat to groundwater is virtually non-existent. The Chevron concession in Ecuador by contrast, is characterized by shallow groundwater and large numbers of groundwater users – that is, the local population relies on natural water sources (largely wells dug out of the ground) for its water supply. To apply the standard that presumes no contact with water used for human consumption in such a situation would be simply unconscionable -- yet that's exactly what Chevron does. For example, at the Sacha-6 site, all 17 soil samples in Chevron's own report exceeded the correctly-applied U.S. EPA standard for barium (82 mg/kg)-- yet by referencing only the 40,000 mg/kg Louisiana standard, Chevron's expert represents to the court that the site contains no unsafe levels of barium whatsoever. Despite these sorts of "sleight of hand" approaches in its sampling and analysis, the barium is still present in the ground and is still posing a threat to the surrounding population.

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[11] *Chevron Response to October 25 and December 27 Amazon Watch Letters*, Letter to Atossa Soltani, Executive Director of Amazon Watch, from Edward J. Scott, Vice President and General Counsel of Chevron, Jan. 20, 2006.

[12] The standard in Ecuador is 750 mg/kg, far more tolerant than the U.S. standards for these areas where people rely on fresh water standards. Decreto 3516 del 2003, Libro VI, Anexo 2, *Suelos Remediados Uso Agricola*, Tabla 3.

V. CONCLUSION

To avoid facing its environmental legacy in Ecuador in this litigation, Chevron has used a sampling and analytical approach that severely minimizes the extent, degree, and toxicity of the contamination still exists in the former concession area. In addition, Chevron is aggressively attacking the credibility and integrity of those who seek to scientifically document the negative health impacts of the failed remediation effort.[13] We hope that this analysis will help the court and the public to appreciate some of the many problems with the way Chevron is conducting environmental science in the Ecuador trial, and to understand the nature of the misinformation that Chevron presents. We will continue to monitor the technical methods used by Chevron to ensure that the company is held to account for any misuse of sound scientific practice.

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[13] *See, e.g., Experts Say Health Studies Promoted by Lawyers and Activists are Flawed, Biased and Inconclusive* (Chevron Press Release), Feb. 20, 2005, *available at* http://www.texaco.com/sitelets/ecuador/en/legal_archives/press/2005-02-02_health_news.asp; Letter to Atossa Soltani, *supra* note 11.