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A Rejoinder to Criticisms of the Expert Opinion of Kenneth J. Goldstein, M.A., CGWP and Jeffrey W. Short, Ph.D. Regarding the Environmental Contamination From Texpet's E&P Activities in the Former Napo Concession Area Oriente Region, Ecuador

In the Matter of An Arbitration Under the Rules of the United Nations Commission on International Trade Law

Chevron Corporation and Texaco Petroleum Company vs. the Republic of Ecuador

PCA Case No. 2009-23

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Executive Summary and Summary of Expert Opinions

The Louis Berger Group, Inc. ("LBG"), an international engineering firm with expertise in environmental evaluations and remediation, was initially retained in 2011 by Winston & Strawn LLP (Winston) on behalf of Respondent, the Republic of Ecuador (Republic), to provide environmental technical consulting relative to *the Matter of An Arbitration Under the Rules of the United Nations on International Trade Law; Chevron Corporation and Texaco Petroleum Company v. The Republic of Ecuador,* an arbitration (Arbitration) arising from the environmental condition of the Former Napo Concession Area ("Concession Area"), Oriente Region, Ecuador ("Oriente").[1] Specifically, we were retained (i) to review the contents of the court record in the *Aguinda et al. v. Chevron* lawsuit (Lago Agrio Lawsuit, or Lawsuit), including the February 2011 Judgment, to assist Winston. In addition, we were asked (ii) to review various documents and data not in the court record which had been prepared and produced by the technical consultants for and the applicable subsidiary of Texaco, Inc. (Texaco), Texaco Petroleum Company (Texpet) (collectively, Claimants), in the course of their defense of the Lawsuit. Subsequently, we were further retained (iii) to independently evaluate evidence of past and persistent environmental contamination in the former Concession Area due to Texpet's exploration and production (E&P) operations in the Concession Area from 1964 and 1990 and (iv) to assess, qualitatively, the reasonableness of the damage elements adjudicated in Judge Zambrano's judgment (Judgment) against Chevron.[2]

In February 2013, we presented the findings of our initial evaluation of then-available information in a report entitled *Expert Opinion of Kenneth J. Goldstein, M.A., CGWP and Jeffrey W. Short, Ph.D. Regarding the Environmental Contamination From Texpet's E&P Activities in the Former Napo Concession Area Oriente Region, Ecuador* (hereinafter referred to as the *LBG February 2013 Expert Report*). In June 2013, Claimants submitted their *Reply Memorial Track 2*, including *Annex A*, and numerous expert rebuttal reports. The opinions presented in this rejoinder report (Rejoinder) are focused primarily (although not exclusively) on the rebuttal reports of Claimants' environmental expert witnesses (John A. Connor,[3] Robert E. Hinchee,[4] and to a lesser extent Gregory S. Douglas[5]), as well as on the environmental section of *Claimants' Reply Memorial Track 2, Annex A*.[6] Those documents contain criticisms of our *LBG February 2013 Expert Report* and the Republic's other February 2013 submissions which are flawed by misstatements and inaccuracies. We,

[1] We reserve the right to amend the findings and opinions in this Report should additional information be presented or reviewed.
[2] We understand that on February 14, 2011, Presiding Judge: AB Nicolas Zambrano , PROVINCIAL COURT OF SUCUMBIOS. – ONLY COURT ROOM OF THE PROVINCIAL COURT OF JUSTICE OF SUCUMBIOS ruling set forth that Chevron could be held accountable for Texpet's liabilities. AGUINDA ET AL. V. CHEVRON CORPORATION, No. 2003-002, dated February 14, 2011 at 16 - 22] (hereinafter reffered to as the Lago Agrio Lawsuit).
[3] *Expert Opinion of John A. Connor, P.E., P.G., B.C.E.E. Regarding Remediation Activities and Environmental Conditions in the Former Petroecuador – Texaco Concession, Oriente Region, Ecuador, Response to LBG Report of February 2013, June 3, 2013)* (hereinafter referred to as Connor, 2013).
[4] *Expert Report of Robert E. Hinchee, Ph.D., P.E.*, May 31, 2013 (hereinafter referred to as Hinchee, 2013)
[5] *Rebuttal Expert Report of Gregory S. Douglas, Ph.D.*, June 1, 2013 (hereinafter referred to as Douglas, 2013)
[6] *Claimants' Reply Memorial Track 2, Annex A*, June 5, 2013

Kenneth J. Goldstein, CGWP[7] and Edward A. Garvey, PhD., P.G.,[8] on behalf of LBG and the Republic and in conjunction with our colleagues, prepared this Rejoinder to, among other things, respond to certain disagreements and criticisms asserted by Claimants and their expert witnesses regarding our *LBG February 2013 Expert Report*.

The opinions[9] presented in this Rejoinder are based upon our own experience and education[10] and the experience and education of our professional colleagues at LBG[11] (collectively, the LBG team), as well as other experts retained on behalf of the Republic.[12] We have relied on the following information and data sources: (i) those relied upon to prepare the *LBG February 2013 Expert Report*; (ii) additional information and data obtained during the course of the §1782 discovery process subsequent to submission of the *LBG February 2013 Expert Report*;[13] and (iii) that resulting from site investigations that we conducted in the Concession Area between July and October 2013 at five former Texpet-operated well sites in Ecuador,[14] as well as (iv) technical research that we conducted to respond to criticisms embodied in *Claimants' Reply MemorialTrack 2* and their accompanying expert reports.[15] Based upon our experience and education (i.e., Mr. Goldstein and Dr. Garvey), and the LBG team's subsequent data evaluation, we reaffirm[16] the accuracy and reliability of the opinions presented in our *LBG February 2013 Expert Report.* The opinions we detail in the body of this Rejoinder Report may be summarized as follows:

1) Texpet created hundreds of uncontrolled contaminant sources (e.g., waste pits, well sites, and production stations) distributed across the Concession Area, causing widespread contamination.[17]

[7] Mr. Goldstein is providing opinions regarding the nature and extent of contamination in the former Concession Area resulting from Texpet's E&P activities in the former Concession Area, including the results of independent site inspections and investigations in which he personally participated.
[8] Dr. Edward A. Garvey, PhD, PG, an LBG employee, is providing opinions and analyses regarding analytical methods and geostatistics contained in this report that were developed to respond to erroneous assertions made by Claimants' experts.
[9] As requested by counsel, we did not provide opinions related to the quantification of monetary damages resulting from Chevron's operations in the Oriente nor does this report offer an opinion as to the assessment of contribution for contamination from Petroecuador after 1990.
[10] A summary of Mr. Goldstein's qualifications is presented in Annex 3 of the *LBG February 2013 Expert Report* and Curricula Vitae for both Mr. Goldstein and Dr. Garvey are presented in Appendix F of this Rejoinder Report.
[11] This includes professional engineers (PEs) and scientists who hold MS and PhD level degrees.
[12] Mr. Ken Kaigler and Dr. Paul Templet (retained directly by Winston); Dr. Jeffrey Short and Dr. Harlee Strauss (retained by LBG on behalf of Winston and the Republic), and Dr. Ed Theriot, an employee of LBG. Descriptions of their respective qualifications are provided in their respective Reports. Dr. Philippe Grandjean (retained by Winston and the Republic) also provided an opinion for the Rejoinder, but his opinion was not referenced or considered here.
[13] Section 1782 of Title 28 of the United States Code (28 U.S.C. § 1782) is the mechanism by which the United States provides assistance to foreign or international tribunals in obtaining evidence.
[14] See Appendix B - Site Investigation and Data Summary Report, Napo Concession Area, Oriente Region, Ecuador. In the Matter of BIT Arbitration, Chevron v. Government of Ecuador (hereinafter referred to as Appendix B)
[15] *Claimants' Reply Memorial*, including *Annex A* and Expert Reports by John A. Connor, Robert E. Hinchee, and Gregory S. Douglas, 2013
[16] With minor clarifications as is presented in Appendix A of this Report
[17] We clarify that we used the term "widespread contamination" to connote: a pattern of contamination at multiple E&P facilities across the Concession Area, present in one or more environmental media beyond the immediate confines of the E&P facilities.

2) Such contamination was a direct and predictable consequence of the endemic substandard operational practices Texpet employed during its E&P operations and activities from 1964 to 1990, which failed to comply with applicable Ecuadorian law, the 1973 Concession Agreement, and generally accepted international E&P practices in similar tropical rainforest environments.[18]
3) Such contamination, which was confirmed by Chevron's own sampling and analysis program during the Lago Agrio trial, persists today outside of the well field facilities.[19] Contamination is present in portions of the Concession Area where both ecological and human receptors have been exposed in the past, and will likely continue to be exposed in the future. These contaminants include chemicals that are known to be toxic and carcinogenic.[20]
4) The results of the LBG team's recent (July to October, 2013) site investigations stand in marked contrast to Claimants' experts' opinions. At each of the five Texpet-drilled-and-operated well sites investigated, we found oil-contaminated pits and oil-based contamination of surface water and sediments[21] attributable to Texpet's operations. We also found that contamination from these sources has persisted in the environment since at least 1990 and probably earlier , and is currently found at locations where ecological systems are impacted and the human and animal inhabitants are exposed.
5) Chevron's sampling and analytical testing program employed during the Judicial Inspections (JIs) in the Lawsuit was inadequate to either establish or negate the extent of adverse impacts to the environment from Texpet's E&P operations. In addition, the Lago Agrio court (Court) did not have Chevron's Pre-Inspection (PI) data, which when reviewed with their JI data presents a more complete understanding of the extent of E&P contamination in the Oriente. Our in-depth analysis of Chevron's JI and PI data shows that Claimants' assertion that they defined "clean perimeters" for all of the pits investigated in the JIs[22] is inherently false. The majority of the sites investigated by Chevron for the JIs have insufficient data (even aggregating the filed JIs and the unfiled PIs) to show that contaminants remain immobile (i.e., that they have not migrated away from their source location through soil or groundwater). Moreover, for the following reasons these data do not support Claimants' assertion that they had delineated clean perimeters:
    a. Many of Chevron's reputedly "clean" perimeter samples were not collected on the well field facility, but rather on neighboring properties.[23]
    b. Chevron's own data show that it is as likely for a sample of sediment collected downstream from its E&P facilities to be contaminated as it is for soil samples collected from un-remediated pits on those facilities.[24]

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[18] Texpet's practices were substandard to other contemporaneous operations in similar environmental settings. *See generally Expert Opinion of Ken Kaigler, P.E. Comparing Texpet E&P Practices in Ecuador to Contemporaneous Practices in the U.S. and Venezuela* (hereinafter referred to as Kaigler, 2013). See *LBG February 2013 Report,* Section 2.2 and supplemented by this Rejoinder; *see generally Expert Report of Paul H. Templet, PhD,* 2013 (hereinafter referred to as Templet, 2013)
[19] *See generally* Appendix B
[20] *See generally* Strauss, 2013
[21] *See generally* Appendix B
[22] Connor, 2013, p. 2-3
[23] *See generally* Appendix C
[24] *See generally* Appendix C

c. Our analysis of Chevron's own data collected in conjunction with the Lago Agrio Lawsuit shows that, as of the time the PIs and JIs were conducted, surrounding Texpet-constructed and operated well sites and production stations: (i) approximately 2.1 square kilometers of surface soil outside of the associated pits likely remained contaminated at concentrations above 1000 mg/kg of Diesel Range Organics (DRO) plus Gasoline Range Organics (GRO)[25] (collectively, DRO/GRO) and (ii) (for purposes of comparison) 10.2 square kilometers of surface soil likely remained above the 100 mg/kg TPH threshold used in the Lago Agrio Lawsuit.

Based on these results, we recommend further investigation to fully characterize and subsequently remediate sites where appropriate Ecuadorian standards are exceeded in soil, sediment, and water.

6) Contamination in the Oriente caused and continues to cause unacceptable risk to human health and the environment. Claimants' expert Thomas McHugh's quantitative risk assessments[26] "have five fatal flaws that lead him to the incorrect conclusion that petroleum contamination in the Concession Area does not result in health risks."[27] Quantitative human health risk assessments, prepared by Dr. Harlee Strauss,[28] indicate that significant residual human health risks attributable to Texpet's activities remain to this day.
7) The Judgment's assessment of damages appears at least reasonable.

As is stated above, our recent investigation of five Texpet well sites demonstrates persistence and migration of contamination from those well sites counter to assertions by Claimants. In summary, we also opine:

1) Claimants' unsupported assertion that any groundwater investigation beyond sampling of nearby, hand dug water wells is unwarranted,[29] is not borne out by field data showing that, where groundwater was found to exist as a resource, it had been contaminated.[30]
2) Chevron's (and Texpet's) blanket assumption that an impermeable clay deposit occurs everywhere, rendering pit lining unnecessary,[31] is false.
3) Our 2013 sampling shows that sediment contamination in streams that flow adjacent to E&P facilities occurs at significant distances from the facility and at locations where people and animals access the streams.[32]
4) Our 2013 sampling demonstrates that contamination caused by Texpet's operations is still present and mobile in the environment.[33] Our well site inspections and follow-up investigations documented instances where natural

[25] DRO and GRO are a fraction of the parameter Total Petroleum Hydrocarbon (TPH), which has an Ecuadorian standard of 1000 mg/kg RAOHE for Sensitive Ecosystems. *See* Short, 2013, Section 4.1.4 and Sections 3.3.4 of this Rejoinder.
[26] *See generally Expert Opinion of Thomas E. McHugh, PHD, D.A.B.T.Regarding Lack of Evidence of Health Risks Associated with Petroleum Operations in the Former Petroecuador-Texaco Concession Area, Oriente Region, Ecuador (2013) Rebuttal to Mr. Caberra's Excess Cancer Death And Other Heath Effects Claims, and His Proposal for a New Health Infrasstruction, Micheal A Kalsh, Ph.D., MPH, Thomas McHugh, Ph.D., D.A.B.T., and Theodore D. Thomasi, Ph.D.,* 2008, and Connor, 2010
[27] Strauss, 2013, p. 11
[28] *See generally* Strauss, 2013
[29] Connor, 2013, p. 14-15, p. 29
[30] *See generally* Appendix B and Section 2.2 of this Report
[31] Connor, 2013, p. 3
[32] *See generally* Appendix B and Section 2.2 of this Report
[33] Short, 2013, p.14-16; *See generally* Appendix B and Section 2.2 of this Report

resources (i.e., soils, sediments, surface water, and groundwater) continue to be impacted by Texpet-era E&P activities. Along the streams adjacent to the sites, we observed crude oil bubbling upward when sediment was disturbed. We also observed areas where people use these same impacted water resources.[34]

5) This Texpet-originated contamination is not limited to open pits or as part of unremediated oil spills, is not confined to localized areas within the oil facility, and includes chemical impacts to groundwater and surface water.[35]

From an environmental and human health perspective, the data and information available to the Tribunal, including the results of our independent investigations and other technical research performed to address Claimants' criticisms, reveal the true nature of Texpet's legacy in the Oriente. The assertions by Claimants[36] that the impact of Texpet's E&P activities was mainly aesthetic,[37] that residual crude oil remaining from those activities is all weathered, immobile, and limited to the immediate area of the oilfield facilities,[38] and that remediation was only important for ill-defined "practical concerns,"[39] are wrong. The environment of the former Concession Area has been damaged by Texpet's E&P activities, and this damage and its impacts to the residents continue to this day; thus, the Judgment's assessment of damages in the Lago Agrio trial appears at least reasonable.

[34] *See generally* Appendix B and Section 2.2 of this Report
[35] *See generally* Appendix B and Section 2.2 of this Report
[36] Including Texpet and Chevron as individual entities.
[37] Henderson, et al., 1990, p. 1
[38] Connor, 2013, p. 2-3
[39] Connor, 2013, p. 2

1 Introduction - Scope of LBG's Assignment

LBG is an international engineering firm with expertise in environmental evaluations and remediation. Winston, counsel for the Republic, retained us as technical consultants relative to *the Matter of An Arbitration*[1] *Under the Rules of the United Nations on International Trade law; Chevron Corporation and Texaco Petroleum Company v. The Republic of Ecuador* arising from the environmental condition of the Concession Area[2]. The Arbitration between Claimants and the Republic is related to the Lawsuit litigated in the Court in Lago Agrio, Sucumbios Province, Ecuador between 2003 and 2011. The Lawsuit involved highly technical testimony and data regarding claims of the indigenous plaintiffs (Lago Agrio Plaintiffs or Plaintiffs) for damages to the environment, human health and indigenous culture from Texpet's E&P activities in the Concession Area between 1964 and June 1990. Texaco was acquired by Chevron in 2001, so Chevron was the defendant in the Lago Agrio Lawsuit.

In February 2013, the Republic submitted to the Tribunal a series of expert opinions regarding the evidence of contamination, damage to ecology, and human health risks due to contamination, as documented in the Lawsuit's trial record. These opinions[3] were presented in support of the *Track 2 Counter-Memorial of the Republic of Ecuador.* On June 5, 2013, Chevron and Texpet submitted *Claimants' Reply Memorial Track 2* inclusive of *Annex A* as a response and rebuttal to *Track 2 Counter-Memorial of the Republic of Ecuador.* In their reply, Claimants criticized us for not having visited the E&P facilities that were the subject of the Lawsuit, and for relying on data from the mid-2000s, (i.e., representing conditions about 6-10 years before our report). For this reason, the Republic further retained us to: (i) prepare rejoinder expert opinions to address these criticisms and (ii) to visit and conduct limited independent site investigations at cetain Texpet E&P sites that had been among those evaluated in the Lawsuit through Judicial Inspections (JIs). We present our results, findings and opinions generated from those two tasks in this Rejoinder.

This Rejoinder thus presents our findings and opinions as a response to the *Claimants' Reply Memorial Track 2* inclusive of *Annex A*[4]. This Rejoinder also references the accompanying expert opinions of five other independent experts retained by or on behalf of the Republic, whose reports are summarized[5] as follows:

1) Kenneth Kaiger, P.E., has provided an opinion regarding the typical conduct of E&P activities in the United States and in Latin America during the 1973 to 1990 period, in which Texpert served as Concession Operator. Mr. Kaiger generally opines that during this period Texpets's environmental practices in the Concession Area

[1] Bilateral Investment Treaty (BIT)
[2] We reserve the right to amend the findings and opinions in this Report should additional information be presented or reviewed.
[3] *Expert Opinion of Kenneth J. Goldstein, M.A., CGWP and Jeffrey W. Short, Ph.D. Regarding the Environmental Contamination From Texpet's E&P Activities in the Former Napo Concession Area Oriente Region, Ecuador* (hereinafter referred to as *LBG February 2013 Expert Report*)
[4] In September, we provided a proposal to the Republic to begin estimating the financial costs of potential remedies for the damages assessed by the Court in the Litigation. As of the date of this Rejoinder, our firm has not been directed to assess the apportionment of any damages with third parties.
[5] The summary of the opinions presented here is simply an overview to distinguish them from opinions presented in this Report, and is in no way inclusive of their analyses or opinions.

were less protective of soil, surface water and groundwater resources than were contemporaneous oil company practices in the United States and Venezuela[6].

2) Dr. Paul Templet is of the opinion that Texpet knew or should have known that its E&P practices would cause contamination. He opines that the crude oil contamination he observed in the Concession Area in 2008 stemmed from substandard E&P-related environmental management practices[7]. He also opines that Texpet's disposal of untreated produced water brines into surface waters was in violation of accepted industry and U.S. regulatory practices.
3) Dr. Jeffrey Short opines that, contrary to Claimants' experts' opinions, the methodology that they relied upon to characterize the extent of [oil] "weathering" (degradation) in the Concession Area is fundamentally flawed and grossly exaggerates the extent of oil degradation. He also opines that as of October 2013, there is lingering oil in the region that is in a state of arrested biodegradation, remains mobile, and retains a complement of toxic hydrocarbons. Lastly, Dr. Short is of the opinion that the Toxicity Characteristic Leaching Procedure (TCLP) is fundamentally inappropriate as a metric of oil field remediation effectiveness and cannot produce results that exceed the 1,000 mg/L TPH RAP threshold [8].
4) Dr. Harlee Strauss has provided an opinion that exposures originating from Texpet sources pose significant risks to the health of the residents of the Concession Area[9].
5) Dr. Edwin Theriot opines, among other things, that the RAP did not address areas damaged ecologically, and that contamination from Texpet's activities within the former Concession Area persists today and negatively impacts flora and fauna in the Concession Area[10].

In their respective expert reports, both Mr. Kaigler and Dr. Templet discuss how Texpet ignored pre-existing and contemporary guidance for disposal of produced water recommending deep well re-injection and advising against use of unlined earthen disposal pits.[11] The authors cite published guidance documents from the American Petroleum Institute (API), the U.S. Bureau of Mines, and U.S. Environmental Protection Agency (EPA) reaching back as early as 1929. Dr. Templet points to Texaco's unsuccessful legal challenge to a rule promulgated by the Louisiana Stream Control Commission (LSSC), part of the Louisiana Wildlife and Fisheries Department, prohibiting discharge of produced water brines into unlined disposal pits in any coastal parish of Louisiana.[12] Texaco ultimately went to the U.S. Supreme Court

[6] *The Expert Opinion of Ken Kaigler, P.E. Comparing Texpet E&P Practices in Ecuador to Contemporaneous Practices in the U.S. and Venezuela* , 2013, p. 6 (hereinafter refrred to as Kaiger, 2013),
[7] *Expert Report of Paul H. Templet, PhD (*hereinafter referred to as Templet, 2013).
[8] *Expert Opinion of Jeffrey W. Short, PhD Regarding Remediation Activates and Environmental Conditions in the Former Petroecuador-texaco Concession, Oriente Region, Republic of Ecuador*. (hereinafter referred to as Short, 2013).
[9] *Rejoinder Opinion of Harlee Strauss, PhD, Regarding Human Health Risks, Health Impacts, and Drinking Water Contamination Caused by Crude Oil Contamination in the Former Petroecuador-Texaco Concession Area, Oriente, Ecuador*, December 2013. (hereinafter referred to as Strauss, 2013).
[10] *A Rejoinder to Chevron's Rebuttal to the Opinion of Edwin Theriot, PhD Addressing Damages to the Flora and Fauna Caused by Texpet in the Concession Area Oritente Region, Ecuador* (hereinafter referred to as Theriot, 2013).
[11] *See generally* Templet, 2013; *see generally* Kaigler, 2013
[12] See E.D. Baton Rouge Division -Texas Co. v Montgomery, Aug. 29, 1947, Civil Action No. 457

to try to block this rule; the lower courts' judgments in favor of the LSSC were affirmed on Nov. 24, 1947.[13] Thus, Texpet knew or should have known that uncontrolled surface discharges of produced water wastes into the environment would result in contamination.[14] Texpet (and Chevron) also should have been aware that industries in the U.S. were being prosecuted in the 1960s and 1970s for discharging industrial wastes into waterways under laws such as the 1899 Refuse Act, which while not containing numerical standards for contaminants,[15] broadly prohibited direct discharge of waste to surface water − similar to Ecuadorian laws and regulations from the 1920s through the 1980s.

The opinions presented in this Rejoinder are focused primarily (although not exclusively) on the findings of Claimants' experts, John A. Connor,[16] Robert E. Hinchee,[17] and, to a lesser extent, Gregory S. Douglas,[18] as well as on *Claimants' Reply Memorial Track 2, Annex A*.[19] We disagree with Mr. Connor's conclusions regarding the findings of the environmental audits, PIs, and JIs, which he describes as follows:

> *The results of the extensive environmental investigations conducted to date show that groundwater and surface water resources are nearly free of any chemical impacts, while significantly impaired by bacterial contamination. Residual soil impacts are principally limited to open pits and un-remediated oil spills on some well sites and production stations. However, perimeter soil sampling shows that such impacts are confined to localized areas within the oilfield facilities.*[20]

Although this Rejoinder (inclusive of its Appendices) responds to many of Claimants' experts' opinions, we note that Connor's assertions are sweeping in nature and would apply both to contamination caused directly by Texpet as Operator, as well as to possible subsequent activity by Petroecuador. We focused on Texpet operated sites and pre-1990 site histories to demonstrate that Texpet's substandard E&P practices caused widespread contamination,[21] in sharp contrast to Claimants' assertions of limited impacts confined to well sites.[22]

The scope of our assignment did not extend to sorting out environmental liability based on temporal distinctions; allocation of possible shared responsibility for the manifestation of contamination in and from pits used by both Texpet and later Petroecuador is primarily a function of Ecuadorian law and would require additional legal and factual evaluation. We performed additional research to identify locations with primarily Texpet legacy. We then conducted reconnaissance and investigations to demonstrate Texpet impacts. While Petroecuador's post-1990 activities may confound allocation at

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[13] See Texas Co. v Montgomery, Nov. 24, 1947, 68 S. Ct 209
[14] *See generally* Templet, 2013
[15] **Ex. 1** The Journal of Criminal Law, Criminology and Police Science, Vol. 63, No. 3. *Criminal Liability Under the Refuse Act of 1899 and the Refuse Act Permit Program*; Northwestern University School of Law; 1972
[16] *Expert Opinion of John A. Connor, P.E., P.G., B.C.E.E. Regarding Remediation Activities and Environmental Conditions in the Former Petroecuador – Texaco Concession, Oriente Region, Ecuador, Response to LBG Report of February 2013, June 3, 2013)* (hereinafter referred to as *Connor 2013*).
[17] *Expert Report by Robert E. Hinchee, Ph.D., P.E.*, May 31, 2013 (hereinafter referred to as Hinchee, 2013)
[18] *Rebuttal Expert Report of Gregory S. Douglas, Ph.D.*, June 1, 2013 (hereinafter referred to as Douglas, 2013)
[19] *See generally Claimants' Reply Memorial Track 2, Annex A*, June 5, 2013
[20] Connor, 2013, p. 37
[21] See Section 2.1 of this Rejoinder for a definition of "widespread contamination"
[22] *Claimants' Reply Memorial Track 2, Annex A*, 2013, p. 23-24

some E&P sites, this does not diminish impacts from Texpet's activities prior to 1990. As such, Chevron's data are insufficient to rule out a conclusion that Texpet's activities caused contamination, and that such contamination has migrated away from well sites.

Our approach in February, and as augmented in this Rejoinder, has been to consider Claimants' assertions as hypotheses that can be tested scientifically, using both the previous body of information and information newly gathered during site inspections and investigations conducted from July through October, 2013. In this approach, it is not necessary to thoroughly describe the nature and quantify the extent of contamination (nor to allocate pollution liability between Texpet and Petroecuador), but only to provide sufficient information to conclude, to a reasonable degree of scientific certainty, whether Claimants' assertion of limited and confined impacts is defensible. As such, evaluating the Lawsuit record and other available data (mostly produced by Claimants) for information contradictory to their assertions is an efficient way to test their claims. Coupled with information demonstrating that Texpet impacts in the Concession Area are widespread, this is a scientifically valid approach and does not constitute our "manipulation" of any data, as alleged by Claimants.[23] Rather, it demonstrates that Chevron's approach during the JIs, like Texpet's before it, was to avoid where possible collecting data inconsistent with its pre-conceived conclusions and to downplay the significance of any actual evidence of the persistence and spread of contamination that Texpet originally introduced into the Concession Area.[24]

2 Clarification of Our Opinions and Presentation of Data Collected and Analyzed in Response to Claimants' Criticisms

In this section, we clarify and expand our February 2013 opinions in the context of responding to Claimants' reply criticisms. We present our present understanding of environmental conditions in the Concession Area, including a summary of our opinions and findings from the *LBG February 2013 Expert Report* and a presentation of our additional evidence that supports these opinions and findings. Specifically, we offer: (i) reinforcement of key points made in the *LBG February 2013 Expert Report*; (ii) information we obtained or conclusions we were able to draw after February 2013 through further analysis of previously reviewed documents and data, analysis of material obtained in the §1782 discovery process, and technical research required to address Claimants' criticisms; and (iii) the results of limited, independent site investigations that we conducted between July and October, 2013 to respond to Claimants' criticism that our experts had not visited the Concession Area to conduct our own tests or measurements. A detailed report describing our recent site investigations is included in Appendix B.

Dr. Hinchee asserted that data collected by Chevron during the JI was "appropriate and consistent with international standards of practice"[25], and that "LBG's claims are based on a lack of understanding of oil field environmental issues and practices, and a confused and biased interpretation and presentation of the data."[26] Particularly in light of the evidence we gathered during our independent site investigations (see Appendix B), this peremptory assessment of our perceived "lack

[23] *Claimants' Reply Memorial Track 2, Annex A,* p. 17-18
[24] See Table 4.1-1
[25] Hinchee, 2013, p. 14
[26] Hinchee, 2013, p. 12

of understanding" is contrary to the facts. At several points in *Claimants' Reply Memorial Track 2*, they claim that we made certain misstatements or factual errors in the preparation of our February 2013 Expert Report. Such claims and our responses are addressed in Appendix A. We did not take these criticisms lightly, and renewed our efforts to acquire an even fuller understanding of the pertinent site facts. As a result of these efforts and our efforts relative to this Rejoinder**, our overall opinion remains fundamentally unchanged.**

2.1 Rejoinder to Claimants' Criticisms of Opinions in the *LBG February 2013 Expert Report*

Opinion 1: As designated Operator of the Concession, Texpet (now Chevron) caused widespread contamination associated with its crude oil exploration, drilling, production, and transport activities. Texpet's operations resulted in past and persistent environmental injury from exposure to toxic and hazardous chemicals and consequent risk to human health and ecological receptors.[27]

In his 2013 report, Claimants' expert, Connor, takes exception to our assertions of "widespread contamination," as well as to our characterization of the consequences of such contamination as presenting potential risks to human health and the environment. For example, Connor states,

> *Contrary to LBG's assertions of widespread contamination, analysis of the environmental data … shows that the environmental effects associated with Texpet's historical oilfield operations were confined to the immediate area of oilfield facilities. The total footprint of these facilities … represents only 0.1 - 0.15% of the full Concession area. Extensive sampling of groundwater and surface water found these resources to meet the drinking water criteria … with no indication of the alleged impacts by historical petroleum operations...*[28]

Later, Connor states,

> *For the additional 10 sites presented in Appendix A of the LBG report as apparent examples of "widespread contamination," my review shows these impacts to be overstated due to errors in interpretation of the Chevron Environmental Database, application of incorrect remediation criteria, and disregard of the scope of the Texpet remediation program.*[29]

In responding to these criticisms, we clarify that we used the term "widespread contamination" to connote:

> a pattern of contamination at multiple E&P facilities across the former Concession Area, present in one or more environmental media beyond the immediate confines of the E&P facilities.

[27] *LBG February 2013 Expert Report*, 2013, p. 3
[28] Connor, 2013, p. 4
[29] Connor, 2013, p. 11

Hence, ours was not a statement about the total hectares of land area occupied by former Texpet facilities; rather, it was about contamination identified at multiple E&P facilities across the Concession Area, the distribution of contamination in environmental media[30], and the presence of potential exposure pathways to receptors.[31]

In fact, Dr. Strauss has provided an opinion regarding exposure pathways and has identified human health risks,[32] supporting the opinion of "widespread contamination" as defined in the above paragraph. In addition , the quantitative human health risk assessments based on data for four sites (LA-02, GU-06, SSF -25, and YU-02) conducted by Dr. Strauss indicate the presence of a non-cancer hazard at all four sites under both current and future conditions and the presence of cancer risk above 10^{-5} (or one in one hundred thousand) at all four sit4es under current conditions. The presence of these non-cancer hazards and cancer risks confirm the findings of her previous February 2013 qualitative risk assessment,[33] concluding that contaminants released into the environment during Texpet's exploration and production of crude oil pose risks to the health of residents living in the Concession Area.[34]

Opinion 2: This contamination is due to the presence and persistence of a large range of hydrocarbon and other compounds; the full suite of such compounds has toxic and hazardous characteristics. Testing and analyses done by Chevron, Plaintiffs, and other entities to assess the persistence and impact of these compounds was limited to a small subset of the full suite of petroleum hydrocarbon compounds. The testing was also geographically limited and was thus inadequate to characterize the risks associated with the presence of the full suite of these compounds and the full extent of their impacts.[35]

This opinion is further supported and confirmed by further review of the available information, as well as by observations and findings from our own field reconnaissance and site investigations in the former Concession Area from July through October, 2013 (see Appendix B and Section 2.2). Claimants[36] assert that analytical results for other compounds of interest, particularly for alkyl-substituted[37] Polyaromatic Hydrocarbons (PAHs), were submitted in Chevron's JI reports (as documented in the Court record), contrary to statements in our expert report.[38] In fact, based on further review of the Lawsuit court record, we have determined that data for alkylated PAH compounds in selected soil samples were buried deep in attachments to the first eight (only) out of the total of 45 JI reports[39] submitted by Chevron[40] and were not

[30] *See generally* Appendix B
[31] *See generally* Strauss, 2013
[32] *See generally* Strauss, 2013
[33] *Expert Opinion of Harlee S. Strauss, PhD Regarding human health-related aspects of the environmental contamination from Texpet's E&P activities in the former Concession Area, Oriente Region, Ecuador, February 18, 2013.* (hereafter referred to as Strauss, February 2013).
[34] Strauss, 2013, p. 6-18
[35] *LBG February 2013 Expert Report*, 2013, p. 3
[36] Douglas, 2013, p. 8-9; *Claimants' Reply Memorial Track 2, Annex A*, 2013, p. 22
[37] Referred to as "alkyl" or "alkylated"
[38] *LBG February 2013 Expert Report*, 2013, p. 34 The alkyl-substituted PAHs are molecularly distinguishable from their 16 "parent" or "priority pollutant" PAH compounds by having various alkyl groups attached to the parent chain. Crude oil contains primarily alkyl-substituted PAHs and relatively fewer unsubstituted PAHs.
[39] For which data are available in Chevron's 2013 Access® Database

discussed in any fashion in the JI narrative. However, even with respect to these eight sites, the analytical results were not processed[41] to the point that they represent soil concentrations. Thus, while the raw alkylated PAH data for these eight sites may reside obscurely in an appendix, they were not presented in a format that lends itself to meaningful evaluation. Chevron's presentation subtly, but directly, served their interest in the case. For example, Connor states,

> *…analysis of the principal toxic components of crude oil in thousands of samples shows that neither the Texpet-remediated pits nor impacted soils associated with the pits and spills not yet addressed by Petroecuador contain concentrations of chemicals that could pose a human health risk, even in the event of direct daily exposure for 30 years.*[42]

This is a sweeping statement, ruling out even the possibility of exposures to toxic chemicals at concentrations posing risk. However, if Chevron had processed and presented and interpreted the alkylated PAH data clearly in the JIs, the result would – contrary to Claimants' assertions – have demonstrated substantial PAH contamination in the relevant samples. As noted by Dr. Short:

> *The alkyl-substituted polycyclic aromatic hydrocarbons (PAHs), which constitute the majority of toxic PAH in crude oils, were largely ignored by Chevron's experts. Contrary to assertions made in Claimants' Reply Memorial Annex A, the toxicity of these compounds to fish has been scientifically confirmed by multiple studies, which include studies conducted by scientists not affiliated with the US government.*[43]

Our observations and recent sampling at the five sites confirmed the presence of residual contamination in surface water, sediment, and soil that exceed relevant ecological screening criteria. These findings confirm and support Dr. Theriot's February (and current) opinion that contamination directly resulting from Texpet's activities persists today and negatively impacts flora and fauna and will continue to do so, absent remedial action.[44] In this context, consideration of the alkylated PAHs would be appropriate.

We recognize that there is a difference between toxicity in fish (or other biota) and toxicity in humans. However, the fact that toxicity has been demonstrated in fish should have given Mr. Connor some pause in his evaluation. As noted in Appendix A of Dr. Strauss' report, "Dose-response values are lacking for many components of crude oil, such as alkyl PAHs other than methylnaphthalenes, naphthenic acids, alkyl phenols, and dibenzothiophenes, although toxicological

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[40] These include records for sites SA-06, SA-21, SA-53, SA-94, SSF-48, SA-10, SA-51, and SSF-Sur Oeste. Using a summary of the well sites, which included a summary of the Cuerpos associated with each site created by others, all pages of each individual Cuerpo document were examined for the presence of alkyl PAH results. Each document included the JI report as well as the associated appendices.

[41] The data are presented only as "raw" concentrations in the liquid extracts of the samples presented on laboratory quantitation reports; to make the data useful for evaluations, a further step is required to convert the mass of each contaminant detected in the liquid extract to a mass of contaminant in the original soil sample from which it was extracted for injection into the analytical instrument.

[42] Connor, 2013, p. 3

[43] Short, 2013, p. 4

[44] Theriot, February 2013, p. 4

evidence indicates that these are all important toxicants to consider."[45] We collected samples from July through October 2013 during investigations focused on Texpet-remediated pits or pits closed prior to the RAP at five well sites investigated by Chevron during the JI. Subsequent analysis of these samples demonstrates the presence of alkylated PAHs and other toxic compounds. As shown in Appendix B (Tables 5.2-1 to 5.6-3 and Figures 5.2-1 to 5.6-4), where they were analyzed during our independent investigations, alkylated PAHs, as would be expected, are present at roughly ten times the concentration of the parent PAH compounds. Per Dr. Strauss' analysis, exposures to such compounds are ongoing and continue to create a risk to the health of residents in the former Concession Area.[46]

Importantly, compounds such as alkylated PAHs and other toxic or carcinogenic compounds were found during our site investigation in contaminated stream sediments downstream from the boundaries of the well sites. The contaminated sediments were found near some locations used by local residents as water resources, such as for laundering clothing and bathing. These water resources were observed to be used by livestock as well.[47] While characterizing the sites and collecting sediment samples, we oberved that disturbance of the stream bed in these locations (as would be experienced while wading in the stream or passage of cattle) releases free-phase oil,[48] creating exposure pathways for human and ecological receptors.

Opinion 3: *The design and implementation of Chevron's limited September 1995 Remedial Action Plan (RAP) failed to identify or address these risks.*[49]

A. The RAP was prepared and implemented without a comprehensive remedial investigation.[50]

The investigations performed by Woodward-Clyde between June and September 1995, prior to implementation of the RAP, were crude and cursory. The only record of testing of soil and sludges is a check mark in the acceptance criteria box in the RAP checklists, indicating that a sample was tested in a portable laboratory.

B. The RAP goals were inadequate to reduce risk; the methods and metrics to demonstrate successful remediation were flawed; and no effort was made to quantify (i) the amount of risk reduction represented by the RAP or (ii) the amount of risk remaining after the RAP.[51]

As shown by Dr. Short, "The toxicity characteristic leachate procedure (TCLP) remains fundamentally inappropriate for the uses Chevron made of it, and *in principle* cannot, even at undiluted concentrations, produce results that exceed a regulatory threshold of 1,000 mg/L through dissolution of contaminants from crude oils into aqueous media."[52]

[45] Strauss, 2013, Appendix A, p. viii
[46] Strauss, 2013, p. 5
[47] Struass, 2013, p. 22
[48] *See generally* Appendix B
[49] *LBG February 2013 Expert Report, 2013*, p. 3
[50] *LBG February 2013 Expert Report, 2013*, p. 3
[51] *LBG February 2013 Expert Report*, 2013, p. 3
[52] Short, 2013, p. 3

Further, our investigations from July through October 2013 at five of the same well sites where pits were remediated in, or closed prior to, the RAP show continuing transport of crude oil in select locations and persistent contamination distributed downgradient in streams or wetlands at all five sites. As discussed in Dr. Strauss' expert report, risk assessments performed based on the data collected demonstrate both cancer and non-cancer health risks to current residents of the Concession Area from the contamination in surface water and sediment.[53] They also demonstrate both non-cancer health hazards and significant cancer risks from realistic future uses of the groundwater in the vicinity of the former pits.[54]

C. *Some of Texpet's pits were either (i) not identified or (ii) not included in the RAP for various reasons, and thus were never remediated. Those pits continue today to be sources of environmental contamination and risk to human health and the environment.*[55]

Notwithstanding conclusions about Texpet having met its contractual obligations under the RAP, while serving as Operator of Concession E&P activities Texpet failed to properly manage its waste streams. During this period, Texpet also failed to close pits properly and in a timely manner when they were no longer needed as dictated by good management approaches practiced elsewhere in the world.[56] Instead, they postponed many pit closures and remediation activities (including those that should have been routine environmental management practices) until after they had turned over operations to Petroecuador.[57] The result was that Petroecuador inherited from Texpet an aging infrastructure and a multitude of environmental problems.[58] As pointed out by Henderson et al.[59], many of the practices used in the Concession were outmoded. Rather than keeping pace with changes in practices implemented decades before in both the U.S. and internationally, the Henderson et al. memo simply suggests "changes in environmental practices to lessen the impact of petroleum operations." The memo states, "Our general impression is that petroleum operations have had a relatively insignificant impact on the environment outside of facility sites."[60] The authors further note that they "saw little evidence of any direct impact on the population."[61] The inherent flaw in this approach is apparent from the findings of previous investigators[62], as well as from our independent site investigations conducted from July through October 2013 (see Section 2.2) and from the risk assessments performed by Dr. Strauss.[63] Even today, persistent contamination

[53] *See generally* Strauss, 2013
[54] Strauss, 2013, p. 38-39
[55] *LBG February 2013 Expert Report*, 2013, p. 3
[56] Notwithstanding the fact that the use of unlined earthen pits to contain E&P wastes were prohibited elsewhere in the world by the time Texpet commenced its operations in the Oriente (*see generally* Kaigler, 2013). Also, On-site burial of wastes in unlined pits and surface discharges of produced waters in a tropical rainforest are not, and were not at the time, sound environmental management practice because excessively harmful impacts to the environment and human health were known and predictable. Legacy buried wastes found on-site today will likely continue to act as a source for future contamination of soil and water. (Templet, 2013, p. 2).
[57] As documented by Woodward-Clyde, 1995 in the RAP.
[58] As documented in audit reports by Fugro-McClelland, 1992, and HBT Agra, 1993; and as addressed in the MOU/SOW and the RAP
[59] Henderson et al., 1990, p. 1, 6-7
[60] Henderson et al., 1990, p. 1
[61] Henderson et al., 1990, p. 1
[62] See Table 4.1-1
[63] *See generally* Strauss, February 2013 and 2013

associated with Texpet-operated well sites (whether included in the RAP or not) remains and presents potential exposure pathways to receptors.

Opinion 4: Even some of Chevron's supposedly remediated sites continue today to (a) exceed the performance standards contained in the RAP, (b) exceed permissible limits promulgated in Ecuadorian laws and regulations and (c) be a persistent source of environmental contamination and risk to human health and the environment.[64]

In addition to the evidence already amassed for the *LBG February 2013 Expert Report*, we subsequently conducted additional site investigations of five well sites sampled during the JIs for the Lago Agrio Litigation (See Appendix B and Section 2.2). In four out of the five sites that we investigated we visually observed, many years after the JIs had been conducted, irrefutable evidence of persistent free-phase oil inside and outside the boundaries of the well site associated with (i) Texpet-remediated pits or (ii) pits closed prior to the RAP,[65] and we measured crude oil constituent concentrations in excess of Ecuadorian standards.[66] At the fifth site, Aguarico-2, we observed free-phase oil at the site in a seep. These observations, along with recent laboratory analytical results, further support this opinion.

Opinion 5: Chevron's claim that "intrinsic bioattentuation / biodegradation" has effectively reduced contamination so as to prevent ongoing risks to human health and the environment is not supported by the results of the JIs included in the evidence adduced at trial.[67]

Free-phase oil was observed visually and later documented by laboratory analysis of samples collected during our current independent site reconnaissance and investigations at Texpet-remediated pits or pits closed prior to the RAP. Stream bottom sediments were found to be saturated with oil associated with these pits and at locations where similar conditions had been found seven or eight years ago during the JIs. Chevron's claim of extensive, intrinsic or "passive" bioremediation is directly contradicted by these observations. Furthermore, evaluation by Dr. Short shows Claimants' retrospective prediction of crude oil's *in situ* "weathering" to be grossly overstated and their methods flawed, [68] and that the weathered state of oil found in 2013 associated with Texpet's former operations has not materially changed as when evaluated by Douglas in 2006 – seven years ago.[69]

Opinion 6: Chevron's sampling programs and testing procedures were not representative and thus did not adequately characterize the extent of contamination as being within legal norms; notwithstanding this limitation, however, Chevron's (and Plaintiffs') sampling and testing evidenced significant contamination by toxic compounds.[70]

Chevron claims that its peripheral samples were taken to establish "clean perimeters" around Texpet-remediated pits. [71] As explained in Section 4.2.1, in nearly all cases, the JI well sites could not be enclosed by a clean perimeter in

[64] *LBG February 2013 Expert Report*, 2013, p. 3
[65] An example is the Pit 3 at the LA-02 well site that was closed by TexPet in 1990 and is documented in Chevron's LA02 JI Playbook and their 2007 Clickable Database, but was not disclosed to the Lago Agrio Court. Submitted with Respondent's Rejoinder.
[66] See Appendix B
[67] *LBG February 2013 Expert Report*, 2013, p. 4
[68] Short, 2013, Section 4.1
[69] Short, 2013, Section 4.1
[70] *LBG February 2013 Expert Report*, 2013, p. 4

compliance with the The February 2001 Substitute Regulation of the Environmental Regulation for Hydrocarbon Operations in Ecuador, Decree 1215 (hereinafter reffered to as RAOHE) permissible limit for sensitive ecosystems (1,000 mg /kg). Based on our analysis of the available data, either: i) data were insufficient (fewer than four sample points available per site[72]), ii) contaminated locations (greater than 1,000 ppm TPH) were on the perimeter with no clean points beyond, iii) the perimeter did not enclose all the pits on a site, or iv) the perimeter crossed a stream in attempting to encircle the contamination.[73] This assertion is not supportable even when the JI, PI, Rebuttal, and "CVX Cabrera shadow team" sample data are considered together. Even based on Chevron's admittedly biased data, the distribution of the surface soil data indicate that [redacted][74] Similarly, the surface soil data indicate that [redacted]. Based on this probability of surface soil contamination, the number of samples collected at any site during the JI is grossly inadequate to be considered statistically "representative" or capable of supporting the conclusions drawn by Chevron in the JIs, and certainly do not meet the standard for a "comprehensive" investigation which Connor claims that Chevron conducted.[75]

<u>Opinion 7</u>: The Judgment's assessment of damages appears at least reasonable.

In our February 2013 Expert Report, we offered the opinion,"The Judgment's assessment of damages appears at least reasonable." That is, while we offered no opinion at that time as to the reasonableness of the ***amount*** of the damages for soil and groundwater cleanup, we opined that the ***fact*** that the Judgment awarded damages (under local Ecuadorian law) for ongoing contamination resulting from Texpet's activities in the Concession Area was reasonable. Quantification of these damages based on assessment of remedial costs was outside our scope.[76] Rather, our scope was limited to demonstrating that environmental impacts had occurred and were persistent in the environment as a result of Texpet's activities (i.e., that the assessment of damages at all was, in fact, reasonable). We were not asked to allocate or apportion

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[71] Connor, 2013, p. 2, 14-15

[72] Connor, 2013, Table 1, page 1 of 2 Bullet 2 "Collect soil samples at 4 or more locations surrounding the site (pit or affected area perimeter samples may also be used as site perimeter sampling locations when applicable), vertically composite a soil sample from each location perimeter location."

[73] Since a stream represents a zone of sediment transport, the inclusion of a stream within a "clean perimeter" provides a means for contaminant transport away from a well site across the perimeter. Thus crossing or contacting a stream in the construction of a "clean perimeter" precludes the assertion that all contaminated soils and sediments associated with a site are contained within the perimeter.

[74] According to ATSDR, EPA Method 418.1 "provides a 'one number' value of TPH in an environmental media; it does not provide information on the composition (i.e., individual constituents of the hydrocarbon mixture). The amount of TPH measured by this method depends on the ability of the solvent used to extract the hydrocarbon from the environmental media and the absorption of infrared (IR) light by the hydrocarbons in the solvent extract. EPA Method 418.1 is not specific to hydrocarbons and does not always indicate petroleum contamination (e.g., humic acid, a non-petroleum hydrocarbon, may be detected by this method). According to ATSDR, "An analytical method commonly used for TPH is EPA Method 8015 Modified. This method reports the concentration of purgeable and extractable hydrocarbons; these are sometimes referred to as gasoline and diesel range organics, GRO and DRO, respectively, because the boiling point ranges of the hydrocarbon in each roughly correspond to those of gasoline (C6 to C10-12) and diesel fuel (C8-12 to C24-26), respectively."

[75] Connor, 2013, p. 11, 14, and 15

[76] Despite representation by Chevron's attorney, Jeffrey D. Dintzer, Esq., to the contrary during his May 13-14, 2013 deposition of Kenneth Goldstein. This was in the presence of the Chevron expert (Hinchee) who prepared the cost estimate spreadsheet entered into evidence. **Ex. 2** Deposition of Kenneth J. Goldstein, May 13, 2013, Vol. 1, p. 69-78.

liability (in monetary or percentage-based terms) between Texpet and Petroecuador – a task which would be undoubtedly be governed by Ecuadorian law.

2.2 Summary of Independent Site Investigations

Claimants[77] and their expert Connor[78] assert that our opinions were insufficiently informed because they were based only on data collected by others, given that we had not conducted independent investigations. Hinchee, in several places in his June 2013 expert report, opines that our criticisms of Chevron's and Texpet's previous investigations are flawed by a lack of understanding as to how investigations at oil fields are routinely conducted,[79] and both Hinchee and Connor attempt to justify their decision to forego detailed groundwater investigations – which we believe for many reasons should have been conducted – by positing (based on their informal and flawed U.S. state survey – to be discussed later) that groundwater contamination at oil field facilities is rare.[80] Moreover, considering the findings of the environmental audits and PIs/JIs, Connor concludes:

> *The results of the extensive environmental investigations conducted to date show that groundwater and surface water resources are nearly free of any chemical impacts, while significantly impaired by bacterial contamination. Residual soil impacts are principally limited to open pits and un-remediated oil spills on some well sites and production stations. However, perimeter soil sampling shows that such impacts are confined to localized areas within the oilfield facilities.*[81]

In response to criticisms leveled by Claimants, we conducted independent site investigations at several of the sites evaluated in JIs for the Lago Agrio Lawsuit. Given time constraints associated with developing this Rejoinder, these investigations were not intended to be comprehensive remedial investigations. Rather, they were intended to test in a focused way the broad (and, as it turns out, insufficiently supported) assertions made by Claimants and their experts about the exact nature and supposedly limited extent of contamination resulting from Texpet's activities in the former Concession Area in their various documents submitted in this Arbitration. In other words, we conducted investigations to determine whether these assertions could stand up to independent scrutiny by capable investigators.

2.2.1 Description of Site Selection Process

2.2.1.1 Identification and Reconnaissance of Study Sites

Since part of the purpose of our site investigation was to examine the basis for the judicial finding, site identification began with the review of available data for 45 well sites visited during the Lago Agrio proceedings.[82] We developed an initial list of 16 candidate sites based on data from the PIs and JIs. This list ultimately grew to encompass 22 candidate sites, including alternates, based on further review and some initial reconnaissance findings – such as discovering significant recent alterations to certain Texpet sites which eliminated them from further consideration. We planned a

[77] *Claimants' Reply Memorial, Annex A*, p.2-3
[78] Connor, 2013, p. 1, 4
[79] Hinchee, 2013, p. 2, 13, 16
[80] Hinchee, 2013, p. 16; Connor, 2013, p. 3
[81] Connor, 2013, p. 37
[82] Connor, 2010, p. 3, 40

series of site reconnaissance visits to screen as many of these sites as possible, and ultimately visited 18 of them as shown on Table 2.2-1 and Figure 2.2-1 (back of ocument).

Table 2.2-1 Candidate and Selected Sites for July 2013 Reconnaissance

	Site	Visited	Reconnaissance Observation
1	YU-02	X	Historical oil spill in wetland area N of platform confirmed
2	SA-Norte PS	X	Significant recent site changes apparent
3	SA-65	X	Visited very briefly, but no field notes; significant recent site changes apparent
4	SSF-Suroeste PS	X	Significant recent site changes apparent
5	SSF-25	X	Oil contamination observed in adjacent stream near residence
6	GU-06	X	Oil contamination observed in wetland and stream
7	GU-07	X	Significant changes to platform and infrastructure since the JI
8	LA-02	X	Oil contamination observed in stream near residence
9	LA-Norte PS	No	Decided against visiting more production stations after observing changes at SA-Norte and SSF-Suroeste
10	LA-15	X	Steep embankment; obvious contamination not observed
11	Dureno-1	X	Recent remediation of pit area; steep terrain and difficult access
12	AG-02	X	Oil seep noted in pit area
13	SSF-18	X	Recent remediation of wetland area
14	SSF-48	X	Densely overgrown; difficult access
15	SSF-04	X	Densely overgrown; difficult access
16	SA-57	X	Densely overgrown; difficult access
17	SA-14	No	Learned that entire well field under control of a different entity; required additional logistics
18	SA Central PS	No	Decided against visiting more production stations after observing changes at SA-Norte and SSF-Suroeste
19	SSF-45A	No	Determined that failed injection well disqualified; would confound interpretation
20	LA-11	X	Obvious contamination not observed
21	AG-03	X	Recent infrastructure development
22	SSF-69	X	Densely overgrown; difficult access
	Total Sites Visited	**18**	

2.2.1.2 Selection of Study Sites

To be selected for further detailed study, we evaluated sites against the following criteria:[83]

1) The presence of a Texpet structure (i.e., pit) that had been used exclusively and closed (or abandoned) by Texpet.
2) No remediation of the structure of interest after the 1995-1998 RAP period.

[83] These criteria were identified in response to assertions made by Chevron's experts in their various documents submitted in the BIT Arbitration.

3) Readily apparent crude oil contamination in the vicinity of the Texpet structure, which could be detected via minimally invasive sampling (i.e., probing).
4) The potential for existence of a complete human or ecological exposure pathway related to the oil under current or possible future land use conditions.

Of the sites that satisfied these criteria, we applied the following additional parameters:

1) Accessibility: If sites were not sufficiently accessible (to permit the completion of investigations within weeks), they were excluded.
2) Spill History: If sites had a history of large spills subsequent to Petroecuador assuming responsibility for operations in June 1990, they were excluded.
3) Geography: If sites were not geographically dispersed, they were excluded. We included sites that represented a range of locations operated by Texpet across the Former Concession Area.

Based on the site visits, the following sites were selected as satisfying the selection criteria:

1) Lago Agrio 02 (LA-02)
2) Shushufindi 25 (SSF-25)
3) Yuca 02 (YU-02)
4) Guanta 06 (GU-06)
5) Aguarico 02 (AG-02)

These sites are shown in the insets on Figure 2.2-1. More detailed scale maps are provided in Appendix B.

2.2.2 Summary of Site Investigation Findings

2.2.2.1 Site-Specific Summary of Findings

Lago Agrio 02 (LA-02)

The Lago Agrio 02 (LA-02) well was reportedly Texpet's second production well drilled in 1967.[84] Texpet dug several pits during its drilling and operation;[85] however, during the RAP, Woodward-Clyde only identified and oversaw the remediation of one pit,[86] and this one remediated pit is the only pit acknowledged by Chevron to the Court during trial of the Lago Agrio Lawsuit.[87] However, Chevron did acknowledge and investigate these pits during its PI.[88] One of the pits that was not acknowledged to the Court (i.e., Pit 3) had been closed by Texpet in 1990.[89] Pit 3 is located at the northern

[84] Chevron's 2006 Clickable Database; Environmental Site Summary Report Form: Part 1 for Lago Agrio 02. (submitted with Respondent's Rejoinder)
[85] Chevron's 2006 Clickable Database; Environmental Site Summary Report Form: Part 1 for Lago Agrio 02
[86] *See generally* Woodward-Clyde International. "Remedial Action Project Oriente Region, Ecuador Volumes I and II." Final Report, May 2000 (hereinafter referred to as Woodward-Clyde, 2000)
[87] Lago Agrio Lawsuit
[88] Chevron's 2006 Clickable Database, LA-02 JI Playbook
[89] Chevron's LA-02 JI Playbook and their 2007 Clickable Database. Note that in Appendix D we provide a detailed evaluation of historical and current documents and databases obtained from Chevron and GSI in order identify two types of pits: Type I pits that are

end of the platform at the northwest corner on a neighboring property. During its PI, Chevron's field team had determined that it was highly contaminated,[90] as shown by borings that encountered oil-saturated sand. See Figure 2.2-1.

Figure 2.2-2 Photograph taken by Chevron of oil saturated sand in "Pit 3" during their unofficial Pre-Inspection[91]

Our investigations of LA-02 focused on Pit 3 and observable impacts associated with it. Our initial site visit found oil at both the ground surface between Pit 3 and the adjacent stream to the west and in the stream for tens of meters downstream of the pit. A family had built their house near the pit and was living within about 10 meters of the contamination. Our Site Investigation found that the subsurface included a layer of sand saturated with groundwater that discharges to the stream[92]. Our site investigation team found oil contamination (as evidenced by visible oil and concentrations of TPH, TPAH, and specific PAHs)[93] and metals[94] above applicable standards in the soil both inside and outside of Pit 3. Furthermore, we found groundwater contamination in the pit area, including visible oil and concentrations of TPH and

exclusively attributable to Texpet and Type II pits that are jointly attributable to both Texpet and Petroecuador. Type I pits are pits dug by Texpet at wells drilled by Texpet and production stations constructed by Texpet that were closed by Texpet. Type II pits were dug by Texpet at wells drilled by Texpet and production stations constructed by Texpet that either were subject to continued use by Petroecuador continued after June 1990 or were subsequently closed by Petroecuador.

[90] 2006 Clickable Database, LA-02 JI Playbook, 2013 Access® Database. (submitted with Respondent's Rejoinder)

[91] 2006 Clickable Database

[92] *See generally* Appendix B

[93] Naphthalene, Benz[a]anthracene, and Pyrene

[94] Barium, Cobalt, Copper, and Lead

Chrysene above applicable standards.[95] Figure 2.2-3 is a photo of a groundwater sample bailer with oil on it from MW-01, one of the monitoring wells near Pit 3. Figure 2.2-4 shows purge water collected during sampling from MW-01 with oil floating on it. Our site investigation team found contamination of sediment by TPH and TPAH (including suites of alkyl PAH typical of spilled, moderately-weathered crude oils[96] lingering in the Concession Area) above applicable standards and barium above background concentrations for several hundred meters downstream of the pit. Contamination of surface water by TPH, metals[97], and phenols was also detected. Both groundwater and surface water samples had detections of naphthenic acids, which are a water-soluble fraction of oil. We determined that Pit 3 was (at least) a historical source of contamination to the stream, and soil, groundwater, surface water, and sediment remain impacted 24 years after Texpet closed the pit. We arrived at this determination based on hopane/sterane fingerprint[98] of the oil found in Pit 3 and in the sediments of the stream, the proximity of Pit 3 to the stream, and the origin of the stream (i.e., just upstream of the pit).

Figure 2.2-3 - Photo of oil on groundwater sample Bailer from well MW-01 taken during our site investigations

Figure 2.2-4 - Photo of purge water from well MW-01 at LA-02

Shushufindi 25 (SSF-25)

Texpet drilled SSF-25 in March of 1973; the well was converted to an injection well by Petroecuador in January 2005.[99] Four pits were identified by Texpet during the RAP; three of these were remediated during the RAP and the fourth, Pit 2 (a water pit), was recently remediated by Petroecuador.[100] [redacted]

[95] Water samples from wells with visible oil were not analyzed.
[96] Short, 2013, p. 14-16
[97] Aluminum, Iron, and Manganese
[98] Short, 2013, p. 16; hopane and sterane are a subset of biomarkers discussed in this section
[99] Chevron's JI Playbook for SSF-25, September 2005, Executive Summary, p. 1 of 3
[100] On-site discussion with PetroAmazonas employee

[redacted].[102] Pit 1 is also adjacent to a small stream used by local residents as a water resource. Our initial site visit found that oil-saturated sediment was apparent in the stream downstream of Pit 1 near a residence. At this time, we also found that an additional pit (not identified in the RAP or by Chevron during the [redacted] or JI) exists north of the platform (as we predicted in the *LBG February 2013 Expert Report.)*[103]

We focused our investigation on contamination associated with Pit 1. While drilling at the SSF-25 well site, we found groundwater in a sand layer beneath much of the site. By contouring water levels measured in monitoring wells and well points tapping this saturated sand, we showed that the groundwater flow direction is from the platform and pit area toward the small stream. The limited site investigation found that soil in and adjacent to the pit was contaminated with TPH, TPAH, individual PAHs, some volatile organic compounds,[104] and some metals[105] above applicable standards.[106] We found contaminated groundwater (with TPH and chrysene) near the pit. We also found contaminated sediment downstream of Pit 1 (see Figure 2.2-5). These sediments were contaminated with TPH andTPAH (including suites of alkyl PAH typical of spilled, moderately-weathered crude oils lingering in the former Concession Area[107]), while surface water in the stream was contaminated with TPH, phenols, and metals[108] above applicable standards. Both groundwater and surface water samples had detections of naphthenic acids. Hopane/sterane fingerprint analyses[109] of oil contamination both in soil samples from near Pit 1 and sediment in the adjacent stream show that the contamination in the pit and the stream are related. Therefore, groundwater, soil, sediment, and surface water contamination related to a Texpet-remediated pit during the RAP is persistent at Shushufindi 25 and is found at locations where people can potentially be exposed.

[101] Chevron's 2006 Clickable Database
[102] Chevron's 2013 Access® Database, SSF25-PI-SB1-GW – 0.26 mg/l DRO
[103] *LBG February 2013 Expert Report*, 2013, p. 57
[104] Ethylbenzene and Total Xylenes
[105] Barium, Chromium, Copper, Lead, Nickel, and Vanadium
[106] A review of Chevron's 88 background samples has found that for all nine metals tested, the average concentration is below the Ecuadorian standards (both TULSMA and RAOHE). The TULSMA in Section 4.1.3.3 states: "*The more reliable background values are those derived from the samples taken in those areas outside the area under study which are considered unaffected by local contamination. In the total absence of background values of the immediate area outside the study area these values may be obtained from applicable regional or national areas. To determine the background or reference value, at least 5 samples should be collected, if taken from 5 to 20 samples, the averaged value must be selected as the background value.*" For this reason we compare the metals to the appropriate standard, understanding if it is above the standard it is also above background.
[107] Short, 2013, p. 18-19
[108] Aluminum, Iron, Manganese, and Thallium
[109] Short, 2013, p. 16

Figure 2.2-5 - Borehole in sediment with oil droplets coming to water surface at SSF-25

Figure 2.2-6 - Oil saturated sediment from wetland just north of YU-02

Yuca 2 (YU-02)

Texpet drilled YU-02 in July 1979. Two pits, Pit 1 to the south and Pit 2 to the northwest of the platform,[110] were used by Texpet at YU-02 and were addressed under the RAP in 1996. YU-02 is currently still active as a producing well. [redacted] The JI Playbook[111] indicated that [redacted] The Lago Agrio Plaintiffs collected a sample from this location, so Chevron collected a rebuttal sample there during the JI. Chevron's JI sample had a concentration of 11,000 mg/kg DRO (sample JI-YU2B-A1-SD1).

We initially visited the site to assess if contamination found by Chevron in 2006 was still apparent seven years later. During the site visit, we found sediment at the Chevron sampled location saturated with oil. Figure 2.2-6 is a photograph of sediment we collected at the same location indicated by Chevron.

During our initial visit, we found oil sheens seeping from the bank of a stream that drains the former Pit 1 area. Our investigations at YU-02[113] focused on former Pit 1 and on the wetland to the north of the platform. While drilling at the site, we encountered groundwater in a sand layer beneath Pit 1 and across the site in other soil borings. Our investigations found soil contamination both in and around Pit 1 that included observations of oil in soil, as well as detections of TPH,

[110] Based on JI Playbook for YU-02; descriptions vary in other Chevron sources
[111] 2007 Clickable Database, Environmental Summary Report Form 1 YU-02
[112] "*An impacted swamp borders the well platform to the N, and was apparently impacted from a spill 20 years ago according to local residents.*" (Based on JI Playbook for YU-02; 2007 Clickable Database, Environmental Summary Report Form 1 YU-02)
[113] See Appendix B for more details regarding investigation results.

TPAH, some PAHs[114], and some metals[115] above applicable standards and background levels. We also found groundwater contamination, including TPH, and barium; sediment contamination, including TPH, TPAH (including suites of alkyl PAH typical of spilled, moderately-weathered crude oils lingering in the former Concession Area[116]), and lead; and surface water contamination, including TPH, phenols and some metals.[117] Hopane/sterane fingerprinting[118] shows that sediment contamination and soil contamination near Pit 1 are related. Groundwater, soil, sediment, and surface water contamination related to a pit remediated by Texpet during the RAP and a spill that occurred in the mid-1980s still exists at YU-02 and is found at locations where people can potentially be exposed.

Guanta 6 (GU-06)

Texpet drilled the GU-06 well in 1987. Based on our review of aerial photographs and satellite imagery obtained from Chevron[119], a pit associated with the well at the base of a slope adjacent to the platform (Pit A) was apparently closed in the late 1980s or early 1990s, and a flare was subsequently constructed above the pit. This site was not addressed by Chevron during the 1990s RAP. [redacted] however, they avoided collecting samples between the pit and the stream during the JI.[120] Evidence from our initial site visit indicated that the area where the PI sample was collected and the sediment in the adjacent stream were saturated with oil (see Figure 2.2-7).

Our limited site investigation[121] of GU-06 found that soil at Pit A was contaminated with TPH, TPAH, and some metals above background levels.[122] Groundwater displayed visible oil (see Figure 2.2-8) and was contaminated with TPH, and PAHs,[123] Sediment showed contamination by TPH, TPAH, (including suites of alkyl PAH typical of spilled, moderately-weathered crude oils lingering in the Concession Area[124]), and cadmium, while surface water was contaminated with visible oil (when sediment is disturbed oil droplets and sheens rise to the water's surface), phenols, and some metals.[125] Stream sediments remain heavily contaminated with crude oil nearly a half-kilometer downstream of the likely point of entry.[126] Hopane/sterane fingerprint analyses[127] show that oil contamination near the pit matched oil contamination in the stream. Both groundwater and surface water had detections of naphthenic acids, which are a water-soluble fraction of oil. The observable oil in the soil and sediment and the confirmed contaminants from sample analyses show that Pit A was a significant source of oil contamination to the stream at one time (while continuing migration cannot be ruled out), and that the contamination at GU-06 associated with Pit A is persistent.

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[114] Benzi(a)anthracene and pyrene
[115] Barium, Copper, and Nickel
[116] Short, 2013, p. 18-19
[117] Aluminum, Barium, Cadmium, Copper, Iron, Manganese, Nickel, Thallium, Vanadium, and Zinc
[118] Short, 2013, p. 16
[119] 2007 Clickable Database, GU-06 'other images'; GU-06 JI Playbook
[120] 2007 Clickable Database
[121] See Appendix B
[122] Barium, Copper, Nickel, and Vanadium
[123] Benz[a]anthracene, Benzo[a]pyrene, and Pyrene
[124] Short, 2013, p. 18-19
[125] Aluminum, Iron, and Manganese
[126] Short, 2013, p. 16
[127] Short, 2013, p. 16

Figure 2.2-7 - Oil seeping from saturated sediment downhill from GU-06 Pit A toward adjacent stream, July 2013

Figure 2.2-8 - Oil on groundwater sample bailer from GU06 MW-04

Aguarico 2 (AG-02)

Texpet drilled well AG-02 in 1970;[128] the well is still active. Three pits associated with the well were remediated by Texpet in 1996 and 1997.[129] [redacted] During our initial site visit, we investigated the location shown in the video. At that location, we observed oil and groundwater seeping out of the ground surface and flowing down the side of the hill into the adjacent river. At the location where the oil meets the river, local residents have built platforms into the river to wash their clothing (see Figure 2.2-9). Borings installed during our investigations at AG-02 encountered clay, but did not encounter shallow groundwater or sand layers; consequently no monitoring wells were installed. We collected five samples from AG-02: a sediment sample from the seep area, a sediment sample from a stream immediately to the south of the pits, and three soil samples (two of which were screened in the field and not sent to the laboratory). The sample from the seep was contaminated with TPH at 31,310 mg/kg and also contained TPAH above applicable standards. Our investigation shows that oil migrating from a Texpet-remediated pit is still impacting the adjacent environment.

[128] Chevron's 2006 Clickable Database; Environmental Summary Report: Form 1 for AG-02
[129] Chevron's 2006 Clickable Database; Environmental Summary Report: Form 1 for AG-02
[130] Chevron's 2006 Clickable Database

Figure 2.2-9 - Platform built by local residents for laundry downhill from oil seep at AG-02

2.2.2.2 Summary of Findings by Environmental Medium

As detailed above, the results of our five independent site investigations indicate petroleum hydrocarbon-related contamination in each of the media investigated, i.e., soils, sediment, surface water and groundwater. For soils and groundwater, it is important to understand for purposes of contaminant distribution whether contamination was found inside a pit or had migrated outside the pit. Therefore, we have conducted an analysis to discern the position of each soil boring and monitoring well sampling location relative to pit boundaries. Because Texpet did not keep records of each pit's exact location and extent, we had to rely on other information. We made this assessment by taking into account a number of factors including:

1) Geographic location of boring in relation to mapped extent of pits
2) Geological descriptions of subsurface material encountered in borings (color, soil type, changes in color and/or soil type, presence of roots/leaves at depth suggesting soil mixing)
3) Observations regarding petroleum impact (in conjunction with other indications such as location and geologic material) – type of impact (odor, sheen or free-phase oil)and depth of impact observed
4) Groundwater flow direction with respect to boring position and pit location (i.e., up-gradient or down-gradient of a known pit)
5) Location of boring with respect to other borings interpreted in/out of pit (e.g., if boring under examination is surrounded by other borings deemed "in", it is highly likely the boring is in the pit, even if no other evidence is available to support that conclusion

By examining and integrating all these factors and using professional judgment, an assessment was made as to whether individual borings were located inside or outside of a former pit (either remediated or simply closed by burial). The results of these assessments are shown in Table 2.2-2.

Table 2.2-2 – Boring Locations Relative to Pit Boundaries

Well Site	Total number of borings at location	Number of borings "in pit"	Number of borings "out of pit"
LA-02	30	11	19
SSF-25	30	6	24
GU-06	22	5	17
YU-02	21	5	16
AG-02	9	0	9

Texpet-remediated/closed Pits

Contrary to claims by Connor and Hinchee, we observed free-phase oil and found TPH concentrations[131] above both RAP[132] and current Ecuadorian standards[133] in soil samples from within Texpet-remediated pits or pits closed prior to the RAP at three of the five sites investigated, i.e., LA-02, SSF-25, and YU-02. Metals and PAHs also exceeded applicable criteria or (for metals only) background values in several samples at these same three sites.

Soils (outside of Texpet-remediated Pits)

We found evidence of contaminated soils (i.e., chemical analytical results, as well as readily apparent free-phase oil and olfactory evidence) adjacent to Texpet-remediated pits or pits closed prior to the RAP at all five sites investigated. This included exceedances of applicable criteria for TPH, PAHs and metals. Despite visual observations of free-phase oil in certain soil borings placed adjacent to pits during site investigations, some individual soil samples collected from those borings did not yield chemical analytical results exceeding regulatory criteria. In addition, several borings did not display gross free-phase oil contamination based on visual observation or exceed regulatory criteria based on chemical analytical results, suggesting that continued lateral migration of free-phase oil through soil from pits at those locations is not appreciable. Some of these borings were intentionally located outside of the expected influence of the pit being investigated to verify the absence of other confounding influences.

Groundwater

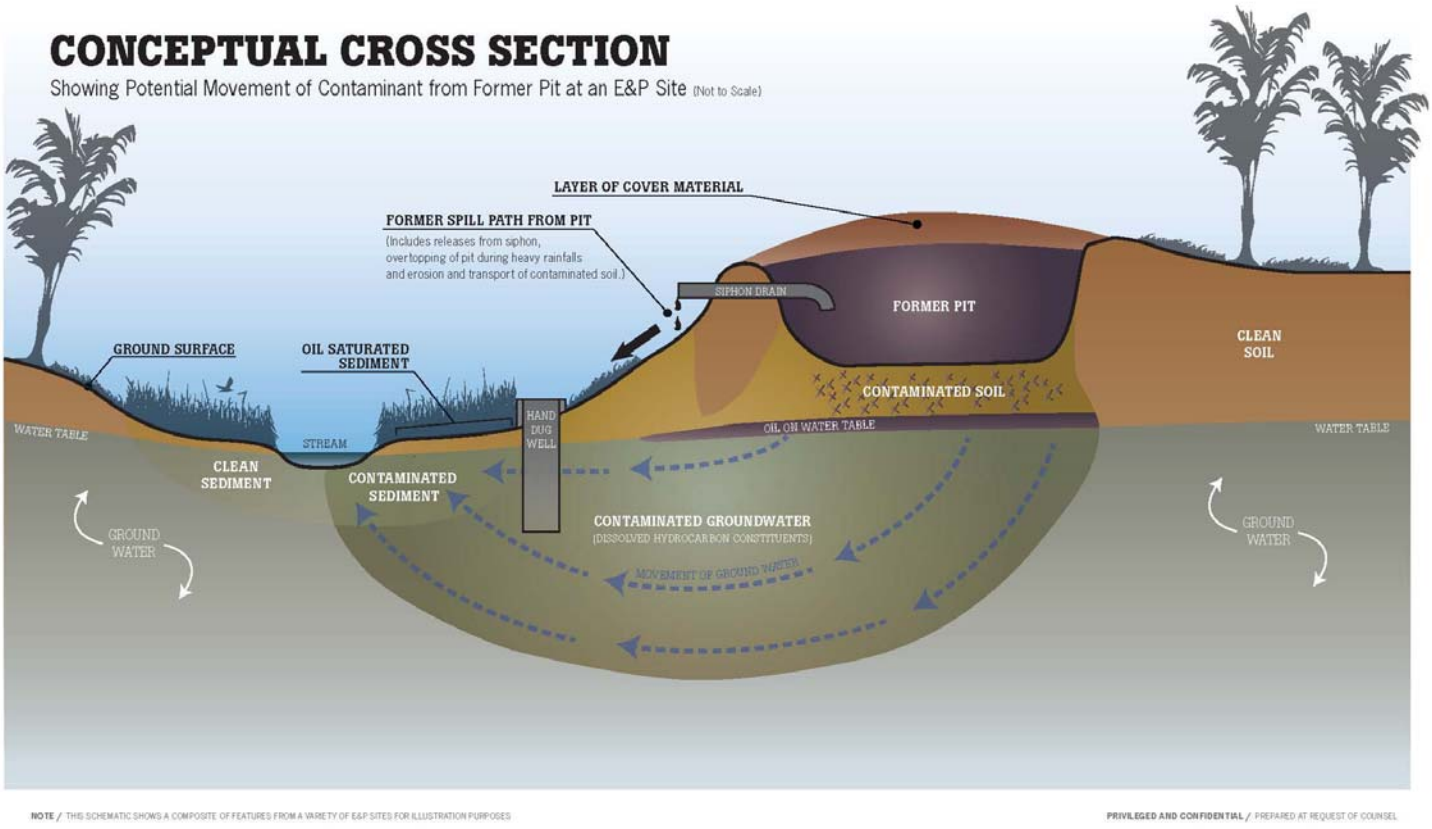
We found groundwater contamination below and immediately adjacent to Texpet-remediated pits or pits closed prior to the RAP at all of the sites where we investigated (LA-02, SSF-25, YU-02, GU-06, and AU-02).[134] This determination

[131] Using extended range *Method 8015B* analyses
[132] RAP soil treatment criterion of 5,000 mg/kg (some at multiples)
[133] Current Decreto 1215 (RAOHE) standard of 2,500 mg/kg for agricultural soils employed by PetroAmazonas for their current pit closure,
[134] No monitoring wells were installed at AG-02. However, we observed free-phase oil in a groundwater seep.

was based on exceedances of applicable criteria for TPH, PAHs, and barium,[135] and /or visual observations of floating oil on the groundwater.

Because a detailed understanding of the groundwater flow direction was unavailable until after these investigations were conducted, we could not optimize well placement vis-à-vis groundwater flow fields (i.e., monitoring wells placed hydraulically downgradient of pits). That being the case, in some cases we could not confirm or refute the presence of downgradient groundwater petroleum hydrocarbon contamination (migration). However, for each of the sites investigated, a stream intercepts shallow groundwater and the groundwater discharges to the stream. The stream is located within 30 meters or less of the downgradient edge of a well platform or pit stream sediments at four of the five sites were confirmed to be contaminated (see below). This proximity to a stream or wetland would tend to limit the downgradient extent of a shallow groundwater contaminant plume; however, it is likely that contaminated groundwater is discharging into the adjacent surface water or wetland complex. See Figure 2.2-10 as an illustration of this concept.

Figure 2.2-10 Conceptual Cross Section



[135] Barium was found in groundwater at YU-02 only.

Wetlands

The terrain in these locations does not lend itself to access by a drill rig. In any case, the sampling plans implemented for these five sites were focused on selected pits remediated or closed by Texpet, and not on the broader features of those sites. However, at one location (i.e., YU-02), we observed the continuing presence of a large swath of oil contamination attributed to a historical Texpet spill[136] in a wetland area adjacent to the north of the well platform. Concentrations detected in all three sediment samples collected in the wetland complex showed TPH levels well in excess of any applicable Ecuadorian criteria. Two samples (T06A and T05) showed concentrations of approximately 50,000 mg/kg, and the third (T04) registered over 5,000 mg/kg. PAHs and, lead also exceeded applicable criteria. The location (T05) with the highest sediment sample concentrations also showed surface water exceedances of TULSMA Appendix 1 TPH, and phenols criteria. Location T06B, while having lower TPH concentrations in sediment, had exceedances of surface water criteria similar to the sample collected at T05.

Streams, Seeps, and Sediments

During site reconnaissance and site investigations, we visually observed sheens and free-phase oil at locations of stream sediment probing. Laboratory results indicated high concentrations of petroleum hydrocarbon contamination in excess of applicable RAOHE[137] or TULSMA[138] criteria, sometimes by multiples, in stream bed sediments adjacent to Texpet-remediated pits or pits closed prior to the RAP. This occurred at four of five sites investigated (LA-02, SSF-25, YU-02, and GU-06) and in sediment from a groundwater seep near the edge of the pit at AG-02. PAH s were exceeded at SSF25, YU-02, GU-06, AG-02 and LA-02. Cadmium was exceeded at AG-02 and GU-06 only.

We found that contamination extended many tens to hundreds of meters downstream of points of likely transport from Texpet pits and well site operations. The oil present in the stream sediments at depths of 0.5 to 1 meter suggests discharges of massive amounts of oil over time. In one case (GU-06), we determined that samples upstream of the pit were contaminated, but at a lower concentration than those adjacent to and downstream of the pit. This suggests the possibility of a second source farther upstream, possibly one or more of the unconfirmed pits identified by Chevron from [redacted][139] Nonetheless, releases from the adjacent pit remain the most likely source of the higher concentrations adjacent to and farther downstream from the pits.

Evidence of Soil and Groundwater Contamination Beyond Pit Boundaries

Observations of contamination, including presence of oil as sheens or free product, strong petroleum odors, and analytical results of soil and groundwater samples were used to assess if there was evidence of contaminant migration beyond the pit boundary. Note that not all locations where there were observable impacts were sampled for laboratory analyses (including all parameters that exceed the applicable standards). Table 2.2-3 presents the number of borings where the presence of contamination was identified outside of pit boundaries.

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[136] Chevron's JI Playbook – YU-02
[137] RAOHE, *Table 6: Permissable Limits for the Identification and Remefiation of Contaminated Soils in all Phases of the Hydrocarbon Industry, Including Service Stations* [English translation], see sensitive ecosystem criteria
[138] TULSMA Book VI, Appendix 2, *Table 3: Remediation and Restoration Criteria* [English translation] see agricultural criteria for soils
[139] Chevron's JI Playbook – GU-06

Table 2.2-3 Borings Showing the Presence of Contamination Outside Pit Boundaries

Location	Visual Observation Only	Visual Observation and Laboratory analyses	Laboratory Analyses Only	Total number of borings outside of pits where contamination was encountered
LA-02	4	6	1	11
SSF-25	2	1	9	12
GU-06	4	1	2	7
YU-02	2	1	2	5
AG-02	3	1	-	4

The observation and confirmation of contamination beyond pit boundaries shows that at least to some extent, contamination does not stay in the pits as asserted by Chevron's experts. However, due to the limited nature of our investigation and the locations where samples were collected, the extent of soil contamination beyond the pits has not been delineated. At some locations, such as LA-02, there is evidence of contamination migrating between the pit and an adjacent stream. At SSF-25, there are several metals, vanadium and barium in particular, found in excess of the applicable standards (and Chevron's average background) in several borings. At YU-02, dissolved TPH were found in a monitoring well (MW-03) that is 30 m downgradient of a RAP-remediated pit, showing migration in the groundwater.

Our investigations at these five well sites have demonstrated that, contrary to Chevron's assertions, groundwater and surface water resources (including sediment) are not free of chemical impacts, and soil impacts are not confined to localized areas within the oilfield facilities. Rather, they extend onto adjacent properties. Contamination resulting from Texpet's E&P activities was widespread and is persistent in the former Concession Area and presents potential exposures to both neighboring residents and to ecological resources. Moreover, we have demonstrated that Chevron's decision to forego detailed investigations of groundwater and surface water resources was biased by their flawed pre-suppositions about the nature and extent of contamination at such sites.

2.3 Texpet Operations Resulted in Persistent and Widespread Contamination

At each of their approximately 325 well sites[140] in the heart of the Amazon rain forest, Texpet disposed of wastes, such as drilling muds and additives, crude oil released during well yield testing and workovers, spill cleanup residues, and well workover wastes (including acid solutions, treatment solvents, brines, formation water, and crude oil) into uncovered,

[140] HBT Agra, 1993 p. 1-3

unlined, earthen waste and/or "reserve" pits.[141] During heavy rains, these wastes either overtopped the pits or flowed out through horizontal pipes (siphons) installed in the containing berms to discharge excess fluids[142]. This effluent poured onto surrounding soils, contaminating drainage courses and surface water bodies/wetlands that received the released wastes and contaminated stormwater. Because Texpet's waste pits were not lined, non-aqueous phase liquids (NAPL) and dissolved contaminants were able to migrate from the unlined pits to groundwater. In some cases, these waste pits were excavated below the shallow water table and therefore, NAPL in the pit would have been in direct contact with groundwater. After reaching the groundwater, NAPL and dissolved phase contaminants may have been transported to seeps, springs, and streams. Uncontrolled disposal of exploration and workover wastes in unlined pits was not the universally-accepted practice at the time, even in Latin America. As discussed by Kaigler, petroleum exploration and extraction in Venezuela and United States, even though taking place at an earlier point in time, avoided similar impacts by:

1) Collecting drilling fluid for reuse at another well or disposing of it in the well annulus or a dedicated disposal well at an appropriate depth.
2) Recovering pre-production crude oil by storing it in the well's production tubing until production could begin.
3) Promptly closing and backfilling open waste pits.
4) Containing workover wastes in steel aboveground storage tanks and disposing of them in a controlled manner[143] (See Table 2.3-1)

Once petroleum production was initiated, Texpet separated formation water from the stream of extracted petroleum and directed this "produced water" to a series of unlined, earthen waste pits at each of the 22 production stations and at least four individual well sites,[144] from which the produced water stream was ultimately discharged to the ground surface or to nearby rivers, streams or wetlands. Produced water typically contains petroleum NAPL, brines and emulsions. Some of the separate phase crude oil may have been skimmed from the surface of the pits during the discharge process, but produced water disposal is documented to have contaminated surrounding soils[145], drainage courses[146], and surface water[147] and sediments in the receiving streams. Contamination related to produced water disposal was caused both (i) by overtopping of the pits during heavy rains, many of which are documented to have been completely covered by a layer of crude oil[148], seepage of NAPL and dissolved phase constituents from the unlined pits to subsurface soils and groundwater,

[141] HBT Agra, 1993, p. 5-14, Section 5.5.2
[142] Woodward-Clyde, 2000, Section 3.2, p. 3-4
[143] *See generally* Kaigler, 2013
[144] Woodward-Clyde, 2000, Section 1.4, p. 1-4
[145] HBT Agra, 1993, p. 6-20
[146] Fugro-McClelland, 1992 p. 6-36
[147] HBT Agra, 1993, art 7 – Surface Waters, *e.g.*, Table 7-2 documenting TPH concentrations in produced water effluent ranging from 1-21 mg/L TPH (C5-C30) and further, Section 7.4.2.1, documenting the change in ionic characteristics of the Rio Niutshinac from a calcium bicarbonate water to a sodium chloride water (page 7-6) and "concentration of TPH showed about a threefold increase at site R3d as compared to the background site" (p. 7-10).
[148] Fugro-McClelland,1992, Figures 6-1 through 6-7.

and (ii) by disposal of wastes directly into surface water, resulting in sediment and surface water[149] contamination. During the period 1964-1990, Texpet processed an estimated total of 375 million barrels of produced water containing petroleum hydrocarbons and brines to rivers and streams in the Concession Area[150] which were noted by Fugro-McClellend to be discharged by Texpet into surface waters.[151]

As related in *Kenneth Kaigler's Expert Report*, VARCO's produced water was disposed via injection into specifically-drilled deep disposal wells (5,000 to 6,000 feet in depth) or via re-injecting it back into the production zones of producing wells as part of water flooding projects intended to increase petroleum yield. The use of injection and re-injection wells by VARCO was specifically intended to prevent contamination of surface water bodies and groundwater resources that were used by the surrounding population for their potable water needs. In contrast, Texpet used clean surface water for water flooding projects, rather than reinject produced water effluent.[152]

Finally, miscellaneous spills, including pipeline releases and spillage of waste oil, maintenance chemicals, and equipment wash water at the production stations, further contributed to contamination caused by Texpet during their operations in the Concession Area.[153] See Table 2-3.1.

3 Response to Select Criticisms by Claimants' Experts

Claimants and their experts Connor and Hinchee have criticized various elements of our opinions as resulting from inadequate understanding of oilfield conditions and investigation approaches, being insufficiently familiar with the findings of the historical audits and investigations, and not conducting our own independent inspections and measurements. In this section, we address specific criticisms and assertions of errors; it should not be inferred that because we may not address any particular criticism directly that we agree with Claimants on the point. Because the Claimants frequently resort to selective use of our statements out of context in order to criticize caricatures of our opinions, we also seek to set the record straight for selected issues. In addition, we point out errors and misstatements made by Claimants and their experts in the course of rendering their criticisms. The first subsection here addresses criticisms made by Connor, the second addresses criticisms made by both Connor and Hinchee, the third addresses criticisms made principally by Hinchee, and the fourth addresses issues raised primarily in Claimants' Reply Memorial, Annex A.

3.1 Responses to Summary Criticisms by Connor

Connor's 2010 expert report offered several opinions relative to Texpet's remediation program (RAP) conducted from 1995 to 1998. He also opined regarding the results of subsequent investigations conducted by Chevron for the Lago

[149] Fugro-McClelland, 1992, Appendix B, *e.g.*, Tables B-1, B-4, B-5, B-9, B-12, B-13, B-17, B-18 (specifically, detections of TPH in 'mixing zone' samples downstream of produced water effluent discharge).
[150] HBT Agra, 1993 Section 5.4.1, p. 5-6
[151] Fugro-McClelland, 1992, p. 6-35 to 6-36
[152] Canfield, 1991, p.. 298 Fig. 13 caption. See also HBT Agra, 1993, Section 5.5.1, p. 5-9
[153] HBT Agra, 1993, p. 6-13 to 6-21

Agrio Trial. Below are five primary arguments summarized by Connor in his June 2013 Expert Report[154] based on his September 2010 Expert Report.[155]

1. "Environmental Management Practices: Texpet operations in Ecuador from 1972 to 1990 were consistent with applicable regulations and prevailing practices for environmental management for oilfield operations at that time."[156]

In the *Connor 2010 Expert Report* Connor states that his "evaluation of available information confirms the findings of the HBT-Agra [1993] and Fugro-McClelland [1992] audit reports" regarding such conformance.[157] However, Connor fails to cite any specific examples of Ecuadorian regulations that would have applied "at that time."[158] This is apparently because he is focused exclusively on regulations containing numerical criteria. In the *LBG February 2013 Expert Report*, we summarize both Ecuadorian regulations in effect "at that time" and requirements stated in the Concession Agreements. In his 2013 expert report, Connor argues that our assertions "that Texpet practices violated applicable Ecuador regulations, and were inconsistent with relevant standards of the time in the U.S." resulted from misrepresentation of "historical documents, which even in their own time, did not reflect consensus opinion, prevailing customary practices, or applicable regulations."[159] Our opinion on this topic is clarified in Section 3.4.1 below in response to Claimants' criticisms of our application of the standards and requirements.

To more thoroughly assess Texpet's activities vis-à-vis Ecuadorian regulation and prevailing practices, additional experts were retained for the team. See the *Expert Opinion by Kenneth Kaigler* (with respect to oilfield E&P operations) and the *Expert Opinion by Paul Templet* (with respect to oilfield regulation and environmental practices) respectively. Both Kaiger and Templet respond to Connor's descriptions of the prevailing practices[160] for environmental management in the U.S. and other countries (including Ecuador). They discuss the use of unlined pits and pit closure procedures. See Table 2.3-1(back of document) which presents a comparison of waste disposal practices employed by Texpet in the former Concession Area with those considered normative at an even earlier time for operations conducted in the US and in Venezuela by Kenneth Kaigler. Based on Kaigler and Templet's opinions, we also observe that Connor misuses snapshot statistical surveys (conducted as regulators continued to phase out outmoded and risk-prone practices from historical

[154] Connor, 2013, p.13
[155] *Expert Opinion of John A. Connor, P.E., P.G., B.C.E.E. Regarding Remediation Activities and Environmental Conditions in the Former Petroecuador – Texaco Concession, Oriente Region, Ecuador*, *Issued: 3 September 2010* (hereinafter referred to as the Connor, 2010). Connor also addresses the Governmental approval of the RAP but the RAP and the government's approval of the RAP are irrelevant here.
[156] Connor, 2013, p. 2
[157] Connor, 2010, p. 7
[158] Connor, 2010, p. 12 cites the TCLP soil leachate criterion for evaluation of remediation effectiveness as being required by Ecuador's Decreto 1215, but this is not an operational regulation. He also provides a discussion of what he considers the relevant U.S. regulations "governing the construction and closure of oilfield pits" (p. 18), as well as more recent regulations promulgated in Ecuador and neighboring countries (p. 19).
[159] Connor, 2013, p. 6
[160] Conner, 2010, p. 21

operations) to determine the appropriateness of various practices.[161] This misguided approach does not adequately consider the environment, land use practices, and surrounding populations in the Oriente.

2. "Proper Completion of Remediation Program: Texpet completed remediation work during the period of 1995 to 1998 in accordance with the Scope of Work (SOW), the Remedial Action Plan (RAP), and the subsequent modifications and additions specified by the GOE and Petroecuador."[162]

In the *LBG February 2013 Expert Report*, we were critical of the investigations used to determine remediation requirements (and the associated lack of appropriate documentation), as well as the effectiveness of the remediation as evaluated using Chevron's PI and JI data. Connor defends the "logical, step-wise process…employed to identify and characterize environmental conditions warranting corrective action…and to assign a portion…for remediation by Texpet."[163] This recitation of the contractual process sidesteps several significant points that we identified in our expert report:

1) As sole operator of the Concession until 1990, Texpet is responsible for all of the site conditions created until that time, including those that warrant remediation.
2) Texpet's practices created significant environmental impacts.
3) Texpet could have avoided or mitigated these impacts had they employed commonly accepted best practices at that time (e.g., by recovering wastes from unlined pits for disposal at an appropriate depth in the well annulus and by disposing of produced water in a deep disposal well, rather than direct discharge of produced water to receiving water resources).
4) Texpet should have been more diligent in its operations and maintenance procedures (i.e., due diligence activities, timely pit closure, and conversion to more acceptable and environmentally sound waste management approaches as work progressed) before their infrastructure was turned over to Petroecuador.

3. "Recent Inspections Confirm Proper Remediation: Inspections conducted during the period of 2003 to 2009 confirmed that Texpet completed the remediation of pits, soils, and spill sites, and other required tasks, in accordance with applicable specifications."[164]

We maintain that underlying observations from the Fugro-McClelland and HBT Agra[165] audits indicated that some pits and spills released contamination beyond the boundaries of the well sites. Despite Chevron's claims that some pits and spills have been sufficiently remediated, JI and PI data indicate contamination was present at the time of the Lago Agrio Lawsuit. In fact, our site investigations confirm contamination persists at the five sites we studied as of the date of this report. While Connor asserts that Texpet's remediation efforts were completed according to applicable specifications, our independent observations in the former Concession Area indicate continuing migration of contamination (see Section

[161] Connor, 2013, p. 3
[162] Connor, 2013, p. 2
[163] Connor, 2013, p. 6
[164] Connor, 2013, p. 2
[165] HBT Agra Limited, 1993. "Environmental Assessment of the Petroecuador-Texaco Consortium Oil Fields, 1964-1990." Prepared for: Petroecuador-Texaco Consortium by HBT Agra Limited, Calgary, Alberta. October 1993. (hereinafter referred to as "HBT Agra")

2.2.2 and Appendix B). As we show in Section 3.3, Hinchee's assessment that JI (and PI) sampling results consistently confirm proper remediation is, with few exceptions, either optimistic or factually incorrect.

4. "Un-Remediated Areas Not in Texpet Scope of Work: The un-remediated pits and spill areas remaining in the Concession area were not included in the Texpet remediation program but should be remediated by Petroecuador for practical concerns but not human health issues."[166]

Contrary to prevailing standards and practices, Texpet ignored the impacts of crude oil in the environment in Ecuador. Their activities with respect to environmental management of oilfield waste products were insufficient and untimely. Moreover, they exhibited a disregard for the implications of failing to properly and promptly remediate discharges. As noted in his next point (shown below) and elsewhere in his expert rebuttal, Connor denies that "impacts allegedly remaining from the Texpet era pose significant risks to human health and the ecosystem…" He asserts that our "opinions are based upon their misinterpretation of the actual data and failure to address the effects of Petroecuador's operations" and that we do not rely on new data or new site investigations.[167]

Upon re-review of the evidence,[168] we opine that the historical audit report conclusions in many cases do not match the import of the actual underlying observations; instead, they disregard or dismiss them.[169] Further, since Connor's rebuttal report was issued in June 2013, we have undertaken a program of reconnaissance at 18 well sites and production stations previously investigated during the JIs and more detailed investigations of a subset of five well sites, containing pits remediated by Texpet under the RAP or closed prior to the RAP and showing no record or other evidence of later influence by Petroecuador.

The results of these investigations are consistent with our initial assessment of data collected by Texpet and Chevron and their consultants, including Connor.[170] To summarize, these investigations document the following:

1) Ongoing releases from Texpet-remediated pits.
2) The presence of contamination at unacceptable levels beyond site boundaries in streams and wetland areas.
3) The existence of groundwater contamination at unacceptable levels originating from Texpet-remediated pits.
4) The existence of pits created by Texpet that were simply not accounted for in the RAP and the JI process containing uninvestigated (and therefore unknown) levels of contamination.

All of these observations are contrary to Connor's expressed opinions (see Section 2.2 above and Appendix B) in that they show Texpet-remediated pits and Texpet-closed pits continue to be sources of contamination. Connor never defines what he means by "practical concerns," hence it is impossible to draw a boundary between actions that would address such concerns and remediation to address "human health issues." Does he mean issues of physical safety such as people or

[166] Connor, 2013, p. 2
[167] Connor, 2013, p. 1
[168] This includes Fugro-McClelland, 1992; HBT Agra, 1993; Woodward-Clyde, 1995 and 2000; and the JI and PI data
[169] See Section 4.1 and Table 4.1-1
[170] *See generally LBG February 2013 Expert Report,* 2013

animals falling into them with the potential for injury? Does he mean, like Henderson, et al., for aesthetic reasons? Or does he mean simply to fulfill contractual agreements regardless of actual value? Any of these reasons may have their place, but we have demonstrated that contamination due to Texpet's substandard E&P operations persists and is present beyond the boundaries of the well sites where people can be exposed.

5. "No Risk to Human Health: The residual impacts (if any) on soils, groundwater, or surface water remaining from the historical operations of the Consortium posed no measurable risk to human health."[171]

This broad statement makes no distinction between pits and spills remediated by Texpet under the RAP and similar pits and spills wherein remediation was assigned to Petroecuador.[172] Connor also opined that:

> *[T]he results of the extensive environmental investigations conducted to date show that groundwater and surface water resources are nearly free of any chemical impacts, while significantly impaired by bacterial contamination. Residual soil impacts are principally limited to open pits and un-remediated oil spills on some well sites and production stations. However, perimeter soil sampling shows that such impacts are confined to localized areas within the oilfield facilities.*[173]

These and similar statements appear to be founded on two highly questionable hypotheses, both of which are in conflict with actual test results:

1) Any residual crude oil contamination is limited in impact and extent.
2) Crude oil existing in the environment is all highly weathered and immobile.

With respect to the first hypothesis, Connor states:

> *The areas of soils containing residual petroleum, either in Texpet-remediated pits or Petroecuador open pits, have been delineated with clean perimeter soil samples, which show that the affected soils are limited in area and do not extend beyond the immediate area of the oilfield facilities (production station or well platform).*[174]

Our analysis of the JI and PI data shows this premise to be false. It indicates that the number and locations of samples collected were insufficient to establish "clean perimeters" in all but a few of the sites evaluated, even according to the less-than-robust rules stated for that purpose (see Section 4.2.1 below and Appendix C). In other words, the investigations completed for the JIs (even if the PI data not submitted to the Court are considered) were insufficient to exclude the likelihood of contamination extending beyond the reputed "clean perimeters."

The second hypothesis is stated by Connor as follows:

> *Visual inspections, soil sampling, and laboratory analyses…show that the petroleum remaining in soils and pits as of 2004-2009 was highly weathered, except in areas of recent spills or discharges by Petroecuador. This*

[171] Connor, 2013, p. 2
[172] *See generally* Woodward-Clyde, 1995
[173] Connor, 2013, p. 37
[174] Connor, 2013, p. 2-3

> *means that the original crude oil has…converted to a solid or semisolid mass that is effectively non-soluble, non-volatile, and immobile within the environment. Consequently these materials will not spread beyond their current location, which is typically in pits.*[175]

Dr. Short has shown that weathering analyses – discussed by O'Reilly and Thorsen[176] and relied upon by Connor and Hinchee[177] – are fundamentally flawed and greatly overstate the degree of weathering that has occurred in crude oil dispersed in the Oriente based on Chevron's own samples. Hypotheses regarding weathering and immobility of petroleum residues in the Concession Area are contrary to the data gathered during the Lago Agrio trial (*i.e.*, PIs and JIs).. Our observations in July 2013 – confirmed by subsequent sampling at five E&P sites distributed over the northern portion of the former Concession Area – have demonstrated that mobile oil exists within pits, outside of the pits (oil-soaked soil), in monitoring wells installed in 2013, and in sediment downstream of site. It was also observed that a slight disturbance of the sediment instantaneously released free-phase crude oil to flowing streams. Finally, a quantitative human health risk assessment by Dr. Strauss demonstrates that the impacts observed from failing Texpet remediation sites present unacceptable health risks both now and in the future. This finding from observation and evaluation of actual data directly contradicts Connor's opinions that stem from inaccurate and faulty evaluations.

3.2 Arguments regarding the need for groundwater investigations (Connor and Hinchee)

In defending the validity and scientific basis of data collected by Chevron and their interpretations in the JI reports, Chevron's experts assert detailed groundwater investigations were unnecessary. Chevron's experts maintain that: "detailed groundwater investigations are not normally conducted" (and were apparently unnecessary in this case:

> [S]ince *hydrocarbon contamination in groundwater in oil fields is rare*[178], [and]
>
> [T]*he absence of such impacts* [to groundwater and surface water] *reflects the nature of crude oil, which converts to an immobile, inert mass more quickly than it migrates in the subsurface environment. This fact is particularly relevant to the Oriente region in Ecuador, where the predominately clay soils strongly impede infiltration of crude oil from pits or spills, and the hot and humid climate promotes volatilization and biodegradation.*[179]

[175] Connor, 2013, p. 3. Given the rates at which Chevron's experts project weathering to occur, one would expect that even the recent Petroecuador discharges referenced (but not identified) by Connor would have been comparably weathered by July 2013 (when Louis Berger commenced its independent investigations). But even if not, the previous universal observation about the limited extent of discharges should apply.
[176] O'Reilly, K. and Thorsen, W., 2010, Impact of Crude Oil Weathering on the Calculated Effective Solubility of Aromatic Compounds: Evaluation of Soils from Ecuadorean Oil Fields, *Soil and Sediment Contamination*, 19:391 – 404
[177] Connor, 2010, p. 47, p. 56-57, p. 72, p. 79; Connor, 2013, p. 46; Hinchee, 2013, p. 72
[178] Hinchee, 2013, p. 16
[179] Connor, 2013, p. 3

This is in direct contradiction to the opinion of Henderson et al. when they evaluated the Concession Area in 1990.[180] They suggested that the degree of groundwater impacts "can only be determined by drilling sampling wells upgradient and downgradient from the pits." This "hypothesis" was never tested by Texpet or Chevron, based on the available record.

To support his conclusion that groundwater contamination is rare, Hinchee cites several sources, all deal exclusively with sites in a few U.S. states and include one survey he coauthored with Connor.[181]

In reviewing the import of this survey, Connor states:

> *Groundwater and Surface Water Impacts by Crude Oil Pits Are Very Rare and Are Not to Be Expected Under the Physical and Climatic Conditions of the Oriente: My published survey of thousands of oil and gas production facilities in the U.S. (Connor, et al. 2011) shows that impacts to groundwater…are quite rare, occurring at only 0.4% of oil and gas facilities.*[182]

In his expert report, Connor fails to disclose that this survey of approximately 4,100 facilities is limited to four relatively arid states (i.e., Texas, Kansas, Colorado, and New Mexico) and applies several other constraining assumptions.[183] This is significant because the Concession Area is wet, not arid, and this is one of the main conditions that determines contaminant mobility.[184] By contrast, U.S. EPA published a report in 1987 that shows many examples of incidents at oilfield facilities that resulted in groundwater and surface water contamination requiring remediation. Notwithstanding, these types of surveys are only helpful in a broad sense; they do not provide much value in determining an investigation approach for a specific situation. This requires an understanding of how contaminants actually move in the environment and how local conditions affect contaminant fate.

Both Connor and Hinchee rely on this weakly-supported notion that groundwater contamination at oilfields is rare, along with the contention that the oil weathers rapidly, as justification to forego detailed investigations. However, as noted above, the premise of rapid weathering and immobility of crude oil residues in the Oriente is flawed. As a result, both Connor and Hinchee erred as to the need for robust groundwater investigations. Claimants' experts thus based their opinions on a flawed program of sampling in drinking water wells using questionable methods.[185] Connor states, "no groundwater impacts were observed at any location."[186] Hinchee adds:

> [T]*he Ecuadorean court had many reports, including one by Chevron independent experts Connor and Landazuri (2008), showing groundwater analysis from 221 drinking water wells immediately surrounding sites visited*

[180] Henderson et al., 1990, p. 3; see also p. 7
[181] Hinchee, 2013, p. 9 and **Ex. 3** Connor, J.A., Molofsky, L.J., Paquette, S.M., Hinchee, R.E., Desai, S.P. and M.K. Connor, M.K. Nature, Frequency, and Cost of Environmental Remediation at Onshore Oil and Gas. Exploration and Production Sites. *Remediation*. Summer 2011. p. 121-144. (hereinafter **Ex.3** Connor et al, 2011)
[182] Connor, 2013, p. 3
[183] **Ex. 3** Connor et al, 2011, p.123 For example, availability of electronic records (p. 122), and a focus on "remediation sites where environmental conditions require site assessment and/or remedial actions that extend beyond the scope of a short-term spill response."
[184] Other factors include the total mass of contaminant released and the lateral and vertical extent of contamination.
[185] *See generally LBG February 2013 Expert Report.* Hinchee, 2013, p. 3 maintains "lacks evidence of groundwater contamination."
[186] Connor, 2013, p. 3

> *during the Judicial Inspection. These data show the wells to be free from petroleum hydrocarbons or related contamination that may have come from the Consortium's oil field operations.*[187]

He further asserts, "[T]here is no scientific basis in the record for the Judgment's determination that groundwater remediation is required and no evidence that groundwater contamination due to operations in the former Concession exists."[188] This approach and the conclusions drawn are dubious given the compelling observations of groundwater contamination made by HBT Agra during its audit. These include:

Shushufindi Field:[189]

1) "A total of 14 groundwater samples were collected within Shushufindi Field…Of these samples, 13 were tested for O&G…Three samples yielded concentrations of 0.5 mg/L and one sample (TP1 at Well Site B66) contained a concentration of 1.0 mg/L."
2) "As discussed above, free phase petroleum hydrocarbons were encountered in the groundwater in a test pit (TP1) at Shushufindi Central Station. This test pit is located 25 meters from the nearest production pond. Groundwater samples collected from two other test pits, located over 50 m from the production ponds, contained concentrations of O&G below detection limits."

Aguarico Field:[190]

1) "Eight groundwater samples were also collected within the field…two yielded concentrations less than 1.0 mg/L, and three were greater than 1.0 mg/L. One sample (TP1 from Well Site 3) was significantly elevated at 67 mg/L. Crude oil was noted in one of three test pits at Well 9. Levels of O&G in the other test pit (TP2) at Well 9 was less than 1.0 ppm."

Sacha Field:[191]

1) "Twelve groundwater samples were collected from Sacha Field…Detectable levels of O&G were present in the groundwater sample collected from a test pit at Central Station (0.6 mg/L), in a domestic water well near Well Site 100 (0.6 mg/L) and in a monitoring well at Well Site 103 (0.2 mg/L)….However, elevated chloride values were found in well site 94 (23 mg/L) and well site 100 (24 mg/L)."

Considering the broad array of data and information available in the record regarding historical environmental management practices, local soils, and hydrologic/hydrogeologic conditions, we suspected that the presence and migration of crude oil or crude oil components via the groundwater pathway was likely. Subsequently, as a result of our site investigations, we found concentrations of petroleum-related contamination in groundwater above Ecuadorian standards

[187] Hinchee, 2013, p. 9
[188] Hinchee, 2013 p. 9
[189] HBT Agra, 1993, Section 8.5.1, p. 8-20
[190] HBT Agra, 1993, Section 8.5.2, p. 8-20
[191] HBT Agra, 1993, Section 8.5.3, p. 8-21

(see Section 2.2); these findings directly refute both the conclusions reported by Connor and Hinchee, and the hypothetical construct advanced to support their approach (i.e., rarity of incidence, immobility of contaminants).

3.3 Responses to Select Criticisms by Hinchee with Respect to Texpet's Remediation Efforts

3.3.1 Hinchee misuses data to create mathematical averages in support of his claim of effective remediation

Hinchee echoes Connor's opinion listed third above with respect to remediation effectiveness. However, his table entitled "Exhibit 5 - Post-RAP soil samples after 3/20/97 having > 5,000 mg/kg TPH, showing Texpet in compliance with RAP standards" is misleading and contains errors, which cause Hinchee to conclude erroneously that all of the pits are in compliance, when some are not. Based on a simple averaging process, which he overcomplicates as "statistical compositing," to place all in-pit sampling results on the same basis, Hinchee states emphatically that no exceedances of RAP TPH standards (5,000 mg/kg) occur. He says:

> *For those sites cleaned up after March 20, 1997, the date the 5,000 mg/kg TPH soil standard became effective, I also compared the soil TPH data to the 5,000 mg/kg RAP standard. I found that for samples composited as required by the RAP, none exceeded the standard. In only 6 pits did some grab samples exceed 5,000 mg/kg. In order to compare the pit sample results to the RAP standards, where possible, I did a statistical compositing in which I averaged all available grab sample data from each pit to simulate composite samples. The result is no exceedances of the RAP standards. These results are summarized in Exhibit 5.*"[192]

Hinchee's Exhibit 5 reputedly presents the samples which have concentrations above 5000 mg/kg TPH from six pits that were remediated after March 1997. As discussed below, there were substantive errors in three of his analyses, one analysis is ambiguous, one is correct according to his constraints, and one is based on one sample taken out of context (and so cannot be resolved). He also incorrectly asserts that these six are the only pits remediated after that time where such a sample result has been obtained. Hinchee's Exhibit 5 misses Pit 1A at SSF-45A which was also closed after March 1997 and yielded four samples above 5,000 mg/kg TPH (as high as 13,290 mg/kg). The average TPH concentration for Pit 1A is 5,151mg/kg, above the RAP standard.

3.3.1.1 SSF-48

Hinchee incorrectly used data he claims to be from Pit 4. He apparently did not verify the database information which incorrectly identifies the samples he used as being from Pit 4, [redacted] Table 3.3-1 below provides the location descriptions from Chevron's 2013 Access® database[195] of the Chevron samples likely[196] used in his analysis. Note that all of these are listed in the

[192] Hinchee, 2013, p. 27
[193] Chevron's 2007 Clickable Database, Environmental Site Summary Report Form: Part 2 for Well SSF-48
[194] Chevron's 2007 Clickable Database SSF-48 Site Map
[195] Chevron's 2007 Clickable Database

'PitorArea' field of the database as '4.' Inspection of the specific location descriptions from the 'LocationofSample' field shows that each of these samples is not within Pit 4, but actually from a location over 75 meters west of Pit 4. Because none of these samples, including the four that Hinchee points out as above 5000 mg/kg, are from Pit 4, his analysis is incorrect. These samples are above existing regulatory criteria, and would also have required remediation based on the RAP's trigger criterion.

Table 3.3-1 – Excerpt from Chevron's 2013 Database (emphasis added)

JI-SH48-SW2-SS-1.20 M	[redacted]
JI-SH48-SW2-SS-1.37 M	
JI-SH48-SW3-SB1-0.5	
JI-SH48-SW3-SB1-1.0	
JI-SH48-SW3-SB1-1.1	
JI-SH48-SW3-SB1-1.37	
JI-SH48-SW3-SB1-4.60M	
JI-SH48-SW3-SS-0.95 M	
JI-SH48-SW3-SS-4.50 M	

3.3.1.2 SSF-25

For this site, Hinchee drew incorrect conclusions about RAP effectiveness because he failed to verify the locations from which the data he used were actually collected. Had he checked, he would have found the composite sample he claims shows Pit 4 was appropriately remediated is actually from a different pit, Pit 3. In order to understand Hinchee's error, it is necessary to first clear up a discrepancy in the database he appears to have used:

[196] Hinchee does not provide a list or the number of the samples he uses only the average of the TPH concentration, we have recreated the average using the samples listed. He also likely included four samples collected by the Lago Agrio Plaintiffs.

1) Based on Woodward-Clyde's Remediation Summary Table[197], Pit 3 has an area of 75 m^2 and Pit 4 has an area of 800 m^2.
2) Based on descriptions of the pits in Chevron's Ecuador Oriente Region Enironmental Database (Clickable Database), Janurary 31, 2006 (hereinafter referred to as Chevron's 2006 Clickable Database)[198] (see Figure 3.3-1, "Site Summary Report Form, Part 1" excerpt reproduced below), [redacted]
3) However, the site map presented in the Chevron's 2006 Clickable Database [redacted]
4) Samples collected during the PI that include "PIT4" in their sample name are located in the larger pit to the southwest. This includes the sample SSF-25-PI-PIT4-SB10-1.7M, that Hinchee presents in his Exhibit 5
5) The composite sample Hinchee uses to show that Pit 4 was remediated, JI-SSF-25-SB7C, is misidentified as being from Pit 4 inChevron's Ecuador Oriente Region Non-Analytical and Analytical Database (Access® Database) August 2013(hereinafter referred to as Chevron's 2013 Access® Database) and in its location description (in the database).
6) The surveyed locations (below) of the two samples show that they are 27 meters (88 feet) from each other. This is approximately the distance between the centers of the two pits.

Sample	Longitude	Latitude
JI-SSF-25-SB7C	371401 E	9970800 N
SSF-25-PI-PIT4-SB10-1.7M	317384 E	9970779 N

7) Finally, considering the distance and direction from the well head given in [redacted]

Given that the two samples are in different pits, JI-SSF-25-SB7C's composite concentration of 369 mg/kg DRO+GRO cannot be used to show that Pit 4 was remediated. Applying Hinchee's "statistical compositing" of the samples actually collected from the same pit (Pit 4) yields an average concentration of 5,477 mg/kg DRO+GRO, above the 5,000 mg/kg TPH criteria for the RAP. This shows that Hinchee's assertion that all pits remediated after April 1997 meet the RAP standard is incorrect.

[197] Woodward-Clyde, 2000, Table 3-25 Sheet 2 of 4
[198] Chevron's 2006 Clickable Database, SSF-25 "ENVIRONMENTAL SITE SUMMARY REPORT FORM: PART 1"

Figure 3.3-1 Excerpt from Chevron's 2006 Clickable Database, "Site Summary Report Form, Part 1"

Figure 3.3-2 Map of SSF-25 from Chevron's 2006 Clickable Database showing Pit 3 and Pit 4 Reversed

Figure 3.3-3 - Locations of Samples used by Hinchee (2013) in Exhibit 5

3.3.1.3 SSF-45A

Hinchee's calculations for Pit 3 are incorrect. He ignores Pit 1A, closed after March 1997 and, similarly to the other pits on Exhibit 5, includes four samples with TPH concentrations greater than 5000 mg/kg. The average concentration of the samples in Pit 1A is 5,151 mg/kg TPH, which is above the RAP standard.[199] We have tried to reconstruct his composite sample for Pit 3,[200] but, could not recreate them exactly. The closest we could come to his average of 2,497 mg/kg was 2,516 mg/kg, which is above the current standard of 2,500 mg/kg TPH. This result requires including samples that are

[199] For this result we used samples SSF45A-PIT1A-SD2-SU1-R(1.2-1.6)M, RB-SSF45A-PIT1A-SD2-SU1-R(1.2-1.6)M, SSF45A-PIT1A-SD2-SU2-R(2.0-2.4)M, RB-SSF45A-PIT1A-SD2-SU2-R(2.0-2.4)M, SSF45A-PIT1A-SD1-SU1-R(1.0-1.4)M, RB-SSF45A-PIT1A-SD1-SU1-R(1.0-1.4)M, SSF45A-PIT1A-SD1-SU2-R(2.0-2.4)M, RB-SSF45A-PIT1A-SD1-SU2-R(2.0-2.4)M, JI-SSF-45A-SBC1-0.3M, SSF-45A-PI-PIT3-SB3-1.6M, SSF-45A-PI-PIT3-SB2-1.6M, and SSF-45A-PI-PIT3-SB2-4.4M

[200] Again, Hinchee (2013) does not share which samples he uses to create his average, so recreating his average is difficult.

outside of Pit 3, and samples of cover material. There are inconsistencies in the sample numbering and database regarding which samples are in Pit 3 and Pit 1A, and which samples are in pits at all. [redacted] If only samples from within Pit 3 are used to calculate the average, the result is 3,292 mg/kg TPH,[201] which is above the current RAOHE standard of 2,500 mg/kg TPH.

Further, the data presented by Hinchee for SSF-45A underscore the discrepancies noted in the results obtained from analytical methods 418.1 and 8015B. Chevron collected samples at the same locations as the Plaintiffs' samples that Hinchee lists (Hinchee uses these Chevron samples along with other samples in his "statistical compositing"). The Plaintiffs used method 418.1 which is also the method prescribed by the RAP, while Chevron used method 8015B. Here is a comparison of the results:

Table 3.3-2 – Comparison of TPH Sample Results for SSF-45A, Pit 3

Sample	Plaintiffs' Result By 418.1	Chevron's Result By 8015B	Factor
SSF45A-PIT3-SD1-SU1-R(1.6-2.0)M	7867	2705.6	2.9
SSF45A-PIT3-SD2-SU2-R(4.6-5.2)M	5106.5	3210	1.6
SSF45A-PIT3-SD2-SU1-R(2.8-3.2)M	5720.9	2886	2
SSF45A-PIT3-SD1-SU2-R(4.2-4.6)M	2956.9	903.9	3.3
SSF45A-PIT1A-SD2-SU1-R(1.2-1.6)M	13290.3	2419	5.5
SSF45A-PIT1A-SD2-SU2-R(2.0-2.4)M	10877.8	1914	5.7
SSF45A-PIT1A-SD1-SU1-R(1.0-1.4)M	8584.9	1916	4.5
SSF45A-PIT1A-SD1-SU2-R(2.0-2.4)M	5167.5	3827	1.4

This comparison shows that had Chevron used the method *prescribed in the RAP* (method 418.1),[202] Hinchee's results for this analysis would have a different outcome. If this were done, the 'statistical composite' for SSF-45A would exceed the RAP standard. In fact, Chevron collected a sufficient number of matched pair *Method 418.1* and *Method 8015B* samples to permit the development of predictive relationship between the two methods. The factors obtained by comparing the Plaintiff's results with those from Chevron are consistent with the factor obtained from Chevon's data alone (2.3 in the range of 500 to 2,500 ppm TPH; see Section 3.3.4).

[201] Uses samples SSF45A-PIT3-SD2-SU1-R(2.8-3.2)M, SSF45A-PIT3-SD2-SU2-R(4.6-5.2)M, SSF45A-PIT3-SD1-SU1-R(1.6-2.0)M, RB-SSF45A-PIT3-SD1-SU1-R(1.6-2.0)M, SSF45A-PIT3-SD1-SU2-R(4.2-4.6)M, RB-SSF45A-PIT3-SD1-SU2-R(4.2-4.6)M, JI-SSF-45A-SBC2-0.3M, SSF-45A-PI-PIT3-SB2-1.6M, RB-SSF45A-PIT3-DUP1, and SSF-45A-PI-PIT3-SB6-3.8M
[202] Woodward-Clyde, 1995, p. 8

3.3.1.4 SA-65

Our evaluation of Dr. Hinchee's assessment of SA-065 is inconclusive because more information would be needed to support a finding that Pit 2 is in compliance with the RAP. At SA-65 the Lago Agrio Plaintiffs collected a sample from within the waste in Pit 2 that had a concentration of 7,519 mg/kg TPH, and a sample from beneath the waste with a concentration of 519 mg/kg TPH.[203] However, Chevron collected composite samples from two borings approximately 3 meters apart that have concentrations of 130 mg/kg TPH (a surface sample) and 15 mg/kg TPH (a subsurface sample). Chevron indicates that these borings were in Pit 2; however, the Plaintiffs' map shows otherwise.[204] It appears that Hinchee uses both of these samples, plus the two Plaintiffs' samples, to calculate an average of 2,021 mg/kg (we arrive at a slightly different value of 2,045 mg/kg). However, the 519 mg/kg value represents material below the waste and the 130 mg/kg value represents cover material. Thus, there are at most two samples that can be averaged (7,519 mg/kg and 15 mg/kg) yielding an average of 3,766 mg/kg, which is above the current RAOHE agricultural limit of 2,500 mg/kg TPH in soils for agricultural land use. If the Lago Agrio Plaintiffs are correct and the Chevron borings were outside of the pit (which seems likely given the very low concentrations detected), then the 7,519 mg/kg TPH value is the only sample representing the waste material; this value is above the RAP standard of 5,000 mg/kg TPH. Note that this sample represents material from 1.2 to 3.6 meters in depth[205] which comprises more than 2 meters of material.

3.3.1.5 SSF-8

In this instance it appears that Hinchee's assessment is correct. There are several samples collected by Chevron during the PI and JI from Pit 2, including many composite samples. The average concentration of these samples would be below both the 5000 mg/kg and the 2,500 mg/kg TPH thresholds[206].

3.3.1.6 SA-95

Louis Berger does not have sufficient information regarding this location to conduct an assessment. If there is a single sample at 11,829 mg/kg TPH as claimed by Hinchee[207] , its "average" is above the 5,000 mg/kg standard. It would require at least two additional samples with 1,500 mg/kg TPH or less to bring the average concentration below 5000 mg/kg, and at least four additional samples with less than 200 mg/kg to bring the average below 2,500 mg/kg TPH.

3.3.2 Hinchee misstates our criticism of Chevron's use of composite samples

On page 15 of his 2013 Report, Hinchee juxtaposes a partial sentence lifted out of context from the *LBG February 2013 Expert Report* with his own thought:

> *LBG says 'collection of composite samples within pit boundaries may be appropriate', **while also criticizing Chevron for collecting composite soil samples.** Soil sample compositing during the Judicial Inspections was appropriate. First, RAP remediation standards were based on composite soil sampling. Second, compositing is a*

[203] Plaintiff's JI Report for SA-065, Cuerpo 618, p. 19 shows that a stratigraphic change occurs at 3.6 m where gray oily sand is above gray brown sandy silt. This is likely the bottom of the pit. Chevron does not provide boring logs for its samples collected at SA-65.
[204] Maps in the Plaintiff's JI Report for SA-065, Cuerpo 618, page 16 show chevron's sample locations outside of the Pit 4.
[205] Plaintiff's JI Report for SA-065, Cuerpo 618, p. 19
[206] Based on a review of Chevron's 2007 Clickable Database and Chevron's 2013 Access® Database
[207] Hinchee, 2013, Exhibit 5

> *standard practice for soil sampling, particularly in oil field investigations, because of the physical properties of oil in soil.*[208] (emphasis added)

Our actual text reads:

> *Collection of composite samples **within pit boundaries** may be appropriate in some cases, but use of composite samples **outside of pits** should be avoided in most circumstances because it dilutes observed concentrations of toxic compounds and blurs the differences in concentration from place to place which are necessary to understanding contaminant movement (direction and distance) away from the source. Likewise, selecting the appropriate locations spatially in comparison to the pit or other source is extremely important in discerning the extent and movement of contamination. Representative air sampling requires development of reliable underlying information about wind speed and direction over time, as well as the location of sensitive receptors (homes, especially with children and pregnant women, crops, or wildlife).*[209] (emphasis added)

As can be seen, Hinchee's abbreviated quote from our report and insertion of his own thought (shown in bold above) misrepresents our arguments. Many of Chevron's composite samples were collected from outside of pit boundaries and were used to suggest that contamination does not migrate from source areas (pits). Most of the composited samples from outside pits were composited from single borings. We maintain that collecting composite samples (as implemented by Chevron) for delineating contamination and assessing the extent of contaminant migration is inappropriate, regardless of the type of contamination.

Chevron obtained approximately 20 percent of its samples as composites. As opposed to direct sample measurement, sample compositing creates a mechanical average of the individual sample concentrations, thereby reducing the chance of identifying high concentration locations. Vertical sample compositing at a location ignores concentration variations with depth and masks the maximum interval concentration. Deeper soil borings have a greater tendency to mask the maximum concentration since more intervals are included in the composite. Additionally, there is a greater likelihood that deeper, uncontaminated segments may be added to the composite, thereby diluting the composite sample and resulting in an artificially low concentration. Horizontal compositing, which can be used to estimate the mean concentration in an impacted area, also has limited usefulness when trying to identify individual contaminated locations or to describe a boundary between impacted and non-impacted areas. Like vertical compositing, it masks the maximum concentrations among locations. Also, the composite may include soils with very different properties, making homogenization difficult and potentially resulting in a low bias value since fine-grained soils (with a relatively high potential for contamination) may be mixed with gravel-type soils (with a low potential for contamination). Horizontal compositing is useful in determining area-based averages but does not provide a basis to establish clean boundaries, one of Chevron's asserted sampling goals.[210] Sampling plans submitted to the Court do not provide guidance as to soil type or distance

[208] Hinchee, 2013, p. 15
[209] *LBG February 2013 Expert Report*, 2013, p. 25-26
[210] Connor, 2013, Example Sampling Strategy Table for SA-Norte-1-PS

considerations in creating sample composites,[211] thus their composite samples are likely subject to large uncertainties related to these considerations.

Approximately 1120 samples were taken by Chevron from areas outside the pits for the 52 sites examined by the Court (45 JI sites plus 7 additional sites added by the Court Expert for which Chevron data exist), including PI, JI, Rebuttal and Shadow Team samples. Of these, 229 were vertically composited samples, and 25 were horizontally composited samples. Therefore, 23 percent of the samples analyzed by Chevron were composite samples (21 percent vertical and 2 percent horizontal). We reassert that Chevron's "composite" sampling (vertical and horizontal) was inappropriate and only served to avoid finding "hot spots" and to reduce contaminant concentrations, especially for vertical compositing of borings outside of remediated pits. Hinchee's claim that such compositing was undertaken to assure that any contamination was identified at any given location[212] is directly contrary to his assertion that crude oil contamination is obvious.[213] Based on this assertion, it should not be necessary to advance a boring beyond the obvious oil contamination.

3.3.3 Hinchee misstates our understanding of the purpose of the JIs

In section 4.2.3 entitled "Chevron Judicial Inspection sampling was appropriate and consistent with international standards of practice," Hinchee again juxtaposes a partial sentence lifted out of context from the *LBG February 2013 Expert Report* with his own thought, twisting our words to provide opportunity for unfounded criticism:

> *The Judicial Inspections were not designed or expected by Chevron, the Plaintiffs, or the Lago Agrio court 'to determine the full extent of contamination at each of the well sites and production stations' [citing LBG, 2013, page 37] <u>throughout the Concession area.</u> The Judicial Inspections were only designed to investigate the presence and extent of contamination at 121 sites selected by both parties and ordered by the Lago Agrio court and to determine Texpet's compliance with the RAP at those locations.*[214]

Our actual text in Section 3.2 entitled "Limitations and Shortfalls of the JIs" reads, "In general, neither the party-appointed nor the court-appointed experts conducted investigations that can be used to determine the full extent of contamination at each of the well sites and production stations to a high degree of certainty."[215]

As can be seen when our actual text is presented, we did not expect and does not state that samples from the JI were used to determine the full extent of contamination "*throughout the Concession area*" (added by Hinchee). Our statement is that the sampling done by Chevron as well as the Plaintiffs could not be used <u>at each of the well sites and production stations</u> to assess the full extent of contamination at those locations. This is exactly what Hinchee says in the next sentence they were designed to do. Yet our assessment of the distribution of Chevron's data and our own investigations confirms that Chevron failed to determine the extent of contamination at even those sites and that Chevron's sampling program design was biased and flawed.

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[211] Environmental Assessment of Judicial Inspection Sites Sampling Plan, August 13, 2004 , Section 1.3, p. 1-1
[212] Hinchee, 2013, p. 15-16
[213] Hinchee, 2013, p. 15
[214] Hinchee, 2013, p. 14-15
[215] *LBG February 2013 Exper Report*, 2013, p. 37

3.3.4 Hinchee misrepresents the comparison of petroleum hydrocarbon analytical methodologies that we conducted and suggests that we should have acknowledged and used a (flawed) methodology present in Chevron's data set, but not used by Chevron JI reports to assess petroleum hydrocarbons

In section 4.2.4.1 of Hinchee's 2013 expert report, entitled "Total Petroleum Hydrocarbons (TPH)," he opines:

> …*Chevron analyzed TPH using both EPA Method 8015 and Texas 1006. EPA Method 8015 accurately detects TPH compounds within the range of greatest environmental significance. Texas 1006 somewhat less accurately detects a broader range of TPH compounds. Both EPA Method 8015 and Texas 1006 are similar to methods recommended by the Government of Ecuador in Decreto 1215.*[216]
>
> …[LBG, 2013] *ignores Chevron's extended carbon range Texas 1006 data and criticizes Chevron's use of EPA Method 8015 while suggesting Chevron should have used EPA Method 418.1, a method not agreed to by the parties and not in the Analysis Plan. LBG's primary criticism of Chevron's use of EPA Method 8015 is that it only detects a portion of the TPH found in soil, which is true; however, the portion that EPA Method 8015 detects contains many of the polycyclic aromatic hydrocarbons (PAHs) and most other compounds of environmental concern found in crude oil. What LBG ignores is that Chevron's Texas 1006 analysis, like LBG's preferred EPA Method 418.1, detects a broader band of TPH. EPA Method 418.1 was once in relatively common use but has been largely replaced today by the EPA Method 8015 or similar GC methods. EPA 418.1 is both less accurate and more biased than modern methods. Exhibit 4 shows LBG's exhibit on carbon ranges for EPA Methods 8015 and 418.1, but also includes Chevron's extended carbon range Texas 1006, which LBG ignored.*"[217]

Hinchee does not provide a definition of "accuracy" or "bias" to support his claims, and he misses the point that, in the RAP, infrared spectroscopy (i.e., *Method 418.1*) is the specified testing method.[218] Stating that *Method 8015B* accounts for most "compounds of environmental concern found in crude oil" is untrue: *Method 418.1* also detects these compounds as well as other compounds in crude oil that are of concern in the environment but not detected by *Method 8015B*. By choosing infrared spectroscopy, the criteria of the RAP already accounts for the range of compounds detected by *Method 8015B* and the broader range of compounds detected only by *Method 418.1*.

Method 8015B is able to detect DRO and GRO accurately, since it was designed to detect refined petroleum products; however, it does not detect all of the compounds present in crude oil. Thus, the reported concentration by *Method 8015B* is not an accurate representation of the crude oil in samples tested, and is, in fact, biased low.[219] *Method 418.1* detects a much larger fraction of crude oil and is therefore more accurate in characterizing the entire burden of petroleum hydrocarbons in a sample from the former Concession Area where crude oil (not refined petroleum) is the contaminant. The inaccuracy of *Method 8015B* with respect to the measurement of TPH of crude oil –bearing soils is illustrated by the following analysis:

[216] Hinchee, 2013, p. 16-17
[217] Hinchee, 2013, p. 17
[218] Woodward-Clyde, 1995, p. 8
[219] Short, 2013, p. 14-15

We used the set of Chevron data wherein both methods were conducted on a set of 22 samples,[220] encompassing a broad range of TPH concentrations (less than 100 to greater than 10,000 ppm TPH by *Method 418.1*). Notably *Method 418.1* yielded a number of low concentration values, including several non-detects. A broad range of concentrations by *Method 418.1* would be unlikely if plant materials were a substantive fraction of the TPH by this method. That is, given the abundance of plant materials in the soils of the Oriente, if plant materials were a substantive fraction of the TPH concentration, there would few low level concentration samples. Yet we observed many low level and nondetect samples in Chevron's limited *Method 418.1* data set (11 of 23 samples were below 200 ppm TPH by *Method 418.1* including 6 nondetects). The absence of substantive plant material in the *Method 418.1* results is also supported by the correlation of the two methods across concentrations, since *Method 8015B* is largely unaffected by plant material.

To demonstrate the low bias of *Method 8015B* with respect to the entire mass of petroleum contamination in a sample, a regression relationship was developed to predict *Method 418.1* from *Method 8015B*, see Figure 3.3-4. Refer to Appendix C for a detailed discussion of the development of this regression relationship. Because several of the *Method 418.1* samples were recorded as less than detection limits, a modified regression method designed to include nondetect data was applied. Based on this analysis, we conclude that in the range of greatest interest, close to the various regulatory permissible limits (500 to 2,500 ppm TPH in soil),[221] the results obtained by *Method 8015B* must be multiplied by a factor of 2.3 to obtain the concentrations that would be reported had *Method 418.1* been performed. Thus, samples obtained by Chevron that appear to fall below the various regulatory permissible limits based on *Method 8015B* could actually exceed these criteria based on *Method 418.1*. For example, in areas where the TULSMA Residential permissible limit of 2,500 ppm is appropriate, samples with reported values between 1,100 and 2,500 ppm TPH by *Method 8015B* likely represent locations that would exceed this permissible limit. Similarly, samples with concentrations in the range of 400 to 1,000 ppm TPH by *Method 8015B* are unlikely to represent locations that are actually below the RAOHE Sensitive Ecosystem permissible limit of 1,000 ppm. The latter example is illustrated in Figure 3.3-5.

[220] In this analysis, one outlier, an extreme value more than an order of magnitude higher than the next highest value, was excluded from the regression.
[221] This range of concentrations is based on the permissible limits specified by the Ecuadorian government, including TULSMA Residential Criteria, Decreto 3516 and RAOHE Agricultural (2,500 ppm TPH), RAOHE Sensitive Ecosystem Criteria, Decreto 1215 (1,000 ppm TPH), TULSMA Agricultural Criteria, Decreto 3516 (500 ppm TPH), and the Lago Agrio Judgment (100 ppm TPH).

Figure 3.3-4. Regression Relationship between *Method 418.1* and *Method 8015B* Results

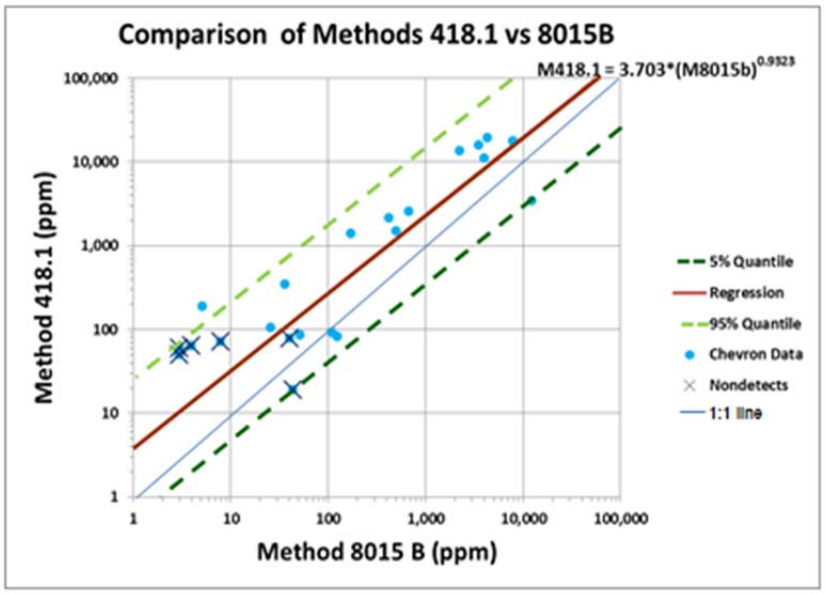
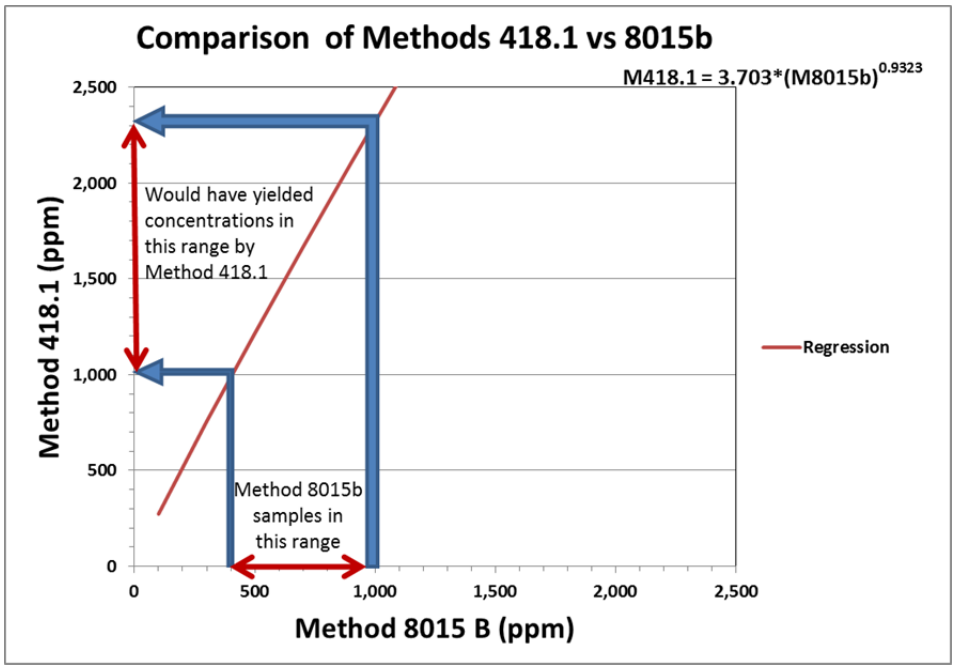


Figure 3.3-5. Conversion of Low Bias Results by *Method 8015B* to More Accurate Results by *Method 418.1* in the Range of 500 to 1,000 ppm TPH by *Method 8015B*



Like Hinchee's assertion that *Method 8015B* is comparable to *Method 418.1,* Hinchee's assertion that TNRCC1006 captures a broader spectrum of hydrocarbons than *Method 8015B* is also without merit. Based on an analysis of extensive set of matched pair samples collected by Chevron, it is clear that TNRCC1006 consistently yields lower and, therefore, less accurate concentrations of TPH in each sample. While it is possible that TNRCC1006 may capture a broader range of individual hydrocarbon compounds, it is clear from the comparison of the two methods, that TNRCC1006 captures many fewer compounds in total, resulting in lower concentrations overall as discussed below.

Figure 3.3-6 A Comparison of Method TNRCC1006 with its Multipier to Obtain a *Method 8015B* Result

The comparability of *Method 8015B* and TNRCC1006 is presented in Figure 3.3-6, which is based on the soil and sediment samples analyzed by Chevron[222] where both methods had detected petroleum hydrocarbons.

[222] The figure represents all sediment and soil samples in the Chevron's Ecuador Oriente Region Non-Analytical and Analytical Database (Access® Database) August 2013 analyzed by Chevron for both *Method 8015B* (DRO + GRO) and TNRCC1006 (total of C6 to C36) where both methods had a detection.

[redacted] This is inconsistent with Hinchee's descriptions of the methods: *Method 8015B* measures only (all that is reported by Chevron) C6 to C28 fractions, while TNRCC1006 measures a greater range, C6 to C35 fractions, so should yield the greater concentration. That 1/3 of the time TNRCC1006 did not detect hydrocarbons when *Method 8015B* did and that the majority of the time when both analyses did detect petroleum hydrocarbons, TNRCC1006 was significantly lower, often by orders of magnitude, shows that the TNRCC1006 analyses conducted by Chevron are inaccurate and biased low, underrepresenting the true TPH of the sample. For Hinchee to suggest that we should use TNRCC1006 as a replacement for *Method 418.1* indicates that Hinchee is unfamiliar with the TNRCC1006 data. In addition, his Exhibit 4 on this point[223] is misleading: *Method 418.1* detects petroleum compounds higher than C44, while the TNRCC1006 reported by Chevron only detects to C35, missing a significant portion of crude oil.

In another example of misrepresentation, Hinchee asserts:

> *LBG multiplies the EPA Method 8015 TPH results by a factor of 4 to somehow equate the method with EPA Method 418.1. I have never seen this approach at any environmental remediation or investigation. In fact Petroecuador frequently uses EPA Method 8015 when analyzing soil TPH for comparison of pit remediated soil to Decreto 1215 cleanup standards and does not multiply the result by 4 or make any adjustment. This simply appears to be LBG's invention to make TPH concentrations appear higher than they actually are.*[224]

Regressions are a common tool in science and engineering (and other mathematically based disciplines) consistent with the Scientific Method.[225] Comparison of different methods is not only common-place, it is necessary to understand how the different methods relate to each other. In the *LBG February 2013 Expert Report*, we make a comparison using Chevron's data where samples were analyzed by both methods. We acknowledge that it was a limited data set in the report and describes the purpose and method used for the comparison[226]. Further, understanding that it was a limited data set, we relied on Chevron's *Method 8015B* results to draw conclusions and only used the scaling factor as a discussion point. However, with the receipt of a larger, more complete database from Chevron,[227] several more samples where both *Method 418.1* and *Method 8015B* were analyzed were found, so a more supported correlation can be drawn spanning a larger range of concentrations as described above. In the concentration range of interest, 500m to 2,500 ppm TPH, the

[223] Hinchee 2013 Exhibit 4, page 63
[224] Hinchee, 2013, p. 17
[225] Use of this tool is sufficiently commonplace that the workplace software spreadsheet Microsoft Excel® has a function that allows one simply to right-click data presented in an x-y scatterplot graph and Excel will insert a regression line and report back the line's formula that relates x to y and the correlation statistic R^2 that measures how well the regression represents the data.
[226] *LBG February 2013 Expert Report*, p. 36
[227] Chevron's 2013 Access® Database received by Louis Berger in August 2013

result from *Method 8015B* is biased low and must be multiplied by a factor of 2.3 to convert it to a value consistent with the more accurate *Method 418.1.* The derivation of the regression is described in more detail in Appendix C.[228]

And here, Hinchee presents partial information to obfuscate the issues:

> *EPA 418.1 was the method specified in the RAP and used by Texpet during the RAP remediation. At the time of the Texpet RAP work, EPA Method 418.1 was more commonly used than it is today, and it was the only practical method for the onsite work Texpet was doing. Texpet needed an analytical method that could be used in the field so that remedial decisions (i.e., was the remediation complete or was excavation complete) could be made in real time. It would have been impractical to use EPA Method 8015 for this purpose. By the time of the more recent Judicial Inspections, EPA Method 8015 was replacing EPA Method 418.1 and Chevron had time to send the samples to a laboratory in the United States for analysis.*[229]

Hinchee fails to mention that *Method 418.1* is not widely used today only because the Freon used as an extractant in the method is no longer available, not because the results are suspect. Note that while Chevron maintains *Method 8015B* was agreed to in the Lago Agrio trial, the Plaintiffs almost exclusively used *Method 418.1*. It appears that the agreement was only on Chevron's side. The court did not admonish the Plaintiffs for using *Method 418.1*. Finally, we note the following limitations regarding *Method 8015B* that cause its low bias relative to *Method 418.1,* thus rendering *Method 8015B* inadequate for TPH delineation. *Method 8015B* determines the concentration of various non-halogenated volatile organic compounds (VOCs)[230] and semi-volatile organic compounds (SVOCs)[231] by gas chromatography.[232] It is also adaptable to the analysis of petroleum hydrocarbons, including calculating TPH by GROs and DROs. Specifically, it is intended to investigate the release of refined petroleum products into the environment, not crude oil. It is well adapted, for example, to determine TPH concentrations in the soil from leaking underground storage tanks. However, *Method 8015B* fails to capture about half of the mass of the hydrocarbons present when used to measure raw bulk crude oil.[233] *Method 8015B* results do not equate to the concentration of total crude oil constituent compounds in the environment. Chevron eschewed *Method 418.1* as likely to produce unacceptable Type I error (false positives) by including non-petroleum substances in the analysis, while failing to consider the potentially very large Type II error (false negatives) by excluding large amounts of the mass of crude oil from the analysis. By insisting on *Method 8015B*, Chevron implemented an extremely low-biased method, guaranteeing the absence of Type I errors but ignoring the likely high frequency of Type II errors.

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[228] See Appendix C
[229] Hinchee, 2013, p. 17
[230] According to U.S. EPA, a VOC is one of a group of carbon-containing compounds that evaporate readily at room temperature. Examples of VOCs include trichloroethane; trichloroethylene; and BTEX.
[231] According the U.S. EPA, SVOCs are composed primarily of carbon and hydrogen atoms and have boiling points greater than 200°C. Common SVOCs include phenols and phthalates.
[232] Gas chromatography is a method for separating the components of a solution and measuring their relative quantities. It is a useful technique for chemicals that do not decompose at high temperatures and when a very small quantity of sample (micrograms) is available.
[233] Short, 2013, p. 14-15

3.3.5 Hinchee makes statements regarding his experience that are contrary to the record

Two paragraphs from Hinchee's June 2013 Expert Report capture the issue:

> *Examples of my petroleum hydrocarbon experience include the following. I served as the Technical Director overseeing characterization and remediation of the Trecate oil well blowout near Milan, Italy. This estimated 4 to 5 million gallon crude oil blowout contaminated approximately 7 square kilometers of farm land with oil more than 1 meter deep in places.*[234]
>
> *The 100 mg/kg TPH cleanup standard used in the Judgment is inconsistent with current Ecuadorean cleanup standards, inconsistent with standards being applied to Petroecuador's remediation efforts, and,* ***in my experience, unprecedented for comparable crude oil cleanup anywhere in the world.***[235](emphasis added)

Hinchee makes the unequivocal statement that 100 mg/kg TPH is unprecedented for comparable crude oil cleanups anywhere in the world in his experiencehowever, one of the few projects he uses to demonstrate his experience,[236] the Trecate oil well blowout, used a remediation trigger of 50 mg/kg.[237] By citing this project first in a very short list (i.e. two projects) of large oilfield projects in his qualifications, Hinchee clearly invokes it as a "comparable crude oil cleanup" when considering remediation of the former Concession Area by Texpet. The following is a translated excerpt regarding the source of the cleanup standard used at Trecate from a course given by the Italian National Agency for Environmental Protection regarding management of contaminated sites and emergencies in 1998:

> *The reclamation plan, in view of the agricultural landscape of the area, characterized mainly by rice fields, had to be designed so as to avoid any variation of agronomic traits and textural farmland. Authorities also, in the absence of specific Italian law, had set as a benchmark, the proposed Dutch legislation (known as "Moen 88" - peral-tro not adopted in the Netherlands), which stipulates as "reference value" for the* ***multifunctionality of land the limit of 50 mg / Kg of hydrocarbons.***
>
> *The plan, whose initial guidelines (fig. 4) were subjected to AGIP from Control Authority on 15 April 1994 was therefore focused on the Bioremediation of land surface, taking into account the positive results of preliminary studies had shown that a good ability of indigenous bacterial populations to the degradation of the hydrocarbons contained in the crude oil.*[238] (emphasis added)

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[234] Hinchee, 2013, p. 1
[235] Hinchee, 2013, p. 5
[236] Hinchee, 2013, p. 1
[237] **Ex. 4** Greco,Toscano, Libisch, French, Hartnik, Anton, Biró, Evaluation of remediation techniques Part 2: Trecate site. 2011, CSOIL 2007 (hereinafter refeered to as Greco, 2011)
[238] **Ex. 5** Dr. Monica Di Noto and Ms. Elisa Satin, Training Course Technical Civil Protection for Emergency Management CONTAMINATED SITES And EMERGENCY SITUATIONS, The National Agency for Environmental Protection Rome, May 1998, Tutor: Dr. Angelo Felli

Figure 3.3-7 is an excerpt from the Greco,Toscano, Libisch, French, Hartnik, Anton, Biró; *Evaluation of remediation techniques Part 2: Trecate site* (2011) document regarding continued remedial efforts at Trecate (15 years after the blowout) that presents the remedial action and TPH triggers for those actions:[239]

Figure 3.3-7 . Excerpt showing cleanup criteria at the Trecate site, note "Zone 2 … 50 – 10,000 ppm" (i.e., mg/kg)

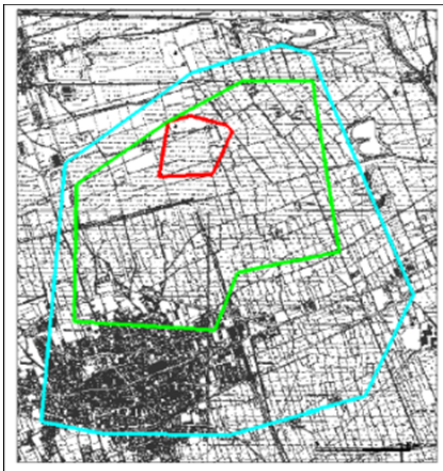

Figure 1.3. The area corresponding to the three remediation zones in the Remediation Strategy (Filauro et al., 1998)

The various characteristics of these three remediation zones are summarized in Table 1.3, below.

Table 1.3. Description of the three remediation zones

Zone Number	Size of surface	TPH concentration	Main actions
Zone 1	700 ha	< 50 ppm	Monitoring, normal agricultural operations without harvesting
Zone 2	480 ha	50 - 10,000 ppm	Landfarming; repetition frequency depending upon pollution degree
Zone 3	40 ha	> 10, 000 ppm	Intensive Landfarming. In the most polluted area (13 ha) soil excavation and *Ex-Situ* treatment in biopiles

[239] Greco, 2011, p. 5

3.3.6 Claimants' assertion that LBG failed to correctly interpret Chevron's "inside/outside" data[240] is incorrect and we reaffirm our opinion regarding Chevron's misuse of composite sampling

Claimants use their assertion that we do not correctly interpret the "InOutPit" column heading data field in their database to sidetrack the issues that were being discussed in the *LBG February 2013 Expert Report* (i.e., the pitfalls of misuse of composite samples).[241] First, we did correctly interpret this data field, so Claimants' criticism is incorrect. Second, Claimants' assertion that the data do not show contamination beyond RAP-remediated pits is not only incorrect, but fails to invalidate the point we were making about misuse of sample compositing.[242] Finally, our recent independent investigation of sites in the Concession Area (see Section 2.2), as well as our analyses of Chevron's data and the representativeness of their JI samples (see Section 4.2.5), show that contamination has escaped from the pits and persists in the environment.

3.3.6.1 LBG correctly understood the InOutPit data field

We have re-evaluated Chevron's "InOutPit" data field by plotting each of the sample locations on available maps of pit locations. The result is that our understanding as presented in our February 2013 expert report is correct: use of the qualifier "inside" refers to areas supposedly "remediated" by the 1995 RAP remediation (specific pit and spill areas, not well sites) and that the qualifier "outside" refers to everywhere else in the Concession Area (except samples collected from No Further Action (NFA) and Change of Condition (CoC) pits which are sometimes specifically identified). The statement in the *LBG February 2013 Expert Report* that is criticized by Claimants[243] is the final sentence of Section 3.2.3 where we indicate that the "outside" data show contamination that appears to have migrated beyond the edge of the pits (referring to Table 3.2-1 which shows that 45% of subsurface, outside, discrete samples exceed 1,000 mg/kg DRO by *Method 8015B*). However, the point of Section 3.2.3 is that composited samples are significantly lower in concentration than discrete samples as shown on Table 3.2-1 (the title of Section 3.2.3 is "*Composite soil sampling"*).

We acknowledge that language was unintentionally ambiguous on this point by our referring to "pits" rather than "remediated pits." However, the analyses are sound and reflect the correct understanding. Even as "corrected" by Connor's Table 2 discussed in his 2013 Expert Report,[244] the data just as clearly show extensive contamination beyond the edges of Texpet-remediated pits. Our correct understanding is also shown in Table 5.5-1 from or February 2013 Expert Report, "Number of TPH Samples from Remediated Pits Exceeding Chevron's Preferred Standard and/or Ecuadorian Regulations" which presents soil results relative to "RAP-remediated" pits in three location categories: "Inside," "Outside," and "NFA."

[240] *Claimants' Reply Memorial Track 2, Annex A*, Section II.C, Item 60, p. 22 to 23
[241] *LBG February 2013 Expert Report*, 2013, p. 39-40
[242] *LBG February 2013 Expert Report*, 2013, p. 39-40
[243] *Claimants' Reply Memorial, Annex A*, 2013, Item 60, p. 22
[244] Connor, 2013, p. 40

3.3.6.2 Evaluation of Chevron's new database confirms our original assessment

Claimants presented to the Tribunal Connor's "corrected Table 3.2-1" as errata in September 2013 (Table 2, referenced in Connor's 2013 rebuttal expert report[245]), which includes information from a data field that was not included in the database Claimants originally provided during the §1782 process (i.e., Chevron's Ecuador Oriente Region Analytical Database [Access® Database]. May 2007 [246]). The version of the database with the field used by Connor to segregate the samples on the "corrected" table ("SampleClass" data field in "LocationData_All" data table, Chevron's 2013 Access® database[247]) was not provided to us by Claimants until August 19, 2013, months after receipt of the *Claimant's Reply Memoria,l Annex A*[248] and Connor's rebuttal expert report[249] had been presented to the Tribunal. Tellingly, in Table 2 (his "corrected Table 3.2-1"), Connor has removed all information regarding sample compositing, the misuse of which was the actual point of our table! But examination of even the "corrected" table shows that the point made by LBG is correct: *67% of the time* soil samples classified by Chevron as "Non-RAP Soil" are above the TULSMA criterion of 1000 mg/kg TPH. Soils thus classified by Chevron include samples collected outside of pits remediated by Texpet under the RAP, as well as pits not addressed under the RAP, but not samples collected from the edges of the study areas (i.e., so called "perimeter samples," see Table 3.3-3).[250]

Table 3.3-3 is a reproduction (insofar as permitted by the contents of the database)[251] of Connor's Table 2 (i.e., his "corrected Table 3.2-1") with the information about composite samples restored. The table again shows that composite samples result in fewer detections of contamination compared to discrete or "grab" samples.

[245] Connor, 2013, p. 40
[246] Chevron's Ecuador Oriente Region Analytical Database [Access® Database]. May 2007 (hereinafter referred to as Chevron's 2007 Access® Database)(submitted with Respondent's Response)
[247] Chevron's 2013 Access® Database
[248] *See generally Claimants' Reply Memorial, Annex A,* 2013
[249] *See generally* Connor, 2013
[250] Note that "perimeter" samples as referenced in Connor's Table 2 (i) were collected at the edges of the study areas, not the edges of the pits, (ii) were collected with bias by Chevron toward expected clean perimeters, and (iii) do not actually show "clean perimeters" precluding the existence of contamination from migrating from the site. See Section 4. 2.1. In our analyses of Chevron's sample distributions, the most telling piece of information about contamination escaping into the environment are sediment samples collected in streams adjacent to well sites and production stations, *which are just as likely to be contaminated as samples collected in pits* (remediated or otherwise). See Section 4.2.5.
[251] Chevron's Ecuador Oriente Region Environmental Database (Clickable Database), April 27, 2007 (hereinafter referred to Chevron's 2007 Clickable Database) (submitted with Respondent's Response)

Table 3.3-3 – Comparison of Inside, Outside, Surface, Subsurface, Composite and Discrete Sample Results [252]

[redacted]

Notes:

1. Our response to Connor's misleading criticism is captured in the cells highlighted yellow. That is, discrete subsurface soil samples outside of RAP items (pits) (and excludingsamples that may fall in non-RAP pits) show, as we opined in our February 2013 Expert Report, "that petroleum hydrocarbon contamination is extensive in the subsurface beyond the edges of the pits."
2. Cells highlighted in blue indicate [redacted]
3. Cells highlighted in green indicate [redacted]

[252] This table is a restoration of important fields in Table 2 from Connor's 2013 Expert Report which purports to "correct" Table 3.2-1 from the *LBG February 2013 Expert Report*.

3.3.6.3 LBG's independent investigations confirm that misused composite sampling obscures contaminant migration

Since writing our February 2013 Expert Report, we have independently investigated five well sites in the former Concession Area using only discrete or "grab" samples (not composite samples). We found that both pits remediated by Texpet under the RAP, and pits closed by Texpet outside the RAP, continue to act as sources of contamination to the environment, and that oil discharged from these pits to nearby streams (over land or through soils) now resides in the sediments of the streams. That is, the streams themselves have become sources emitting stored contamination, thus reinforcing our continued assertion that contamination resulting from Texpet's activities in the Concession Area is "widespread."

3.3.7 Claimants' criticism that LBG incorrectly applied CERCLA to oilfield cleanup[253] is misleading and a distraction from Texpet's inferior investigation approach

In his 2013 Expert Report, Hinchee explains his objections as follows:

> *The remedial investigation LGB suggests TexPet should have undertaken is based on the EPA's guidance for conducting remedial investigations at US Superfund sites. This is totally inappropriate for application to TexPet's situation. Oil field sites produce crude oil, which is the primary contaminant of concern; the locations impacted are known, i.e., pits and spills; and oil contamination is highly visible. At Superfund sites, the contaminant source is often unknown, usually far more toxic than oil, and rarely visible. Superfund sites are typically much more complex and riddled with unknowns; oil field sites are far simpler to investigate. As a result, Superfund-type investigations are not used at oil field sites in the US or elsewhere in the world and would have been inappropriate for the limited purpose of the Judicial Inspections. In the US crude oil contaminated sites are specifically excluded from Superfund. TexPet's use of the audit information and its remedial investigation were overseen and approved of by the Government of Ecuador and Petroecuador, and were consistent with international practice in oil fields.*[254]

This assertion, which Claimants ties back p. 25 of our 2013 Expert Report[255] is a misguided attempt to divert attention from the inferior investigations conducted by Woodward-Clyde in preparation for conducting the RAP. Several facts are important in addressing this criticism:

1) Both Texpet and Chevron resorted to U.S. EPA guidance when local standards or protocols were unavailable.
2) Analytical methods used for the JIs are nearly all defined by U.S. EPA guidance.[256]
3) We specifically disclaimed any suggestion that the legal or liability framework of CERCLA was appropriate for applicability to the oilfield investigations conducted for the trial.[257]

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[253] *Claimants' Reply Memorial Track 2, Annex A*, Section II.A.3, Items 15 and 16, p. 6
[254] Hinchee Expert Report, 2013, p. 22-23
[255] *Claimants' Reply Memorial Track 2, Annex A,* Section II.A.3, Item 15, p. 6
[256] (e.g., Method 8015B and Method 418.1)
[257] *LBG February 2013 Expert Report*, p. 25

4) We did not assert in any respect that technical guidance associated with CERCLA should be rigidly or blindly applied to oilfield investigation or cleanup.

In fact, the only reference to CERCLA (or, actually "Superfund") on p. 25 of our 2013 Expert Report is in connection with the terminology used by Woodward-Clyde itself to describe its RAP investigation.[258] As we explained, Woodward-Clyde employed the term "Remedial Investigation" (with initial capital letters) – which is the hallmark of a CERCLA proceeding – to describe its inadequately implemented and documented screening studies used to plan the RAP remediation. Their characterization of these studies using this CERCLA term-of-art invited comparison to the more robust standards of investigation implied by that legislation, although those studies failed utterly to approach any resemblance to a CERCLA Remedial Investigation. The levels of scientific rigor required to conduct CERCLA investigations (*i.e.*, to define the nature and extent and fate and transport of contamination in the environment) and to decide on an appropriate remediation are certainly germane as general benchmarks to evaluate the investigations conducted to present before the court. As such, and since the literature and guidance developed to implement it embody principles of sound science in such endeavors, CERCLA technical guidance is not "irrelevant" to oilfield cleanup where it intersects with similar investigation activities.

We also note that in the paragraphs following our assertions about the inadequacy of Woodward-Clydes investigations, we provided, based on our experience at contaminated sites (not specifically Superfund), a summary of the basic components of an environmental investigation adequate to determine nature and extent, and fate and transport of contamination. Contrary to Hinchee's assertions, while the oil itself may be generally visually obvious, the presence of dissolved constituents in groundwater and surface water is not. Likewise, the presence of contaminants in sediments cannot always reliably be determined without probing at a minimum nor, in some cases, without chemical analysis. Texpet's and Chevron's biases (as expressed above in the passage from Hinchee's report) appear to have misled them to conduct insufficiently robust investigations. As noted in Section 3.1 above, the "success" of the RAP is irrelevant to the Lago Agrio Litigation regarding the impact of pollution stemming from Texpet's E&P activities on the environment and peoples' lives.

3.4 Response to Selected Chevron Arguments in Annex A and Goldstein Deposition

3.4.1 Chevron's argument that LBG incorrectly applied environmental regulations or health standards retroactively misrepresents our opinion and is wrong in substance[259]

As we explained in our February 2013 Expert Report, the environmental laws, regulations, and contractual restrictions in force during Texpet's operations in the former Concession Area constrained it to do no damage to natural resources. For example, a key provision of the 1921 Hydrocarbon Deposits Law is that oil field E&P operations should be conducted so as to "not affect the water in terms of its potability and purity and without affecting fishing." [260] Similarly, Clause 10 of

[258] Woodward-Clyde, 2000, Executive Summary and p. 1-4
[259] *Claimants' Reply Memorial Track 2, Annex A,* 2013, p. 17, 20
[260] See Article 3, Hydrocarbon Deposits Law, October 1921

the original 1964 concession agreement[261] authorized Texpet to use the lands and resources of the Concession Area "without depriving the towns and villages of the water sources they require for their domestic uses and their fields, or impairing in any way whatsoever the navigation, or deprive the waters of their pure or drinkable qualities, or jeopardizing the fishing." When the concession agreement was renegotiated for a somewhat smaller tract in 1973, Texpet was required to "adopt appropriate measures for the protection of plant and animal life and other natural resources and…[to]… avoid contamination of waters, the atmosphere and land…."[262]

As described in our Expert Report[263], Article 29 of the 1971 Law of Hydrocarbons required a concession operator (i.e., Texpet) to "adopt all measures necessary to protect the flora, fauna, and other natural resources" as well as "to prevent contamination of the water, the atmosphere, and the land."[264] Article 22 of the 1972 Law of Waters "prohibits all contamination of water that affects human health and the development of flora and/or fauna." [265] Regulations promulgated in 1973 to implement this law [266] consider as "contaminated" all "flowing or stagnant waters…that present deterioration of its physical, chemical or material characteristics" or that contain any "substance that results in the partial or total impairment of them for domestic, industrial, agricultural, fishing, recreation, and other uses."[267]They further require industrial entities (among others) "to perform a periodic analysis of their effluent waters to determine the 'degree of pollution'."[268] As summarized in our Expert Report, additional laws and regulations reinforcing these and similar requirements were passed or promulgated throughout the 1970s and early 1980s,[269] including requiring the operator (i.e., Texpet) to "take all measures and necessary precautions when performing their activities to prevent damage or danger to people, properties, natural resources, and sites of archeological, religious, or touristic interest."[270]And further, "when salt water, drilling mud, petroleum test material or other elements, can cause harm to flora or fauna, the operator shall propose to the Ministry appropriate means to dispose of them to prevent harm." [271]

These regulatory precautions are not less important simply because they did not specify numerical standards to measure compliance. They are broad and performance-based; that is, they require protection of natural resources and prohibit doing harm to the environment, to people, to water resources used for daily living, and to property. Claimants agreed regarding applicability of these standards and their intent, while relying on the conclusions of Fugro-McClelland affirming Texpet's "compliance" with these standards during their operations in the former Concession Area.[272] The key, however, to Texpet's approach to "compliance" throughout this period appears to be summed up in the facile conclusions of Henderson et al. "that petroleum operations have had a relatively insignificant impact on the environment outside of

[261] *See generally* 1964 Concession Agreement
[262] *See generally* 1973 Concession Agreement
[263] *LBG February 2013 Expert Report*, 2013, p. 8
[264] Law of Hydrocarbons, Decree No. 1459, Article 29, September 1971
[265] Law of Waters, Supreme Decree No. 369, Article 22, May 1972
[266] General Regulations for the Application of the Law of Waters, Supreme Decree No. 40, January 1973
[267] Law of Waters, Chapter 11 Pollution, Article 89, January 1973
[268] Law of Waters, Chapter 11 Pollution, Article 91, January 1973
[269] *LBG February 2013 Expert Report*, p. 9-10
[270] Regulation of Exploration and Exploitation of Hydrocarbons, Ministerial Decree No. 11850, Chapter IV, Article 41, April 1974
[271] Regulation of Exploration and Exploitation of Hydrocarbons, Ministerial Decree No. 11850, Chapter IV, Article 42, April 1974
[272] Deposition of Kenneth J. Goldstein, Vol.1, May 2013, p. 207

facility sites. It is our opinion that the impact within facilities is mainly an esthetic impact."[273] However, this approach is clearly at odds with the stated regulatory concern over the likely impacts of uncontrolled discharges of E&P wastes to the land and streams; impacts that were documented by Fugro-McClelland[274] (their conclusions as cited by Claimants[275] notwithstanding), HBT Agra,[276]and the PI and JI reports,[277] as described in section 4.2 below, The persistence of these impacts to the environment beyond the immediate boundaries of E&P facilities related to Texpet's substandard E&P practices has been documented based on our independent investigations of five well sites between July and October 2013 (see Section 2.2).

Thus, Claimants[278] are clearly wrong about the nature and extent of the impacts of Texpet's practices on the environment. However, it is necessary to employ numerical criteria in order to evaluate the magnitude of the insult and calculate risks when dealing with chemical analytical results, and not simply addressing visual information about the presence or absence of crude oil or apparent effects on the health and well-being of plants, animals (including fish), and people. In this context, Claimants have argued that we retroactively and incorrectly applied standards which did not exist at the time the RAP was completed.[279] Chevron's experts Connor[280] and Hinchee[281] have also claimed that we do not understand these Ecuadorian regulations and have applied them improperly in the *LBG February 2013 Expert Report* to discussions and evaluations of the PIs and JIs conducted by Chevron. Thus, it is important to clarify the argument we made in our Expert Report. The essence of our opinion is that numerical standards had begun to be put in place by the time the RAP was implemented (1995 to 1998). Further, the RAOHE and TULSMA standards we cited were in force at the time the JIs for the Lago Agrio Trial were conducted and are therefore legitimately and properly considered in a current evaluation of the effectiveness of remediation of contamination (both inside RAP-remediated pits and elsewhere) associated with Texpet's substandard oil field E&P practices.[282] In order to illuminate this perspective, we briefly summarize below the criteria presented in our Expert Report, and provide corroborating authoritative interpretation of the applicability of these criteria from the Republic.

Numerical criteria and license requirements governing discharges to surface water bodies by "all activities and sources that cause water pollution" were defined by the 1989 Regulation for the Prevention and Control of Environmental Pollution Related to Water Resources, Ministerial Decree 2144.[283] The February 1992 Environmental Regulations for Hydrocarbon Activities in Ecuador, Ministerial Decree 621 established operational and numerical standards for all aspects

[273] Henderson et al., 1990, p. 1
[274] *See generally* Fugro-McClelland, 1992
[275] Deposition of Kenneth J. Goldstein, May 2013, Vol. 1, p. 214
[276] *See generally* HBT Agra, 1993
[277] Chevron's 2006 Clickable Database and Chevron's 2007 Clickable Database
[278] See summaries of opinions on this matter by Connor, 2013, p. 2-3, and Hinchee, 2013, p. 2, especially the second bullet of Section 3.0
[279] *Claimants' Reply Memorial, Annex A*, p. 17, 20
[280] Connor, 2013, p. 6
[281] Hinchee, 2013, p. 23
[282] *LBG February 2013 Expert Report*, p. 10 to 12; we have clarified and corrected our understanding of the specific criteria applicable to evaluation of the Texpet-remediated pits themselves in Appendix A.
[283] Regulation for the Prevention and Control of Environmental Pollution Related to Water Resources, Ministerial Decree 2144, Article 1 and Articles 42 through 86, May 1989

of exploration, production, transportation, and industrialization of oil and gas capable of producing environmental impacts. Key provisions of this regulation establish guidelines for the construction of pits and their use and limits for the discharge of water (but no closure criteria), operational guidelines and discharge limits for gas burners, and permissible surface water discharge limits for fluids and produced water, sewage, and industrial water.[284] The August 1995 Environmental Regulations for Hydrocarbon Activities in Ecuador, Decree 2982 superseded and replaced Ministerial Decree 621.

The 1989 Ministerial Decree 2144 was repealed in January 2003.[285] RAOHE[286] was published in Official Register No. 265 of February 13, 2001 and TULSMA[287] was published in Official Register Supplement No. 2 of 31 March 2003. RAOHE and TULSMA were previously discussed in Sections 2.2.5 and 2.2.6 of our *February 2013 Expert Report*.[288] While these regulations were promulgated after the E&P operations conducted by Texpet had ceased in June 1990, they were in force at the time of Chevron's PIs and JIs during the Lago Agrio Trial. The associated numerical criteria are still in force and are relevant to evaluations of the environmental sample analytical results of the investigations we conducted between July and October, 2013.

For RAOHE, the pertinent numerical criteria are found in Table 6 of the regulations which provides permissible limits for restoration of contaminated soils for various land uses including agricultural, industrial, and sensitive ecosystems. For TULSMA, the pertinent Book VI, Appendix 1 numerical criteria are found in Tables 3 (water quality criteria for the preservation of flora and fauna in cold or warm fresh waters, marine waters, and estuaries), 4 (additional permissible limits for evaluating water quality), and 5 (permissible limits for groundwater). In addition, the pertinent Book VI, Appendix 2 numerical criteria are found in Table 3 (soil remediation criteria for various land uses including agricultural, residential, commercial, and industrial).

As noted above, current numerical standards under the RAOHE have been in place since 2001, while TULSMA criteria have been in force since 2003, the year the Lago Agrio Trial commenced. For soils at well sites and production stations that are within the boundary of E&P operations (i.e., the well head, platform, and pits at well sites and the processing plant equipment including pumps and separators, pipelines, and pits at production stations) the RAOHE Table 6 permissible limit for total petroleum hydrocarbons (TPH) of 2,500 mg/kg for agricultural land use is considered to be applicable to determine wheather remediation was successsful.[289] This is the standard adopted by PetroAmazonas under

[284] Environmental Regulations for Hydrocarbon Activities in Ecuador, Ministerial Decree 621, Articles 13b (pits), 16 (abandoned wells), 21 (production facilities), Article 21o (gas burners), Article 40, Tables 2 through 4 (February 1992)
[285] Programa electronic de Legislacion Ecuatoriana [English: Electronic Program of Ecuadorian Legislation], Decree 3609, January 2003
[286] Reglamento Sustitutivo del Reglamento Ambiental para las Operaciones Hidrocarburiferas en el Ecuador, Decreto 1215, February 2001
[287] Texto Unificado de la Legislacion Ambiental Secundaria del Ministerio del Ambiente, Decreto 3516, March 2003
[288] *LBG February 2013 Expert Report*, 2013, p. 11-13
[289] RAOHE, *Table 6: Permissible Limits for the Identification and Remediation of Contaminated Soils in all Phases of the Hydrocarbon Industry, Including Service Stations* [English translation]; refers to permissible limit in soil protective of agricultural uses. It should be noted that this value is the same as the TULSMA Table 3 permissible limit for "oils and fats" (i.e., TPH) for residential land use. TULSMA, Book VI, Appendix 2, *Table 3: Remediation or Restoration Criteria* [ENG translation]; refers to soil where the primary activity is the use of the land for residential purposes and recreational activities

the PEPDA program.[290] Permissible limits for application of the TCLP in the PEPDA program follow RAOHE Table 7 and are 1 mg/L TPH for unlined pits and 50 mg/l TPH for lined pits. For soils outside this boundary, the RAOHE Table 6 permissible limit for TPH of 1,000 mg/kg for sensitive ecosystems (such as the Amazon rainforest) can be applicable, depending on the adjacent land use.[291]

It should be noted that PetroAmazonas originally targeted the 1,000 mg/kg threshold for pit remediation, but were unable to meet this standard with the remediation technologies employed. Thus, consistent with interpretations in our February 2013 Expert Report, it was the Republic's original intention to remediate (both inside and outside of pits) to the sensitive ecosystem permissible limit, which would effectively allow environmentally unconstrained land use in the restored area and promote restoration of the E&P sites to pre-crude oil production conditions (as demanded by the Plaintiffs in the Lago Agrio Lawsuit). In evaluation of environmental conditions, including the effectiveness of remediation, consideration may also be given to a competing standard in the TULMA, which states a lower permissible limit of 500 mg/kg TPH for agricultural use[292], which appears to be the dominant land use that we observed during our site inspections in July 2014 in the northern portion of the Concession Area .

It is our understanding that both RAOHE and TULSMA are valid, relevant, applicable and appropriate for regulation of oil field environmental management, and that:

1. The Regulations to replace the Environmental Regulations for Hydrocarbon Operations in Ecuador (RAOHE. D.E.1215) are regulations on environmental management of oil and gas operations throughout Ecuador, in which, among other things the permissible limits are established for the identification and remediation of contaminated soil in all phases of the oil industry through Tables 6 and 7a and 7b of Annex 2 of the environmental regulations, including service stations and leachate permissible limits for sludge disposal and drill cuttings at the surface, respectively.
2. In turn, the TULSMA aims to "preserve the quality of soil resources to safeguard and preserve the integrity of people, ecosystems and their interactions and the environment in general." Therefore it is applicable to the full extent of the Ecuadorian territory and not merely to areas designated as Protected Areas. In substance, it addresses environmental regulation of matters in and pertaining to oil fields not specifically addressed by the RAOHE.

Our understanding encompasses the consistency of the intent of the current regulations, including numerical standards, with the intent of the earlier non-numerical requirements in the regulations, as well as in the Concession Agreements. The intent of the Ecuadorian laws and regulations from 1921 through 2009 cited above should have been clear first to Texpet and subsequently to Chevron. In his opinion, Dr.Templet points to Texaco's legal challenge of guidance issued in 1946 by the Louisiana Stream Control Commission, part of the Louisiana Wildlife and Fisheries Department, in District Court.[293] The case ultimately went to the U.S. Supreme Court; the lower courts' judgments in favor of the State were affirmed on

[290] TULSMA, Book VI, Appendix 2, *Table 3: Remediation of Remediation or Restoration Criteria* [ENG translation]
[291] RAOHE, *Table 6: Permissible Limits for the Identification and Remediation of Contaminated Soils in all Phases of the Hydrocarbon Industry, Including Service Stations* [ENG translation]; refers to permissible limit values for the protection of sensitive ecosystems, such as Natural Heritage Areas
[292] TULSMA Book VI, Appendix 2, *Table 3: Remediation or Restoration Criteria* [ENG translation]
[293] See E.D. Baton Rouge Division -Texas Co. v Montgomery, Aug. 29, 1947, Civil Action No. 457

Nov. 24, 1947.[294] Thus, Texpet knew, or should have known, that uncontrolled surface discharge of E&P wastes into the environment and use of unlined pits would cause contamination.[295] Texpet (and Chevron) also should have been aware that industries in the US were being prosecuted in the 1960s and 1970s for discharging industrial wastes into waterways under laws such as the 1899 Refuse Act, which did not contain numerical standards for contaminants but broadly prohibited direct discharge of waste to surface water similar to Ecuadorian laws and regulations from the 1920s through the 1980s. As noted in a 1972 article,[296] "In *United States v. Standard Oil Company*, the Court broadly defined refuse matter as 'anything which has become waste including foreign substances and pollutants.' Consequently discharges of commercially valuable oil…phenols…and heated water have been held to violate Section 407 of the Act."

3.4.2 Claimants' criticism that LBG failed to properly consider claimed fraud and other "due process" violations in Lago Agrio Judgment[297] is misplaced

Our duties were to review the Lago Agrio record, and primarily Chevron's investigation data, not to analyze the legal strategy or trial tactics of either side. A discussion of claimed fraud is a legal topic and therefore, outside our expertise and scope of work.

4 Assessment of the Origin and Fate of Contamination in the Former Concession Area

4.1 Historical Assessment of Texpet's Impacts and Remedial Response

Readily available documentation regarding historical practices at the Texpet-operated well sites and production stations consists of four primary documents:

1) Memorandum from U.V. Henderson et al. to W.C. Benton dated November 14, 1990 and titled *Environmental Assessment – Consortium Operations in Ecuador*[298]
2) *Final Environmental Field Audit for Practices 1964-1990, PetroEcuador-Texaco Consortium, Oriente, Ecuador* prepared by Fugro-McClelland (WEST), Inc. under contract to Texaco Petroleum Company[299]
3) *Environmental Assessment of the PetroEcuador-Texaco Consortium Oil Fields* prepared by HBT Agra Limited for the PetroEcuador-Texaco Consortium[300]

[294] See Texas Co. v Montgomery, Nov. 24, 1947, 68 S. Ct 209
[295] Templet, 2013, p. 2
[296] **Ex. 1** The Journal of Criminal Law, Criminology and Police Science, Vol. 63, No. 3. *Criminal Liability Under the Refuse Act of 1899 and the Refuse Act Permit Program*; Northwestern University School of Law; 1972
[297] See Goldstein Dep. Vol. I, p. 34-60 and 255
[298] Henderson et al., 1990
[299] Fugro-McClelland, 1992
[300] HBT Agra, 1993

4) *Remedial Action Project, Oriente Region, Ecuador – Final Report Volume I of II* prepared by Woodward-Clyde International for Texaco Petroleum Company[301]

In the *LBG February 2013 Expert Report*, we noted that the findings of two environmental audits – performed by Texpet's outside consultant[302] and the Consortium's joint consultant[303]– showed that Texpet's E&P activities and practices in the Concession Area were associated with broad-based environmental contamination of air, soils, sediments, surface water, and groundwater. In his expert report, Connor writes:

> *LBG selectively cites the audit reports prepared by HBT Agra (1993, 1997a, 1997b) and Fugro-McClelland (1992a, 1992b) by highlighting the presence of soil impacts or open pits on the oilfield facilities, but fails to acknowledge the audit findings with regard to regulatory compliance, absence of significant groundwater impacts, absence of significant subsurface migration, and the limited extent of soil impacts.*[304]

Connor's response points out the inherent contradictions within the audit documents. Specifically, numerous observations of crude oil contamination in soil, groundwater, covering pits, along drainage courses from pits to streams, etc. are ultimately dismissed in each document's concluding statements. As summarized and discussed in Table 4.2-1, the documents' respective conclusions[305] are unsupportable. Each document listed in the table records observations of the disposal of crude oil and other drilling/production wastes to the environment. Nonetheless, each document omits a scientifically credible, robust conclusion regarding the impacts of the disposed wastes on environmental media (i.e., soils, groundwater, surface water, and sediments). This pattern of acknowledging the continuous disposal of petroleum exploration and production wastes in the Oriente region, while subsequently dismissing or diminishing the impacts as merely aesthetic impacts, localized/limited in spatial extent, and/or extremely transitory begins in the *Henderson et al. memorandum* and is consistently applied throughout subsequent relevant documents. The net effect of this approach yielded two major outcomes:

1) It served to minimize the potential that Texpet might be directed to characterize and possibly remediate resources (e.g., groundwater) that were not addressed under RAP activities or in Chevron's subsequent JIs.
2) It attempted to contain investigation and remediation activities within an entirely arbitrary set of boundaries (i.e., specifically, the removal/treatment of pit wastes, visibly-contaminated, shallow pit soils, and the backfilling of open pits).

[301] Woodward-Clyde, 2000
[302] *See generally* Fugro-McClelland, 1992
[303] HBT Agra, 1993
[304] Connor, 2013, p. 8
[305] Reiterated by Connor on pages 8-10 of his 2013 Expert Report

4.2 Forensic Analysis – Assessment of JI Sampling Objectives and Outcomes

Contrary to Connor's assertion,[306] Chevron did not have court permission to conduct the more extensive investigations involved in the PIs, as opposed to brief reconnaissance shortly in advance of the JIs.[307] The Playbooks clearly reveal Chevron's [redacted] Connor claims that JI investigations were "comprehensive."[309]

Hinchee states, "*The Judicial Inspections were only designed to investigate the presence and extent of contamination at 121 sites selected by both parties and ordered by the Lago Agrio court and to determine Texpet's compliance with the RAP at those locations*"[310]

We have evaluated the comprehensiveness and representativeness of the investigations conducted through the use of geostatistical principles and techniques commonly used to support environmental investigations to address sampling program uncertainties, and in the petroleum and mining industries to demonstrate the worthiness of mineral extraction. This exercise has demonstrated that the investigations undertaken where Judicial Inspections were completed were consistently and wholly inadequate to support Connor's assertion of a comprehensive investigation.

4.2.1 "Clean Perimeters" Do Not Exist around Most Well Sites

Connor's assertion of sufficient data to define a "clean perimeter" around each of the JI sites is not supported by the observations available to the Court. Connor states:

> ***Affected Soil Areas Have Been Delineated:*** *…The areas of soils containing residual petroleum, either in Texpet-remediated pits or Petroecuador open pits, have been delineated with clean perimeter soil samples, which show that the affected soils are limited in area and do not extend beyond the immediate area of the oilfield facilities (production station or well platform).*[311]

We reviewed data from the entire set of 45 JI sites to assess this statement. Since Connor asserts that contamination is not migrating away from the site (as per above) and, by inference, therefore, not impacting adjacent forests and wetlands, we used the RAOHE Sensitive Ecosystem (Decreto 1215) permissible limit of 1,000 ppm TPH in this analysis. Since the Court would have initially had only the JI data for these sites to consider in its deliberations, we first analyzed only the JI data in attempting to construct "clean perimeters." In 41 of the cases, the JI well sites could not be enclosed by a clean perimeter in compliance with the RAOHE permissible limit for sensitive ecosystems. Based on our analysis of the available data, we have four conclusions:

[306] Connor, 2013, p. 14
[307] Connor, 2013, p. 14
[308] Connor, 2013, p. 14
[309] Connor, 2013, p. 14
[310] Hinchee, 2013, p. 15
[311] Connor, 2013, p. 2-3

1) Data were insufficient (fewer than four sample points available per site[312]) to create a perimeter. Four sample points was the criterion established by Connor[313].
2) Contaminated locations (greater than 1,000 ppm TPH) were on the perimeter with no clean points beyond.
3) The perimeter did not enclose all the pits on a site
4) The perimeter crossed a stream in attempting to encircle the contamination.[314]

Even considering the JI, PI, Rebuttal and Shadow Team data, Connor's claim that clean perimeters were established is not supported. Specifically, a clean perimeter could not be defined for 41 of the 44 JI sites using JI data alone.[315] Of these sites, 31 (70 percent) of the JI sites failed based on the first two criteria alone. We also examined data for the 56 sites ultimately reviewed by the Court (i.e., the original 45 JI sites plus the 11 inspected by the Court Expert). In this instance, 52 well sites had reported sample results for at least one of the four data sets. Using the data from all four data sets, a clean perimeter could not be defined for 51 of them. Like the JI only sites, 73 percent (38 of the 52 sites) failed based on the first two criteria alone. Thus the assertion by Chevron's expert on the existence of "clean perimeters" is incorrect and without merit. Figures 4.2-1 and 4.2-2 present example results of the "clean perimeter" construction for two JI sites.

4.2.2 Poor Agreement between Chevron Co-located Sample Pairs Indicates High Uncertainty in the TPH Concentration at a Given Location

We conducted an analysis to assess the amount of variability in closely spaced samples. This information provides an estimate on the uncertainty of an individual measurement when used as an estimate of the local contaminant concentration. This consideration is important when comparing individual values to a threshold, such as the RAOHE Sensitive Ecosystem permissible limit of 1,000 ppm.

We calculated the relative percent difference (RPD) for samples located 5m apart or less for surface soil and sediment samples located outside the pits. The mean RPD value was 97 percent and the median value was 95 percent. These RPD values translate to a factor of 3 difference between the two concentrations (maximum divided by minimum). We opine that this represents a high degree of local variation. This indicates that the true level of contamination at a given location \ may be as much as three times higher or three times lower than the reported value. This uncertainty is a direct result of the observation just described that sample locations in close proximity routinely differ by a factor of three. That is, one need not move very far from a given location (5m or less) before soil concentrations may change in a significant fashion.

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[312] Connor, 2013, Table 1, page 1 of 2 Bullet 2 "Collect soil samples at 4 or more locations surrounding the site (pit or affected area perimeter samples may also be used as site perimeter sampling locations when applicable), vertically composite a soil sample from each location perimeter location."
[313] Connor, 2013, Table 1, page 1 of 2 Bullet 2 "Collect soil samples at 4 or more locations surrounding the site (pit or affected area perimeter samples may also be used as site perimeter sampling locations when applicable), vertically composite a soil sample from each location perimeter location."
[314] Since a stream represents a zone of sediment transport, the inclusion of a stream within a "clean perimeter" provides a means for contaminant transport away from a well site across the perimeter. Thus crossing or contacting a stream in the construction of a "clean perimeter" precludes the assertion that all contaminated soils and sediments associated with a site are contained within the perimeter.
[315] For one JI site (Shushufindi Central PS), we were unable to identify any JI data and so this site was excluded from the JI site calculation described here. Shushufindi Central PS did have other data, however, and so was included in the second "clean perimeter" evaluation.

Therefore, assignment of a given location as above or below a specific threshold is highly uncertain. This uncertainty is a direct result of the highly variable nature of contamination levels observed on the well sites. To properly define areas as above or below thresholds, much more sampling is needed than was conducted by Chevron, along with geospatial analysis as a basis to address local uncertainty.

4.2.3 Unremediated Pits and Streams have Similar Frequencies of Contamination in Excess of a Range of Thresholds

As described in Section 4.2.1, the data available from the four sample collection efforts are insufficient to define the extent of contamination on a site-by-site basis. This is apparent since the data are insufficient to define a simple "clean perimeter" for nearly all sites. As noted in section 4.3.7 below, the sample locations were not collected in a spatially representative fashion, but rather are biased to an unknown degree toward less contaminated or uncontaminated locations. These limitations on sample placement and samples per well site, however, do not preclude an assessment of the average extent of contamination across all the sites examined by the Court. In fact, by combining data across the sites, it is possible to estimate the frequency of exceedance of a series of numerical thresholds in a quantitative fashion across the JI sites, including calculation of the uncertainty in the estimate.[316] These numerical thresholds are used to identify which areas are characterized by a higher frequency of exceedances relative to other areas. Given the known direction of the sample collection biases toward less contaminated locations, this use of the data is expected to generate a lower bound estimate on the frequency and spatial extent of contamination associated with the JI sites.

We assessed the frequency of exceeding these thresholds (100, 500, 1,000 and 2,500 ppm TPH)[317] within the pits, in the areas adjacent to the pits, and in the streams. The purpose of this analysis was to assess the spatial distribution of contamination. The expectation was that for any given threshold, the most contaminated areas would have the highest frequency of exceeding the threshold. Thus, the unremediated pits were expected to have the highest frequency of exceedance for any threshold, with declining frequencies of exceedance moving radially away from the pit boundaries. Each of the thresholds was considered here to examine how the frequencies varied against a range of concentrations.

As discussed in Sections 4.2.1 and 4.2.2, for nearly all well sites the available data are too limited and too uncertain to characterize the local extent of contamination. The available data generally do not provide sufficient information to determine the average level of contamination in an area (*e.g.,* unremediated pit) nor do they form a basis to delineate areas above and below a given permissible limit. Although the data generally are too limited on a single well site basis,

[316] For illustrative purposes, we selected threshold values equivalent to the permissible limits for three Ecuadorian standards and the soil remediation criterion applied in the Lago Agrio Judgment. These criteria have been compared with soil sample results in various discussions in this rejoinder. We recognize that each of the three Ecuadorian standards actually applies to subsets of the samples depending on their location inside or outside of pits or in streams, while the Judgment criterion was universally applied. The thresholds are used here solely to compare concentrations across classes of site areas and not to draw conclusions regarding exceedances of the permissible limits.

[317] Thresholds derived from three permissible limits specified by the Ecuadorian government and the soil remediation criterion applied in the Lago Agrio Judgment were considered in this analysis, including TULSMA Residential Criteria, Decreto 3516 and RAOHE Agricultural (2,500 ppm TPH), RAOHE Sensitive Ecosystem Criteria, Decreto 1215 (1,000 ppm TPH), TULSMA Agricultural Criteria, Decreto 3516 (500 ppm TPH), and the Lago Agrio Judgment (100 ppm TPH).

taken together they can be combined across well sites to understand the nature of contamination within pits and at varying distances from the pit perimeters. In order to assemble as representative a data set as possible, data from 52 of the 56 sites examined by the Court were included in the analysis. The 52 sites include the 45 JI sites plus the additional 11 sites examined by the Court where we were also able to obtain *Method 8015B* results. The combination of data from similar types of areas across the well sites is based on the premise that similar operations across the various well sites would produce similar soil contamination conditions. In this analysis, samples collected within the pits were separated by pit type to form two categories (remediated pits *vs.* unremediated pits) and then tallied to determine the frequency of samples exceeding each of the thresholds considered. Surface samples were grouped based on distance from the pits or from a stream. Samples collected outside the pits were grouped by radial distance from the pit edge, based on two intervals: 0-200m and 200-500m. An additional group comprised of samples proximal to the streams was also created Samples inside of 500m of the pits but within 10m of a stream were included in the stream category and not in the radial distance categories. The data were then used in a logistic regression[318] to estimate the probability for a soil sample in each category to exceeding the four thresholds for each group.

The unremediated pits and the streams surrounding the various well sites exceed the four thresholds at very similar frequencies (See Tables 4.2-1 to 4.2-4). In each instance, the frequencies for unremediated pits and for the stream areas agree within statistical uncertainty. For the streams, the frequency of exceeding the four thresholds increase from 8 to 38 percent, as the thresholds decline from 2,500 to 100 ppm TPH. For all thresholds except 2,500 ppm TPH, the frequency of exceedance for the stream areas is statistically significantly greater than the frequency of contamination in the immediate vicinity of the pits (0-200m). Overall, the ranking of the five areas for exceeding each threshold from highest to lowest frequency is:

1) Inside Pit, Not Remediated
2) Stream (10 m buffer zone)
3) Area from Edge of Pits to 200 m
4) Inside Pit, Remediated,
5) Area from 200 to 500 m

The last two area categories switch back and forth in ranking, depending on the threshold. Given that the stream areas are contaminated at a frequency not statistically different from the unremediated pits and are more frequently contaminated than the areas immediately adjacent to the pits (0-200m), this indicates extensive release of petroleum wastes to the streams and the continued persistence of contamination in the streams.

[318] A logistic regression measures the relationship between a categorical dependent variable (in this case the soil category) and one or more independent variables (in this case the sample concentration). **Ex. 6** Hosmer, David W. and Lemeshow, Stanley (2000). Applied Logistic Regression (2nd ed.). J. Wiley and Sons, Inc. Hoboken, NJ.

Table 4.2-1 - Frequency of Exceeding 100 ppm TPH by Area Category

Category	Percentage of Samples Exceeding 100 ppm TPH by *Method 8015B*		
	Mean	Lower[319] Bound	Upper Bound
Inside Pit, Not Remediated	49%	36%	62%
Inside Pit, Remediated	24%	16%	33%
Area from Edge of Pits to 200 m	26%	22%	31%
Area from 200 to 500 m	19%	9%	37%
Stream (10 m buffer zone)	38%	31%	46%

Table 4.2-2 - Frequency of Exceeding 500 ppm TPH by Area Category

Category	Percentage of Samples Exceeding 500 ppm TPH by *Method 8015B*		
	Mean	Lower Bound	Upper Bound
Inside Pit, Not Remediated	30%	19%	43%
Inside Pit, Remediated	7.3%	3.5%	15%
Area from Edge of Pits to 200 m	12%	8.5%	15%
Area from 200 to 500 m	3.2%	0.5%	20%
Stream (10 m buffer zone)	23%	17%	30%

[319] The upper and lower bounds represent the 95 percent confidence intervals on the mean given in each row, based on the logistic regression.

Table 4.2-3- Frequency of Exceeding 1,000 ppm TPH by Area Category

Category	Percentage of Samples Exceeding 1,000 ppm TPH by *Method 8015B*		
	Mean	Lower Bound	Upper Bound
Inside Pit, Not Remediated	23%	14%	35%
Inside Pit, Remediated	2.1%	0.5%	7.9%
Area from Edge of Pits to 200 m	7.1%	4.8%	10%
Area from 200 to 500 m	3.2%	0.5%	20%
Stream (10 m buffer zone)	16%	11%	22%

Table 4.2-4- Frequency of Exceeding 2,500 ppm TPH by Area Category

Category	Percentage of Samples Exceeding 2,500 ppm TPH by *Method 8015B*		
	Mean	Lower Bound	Upper Bound
Inside Pit, Not Remediated	14%	7.2%	26%
Inside Pit, Remediated	0%	0%	100%
Area from Edge of Pits to 200 m	4.7%	2.9%	7.6%
Area from 200 to 500 m	0%	0%	100%
Stream (10 m buffer zone)	8.3%	5.0%	14%

4.2.4 Approximately 2.1 Square Kilometers of Soils and Sediments within 500 m of the Pits Exceed the RAOHE Sensitive Ecosystem permissible limit, Decreto 1215 (1,000 ppm TPH) Threshold, based on Method 8015B and 52 Well Sites

We applied the results of the frequency analysis in section 4.2.3 to the areas of the pits, streams, and areas around the pits associated with 52[320] of the 56 sites examined by the Court to assess the spatial extent of contamination. This is a standard means of estimating the extent of contaminated area when using samples that are randomly placed in an area.[321] Given that the sampling programs conducted by Chevron attempted to avoid contaminated locations, (based on their goal of identifying clean perimeters, as well as the guidance provided by the Chevron playbooks), these estimates of contaminated area are likely lower bound estimates of the actual extent of contamination. The extent of contaminated area exceeding each of the four threshold values was estimated. [322] We also prepared upper bound and lower bound estimates of the extent of contamination based on statistical considerations of the available data. These bounding estimates are also likely to be underestimates of the bounds on the true area of contamination. Finally, given the bias in *Method 8015B* relative to *Method 418.1*, it is likely that the extent of contamination would increase significantly were the soils and sediments analyzed by *Method 418.1*. The estimates of contaminated area based on results obtained by *Method 8015B* are summarized for each of the four threshold criteria in Tables 4.2-5 through 4.2-8 below. These tables show that the estimates on the extent of contamination for the areas within 500m of the pits exclusive of the pits themselves, but including streams, are 10, 2.6, 2.1, and 0.56 km^2 for the 100, 500, 1,000 and 2,500 ppm thresholds, respectively. These results represent conditions only for 52 JI sites. The actual extent of contamination in the approximately 350 well sites[323] of the Oriente is expected to be about seven times greater (350 total sites/52 JI sites).

This analysis also identifies one other important observation. The estimated extent of contaminated areas around the pits dwarfs the total area associated with the pits themselves (both contaminated and uncontaminated pit areas, 117,000 m^2) for each of the four thresholds. For example, for the areas within 200m of the edge of the pits, the areal extents of contamination are 24, 10.5, 6.5, and 4 times greater than the total pit area for the 100 ppm, 500 ppm, 1,000 ppm, and 2,500 ppm TPH permissible limit thresholds, respectively. As another example, the areal extent of contamination associated with the streams alone is four to five times greater than the contaminated area of the pits for each of the permissible limit thresholds. Based on this analysis, we opine that pit remediation alone has addressed only a small fraction of the contaminated area associated with the well sites.

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[320] These 52 sites represent the sites where we were able to obtain sample information and specifics on pit locations. These are the same sites examined in 4.2.5 above.
[321] **Ex. 7** Bellhouse, D.R. 1981. Area Estimation by Point-Counting Techniques, Biometrics, Vol. 37, p. 303-312.
[322] Four permissible limits specified by the Ecuadorian government were considered in this analysis, including TULSMA Residential permissible limit, Decreto 3516 and RAOHE Agricultural (2,500 ppm TPH), RAOHE Sensitive Ecosystem permissible limit, Decreto 1215 (1,000 ppm TPH), TULSMA Agricultural permissible limit, Decreto 3516 (500 ppm TPH), and the Lago Agrio Judgment (100 ppm TPH).
[323] *See generally,* HBT Agra Limited, 1993

Table 4.2-5 - Contaminated Area in Pits, Streams and Surrounding Areas Exceeding 100 ppm TPH Threshold

Category	Area (m^2)	Frequency of Contamination (>100 ppm)	Contaminated Area (m^2)	Area Lower Bound (m^2)[324]	Area Upper Bound (m^2)
Pit Not Remediated	79,000	49%	39,000	29,000	39,000
Pit Remediated	38,000	24%	9,100	6,300	13,000
Pit to 200 m	11,000,000	26%	2,800,000	2,300,000	3,300,000
200 m to 500 m	38,000,000	19%	7,400,000	3,400,000	14,000,000
Stream (10 m buffer zone)	530,000	38%	200,000	160,000	240,000
Total Contaminated Area >100 ppm within 500m of Pits 10 km^2 (10,000,000 m^2)					

Table 4.2-6- Contaminated Area in Pits, Streams and Surrounding Areas Exceeding 500 ppm TPH Threshold

Category	Area (m^2)	Frequency of Contamination (>500 ppm)	Contaminated Area (m^2)	Area Lower Bound (m^2)	Area Upper Bound (m^2)
Pit Not Remediated	79,000	30%	24,000	15,000	27,000
Pit Remediated	38,000	7.3%	2,800	1,300	5,500
Pit to 200 m	11,000,000	12%	1,200,000	910,000	1,600,000
200 m to 500 m	38,000,000	3.2%	1,200,000	170,000	7,500,000
Stream (10 m buffer zone)	530,000	23%	120,000	92,000	160,000
Total Contaminated Area >500 ppm within 500m of Pits 2.6 km^2 (2,600,000 m^2)					

[324] The upper and lower bounds represent the approximate 95 percent confidence limits on the contaminated area given in each row, based on the total area in each category and the confidence limits on the frequency of contamination.

Table 4.2-7 - Contaminated Area in Pits, Streams and Surrounding Areas Exceeding 1,000 ppm TPH Threshold

Category	Area (m^2)	Frequency of Contamination (>1000 ppm)	Contaminated Area (m^2)	Area Lower Bound (m^2)	Area Upper Bound (m^2)
Pit Not Remediated	79,000	23%	18,000	11,000	22,000
Pit Remediated	38,000	2.1%	1,000	0	3,000
Pit to 200 m	11,000,000	7.1%	760,000	510,000	1,100,000
200 m to 500 m	38,000,000	3.2%	1,200,000	170,000	7,500,000
Stream (10 m buffer zone)	530,000	16%	85,000	60,000	120,000
Total Contaminated Area >1,000 ppm within 500m of Pits 2.1 km^2 (2,100,000 m^2)					

Table 4.2-8- Contaminated Area in Pits, Streams and Surrounding Areas Exceeding 2,500 ppm TPH Threshold

Category	Area (m^2)	Frequency of Contamination (>12500 ppm)	Contaminated Area (m^2)	Area Lower Bound (m^2)	Area Upper Bound (m^2)
Pit Not Remediated	79,000	14%	11,000	5,700	16,000
Pit Remediated	38,000	0%	0	0	38,000
Pit to 200 m	11,000,000	4.7%	510,000	310,000	810,000
200 m to 500 m	38,000,000	0%	0	0	38,000,000
Stream (10 m buffer zone)	530,000	8.3%	44,000	26,000	72,000
Total Contaminated Area >2,500 ppm within 500m of Pits 0.56 km^2 (560,000 m^2)					

4.2.5 Chevron's Sample Locations Are Not Spatially Representative

Chevron's sampling schemes were loosely defined with much of the selection of sample sites based on field decisions or prior samples. Their procedures did not follow standard practice in defining locations prior to sample collection so as to avoid biased sampling. Compounding matters, Chevron has used the data itself to develop their analysis procedure. In particular they use the sample data to identify new places to sample and to then define clean boundaries. This data "peeking" is well known to be unreliable and particularly bad when used to "post-stratify" the data after the fact (Smith 1983).[325] Generally these approaches result in understatement of uncertainties and a tendency for extrapolation to unsampled areas to be inaccurate. In effect, Chevron can do little to demonstrate successful remediation given these limitations on their data. As a result, their assertions[326] on the cleanliness of the areas around the site are not supported.

Given Chevron's claim of successful remediation, without having quantified the likelihood that areas remain unremediated, we examined the available Chevron data to test this hypothesis. The frequency with which unremediated contamination is identified provides an estimate of the reliability of their claim. Studies designed to test this hypothesis are relatively straight forward and do not require the levels of data necessary to characterize the site features. In particular, an area site is demonstrated to be incompletely remediated simply by identifying a small number of locations at which contamination remains. This could be demonstrated with a single sample of contaminated river or creek sediment. The ease with which contamination can be found is an indicator of the degree to which the site area may be incompletely remediated. The frequency analysis conducted in section 4.2.3 shows the high frequency of contaminant detection in the streams, regardless of threshold criteria as well as the existence of elevated concentrations even as far as 200 to 500m from the pit boundaries. The "clean perimeter" analysis that we conducted in section 4.2.1 shows that more than two-thirds of the sites examined by the court have perimeters containing values in excess of the RAOHE Sensitive Ecosystem permissible limit (Decreto 1215) threshold of 1,000 ppm TPH, and therefore in excess of the other two lower criteria as well. Chevron claims the pits area sites have been fully characterized and that important sources of TPH have been remediated, an unquantified assertion. Conversely, our inspection of the data identifies many counter examples to their claims. These observations, and the lack of a technically sound study design including a probability-based sampling and analysis plan, preclude Chevron developing any rigorous and reliable quantitative statements about the nature and limits of contaminated soils and sediments at these sites.

4.2.6 Chevron's Data are Insufficient to Support its Assertions

As discussed in the five subsections above and in Section 3.3, Chevron's data are clearly too spatially limited, too biased and too uncertain to support identification of contaminated and uncontaminated areas on a well site-by-well site basis. However, taken together with other data obtained by Chevron (e.g., *Method 418.1* results), the data can provide general characteristics on the degree of uncertainty, the degree of bias, the overall contaminated area, and the general level of contamination in and around the well site areas.

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[325] **Ex. 8** Smith, T.M.F. 1983. On Validity of Inferences from Non-random Sample. Journal of the Royal Statistical Society. Series A (General). Vol. 146, No. 4. p. 294-403.
[326] Connor, 2013, p. 37

The high degree of spatial variation in combination with the intrinsic bias of *Method 8015B* as applied by Chevron means that the identification of locations less than a specific permissible limit for TPH is extremely uncertain. Using individual *Method 8015B* values as reported is likely to fail to identify many contaminated areas. As a result, assertions by Chevron and its experts regarding the limits of contamination and the existence of "clean perimeters" are not supported.

4.3 Information Presented to the Lago Agrio Court and the Basis for the Judgment

As noted by Dr. Hinchee, "Environmental impacts in oil fields are typically visible and obvious, such as at pits and spills…"[327] During our reconnaissance of 18 well sites and production stations in the former Concession Area in July 2013 and our investigations of five well sites between August and October 2013, three of our experts[328] and other field team members witnessed first-hand the environmental conditions associated with Texpet's substandard E&P practices more than 20 years after the end of its operations there. These included extensive contamination of stream sediments extending many tens or hundreds of meters downstream of the immediate vicinity of well platforms or pits in locations where local residents bathe and launder their clothing; the presence of free-phase oil emerging from disturbed or eroded cover of Texpet-remediated pits; and the remains of a major spill reputed to have been caused by Texpet's activities prior to the conclusion of its operations (see Section 2.2). Texpet and Chevron have a history of considering these conditions as mainly an aesthetic issue (see Section 4.1) or requiring remediation only for "practical concerns"[329] – but they form the day-to-day living environment of many people from across the former Concession Area, posing the very real potential of exposures to their families, livestock and crops. Judges involved in the Lago Agrio trial personally visited the sites being investigated and personally oversaw the JIs, enabling them to see for themselves the conditions created by Texpet's operations, even aside from the chemical analytical data and other information presented. Direct observation played a role in forming the basis for the Judgment. While it has been many years, those conditions are still evident in many places, and members of the Tribunal would be able to witness them personally as well.

5 Conclusion: Summary of Opinions and Rejoinder Statement

After reviewing information and data produced by Chevron and their experts subsequent to our February 2013 Expert Report, as well as information gathered to respond to criticisms presented in Chevron's June 2013 Reply Memorial (including our independent investigations of five well sites), our seven opinions have not fundamentally changed from our February 2013 Expert Report. Points of amplification of these opinions as presented in this Rejoinder are as follows:

1) Chevron's criticisms of our February 2013 Expert Report are generally mistaken or misleading; and those few factual errors they identified do not substantively change our opinions.
2) Through our independent reconnaissance of 18 E&P facilities (at which Chevron collected data for JI investigations) across the northern half of the former Concession Area and subsequent investigations of five of these facilities, we have confirmed that contamination due to Texpet's substandard E&P practices is

[327] Hinchee, 2013, p. 15
[328] Goldstein, Theriot, and Strauss
[329] Connor, 2013, p.2

persistent in multiple environmental media beyond the immediate confines of the E&P facilities and associated pits.

3) Borings and monitoring wells at four out of the five sites that we investigated confirmed the presence of extensive deposits of permeable (sandy) shallow soils saturated with groundwater, contrary to Chevron's assertions that the soils of the region are predominantly clay and impermeable; as such, we reasonably infer that TexPet frequently constructed its unlined pits in permeable soils with shallow groundwater.
4) Sampling results from monitoring wells that we installed demonstrated that groundwater contamination persists beneath and around the pits (remediated by Texpet under the RAP or closed prior to the RAP) that we investigated.
5) Chemical analytical results and our direct observations demonstrate that contamination associated with Texpet's substandard E&P practices persists outside of pits in soils, surface water, and stream sediments.
6) Through our site reconnaissance and investigations, we confirmed that free-phase crude oil exists at and outside Texpet-operated E&P facilities in the former Concession Area, contrary to Chevron's mischaracterization that residual oil is highly weathered and immobile in the environment of the Ecuadorian Oriente.
7) Contamination associated with Texpet's substandard E&P practices is present at locations where people and animals are potentially exposed.
8) Contamination due to Texpet's substandard E&P practices is widespread[330] in the former Concession Area.

From an environmental and human health perspective, the data and information available to the Tribunal, including the results of our independent investigations and other technical research performed to address Claimants' criticisms, reveal the true nature of Texpet's legacy in the Oriente. The assertions by Claimants[331] that the impact of E&P activities was mainly aesthetic,[332] that residual crude oil remaining from those activities is all weathered, immobile, and limited to the immediate area of the oilfield facilities,[333] and that remediation was only important for ill-defined "practical concerns,"[334] are wrong. The environment of the former Concession Area has been damaged by Texpet's E&P activities, and this damage and its impacts to the residents continue to this day; thus the Judgment's assessment of damages in the Lago Agrio Trial appears at least reasonable.

[330] As noted in Section 2.1, we clarify that the term "widespread contamination" means a pattern of contamination at multiple E&P facilities across the former Concession Area, present in one or more environmental media beyond the immediate confines of the E&P facilities.
[331] Including Texpet and Chevron as individual entities.
[332] Henderson et al., 1990, p. 1
[333] Connor, 2013, p. 2-3
[334] Connor, 2013, p. 2

6 Expert Disclosures

6.1 Documents Reviewed

Following submission of our February 2013 Expert Report to the Tribunal, we have reviewed thousands of documents and data presentations produced during the BIT Arbitration. Our document review was undertaken primarily to enable us to evaluate and respond to specific criticisms made by Chevron during depositions of our experts in April and May 2013 and in Chevron's *Reply Memorial,* including *Annex A* dated June 5, 2013. The documents reviewed and/or relied upon in preparing this Rejoinder Report include the documents referenced in Sections 1.1.1, 1.1.2, and 1.1.3 of the *LBG February 2013 Expert Report*, as well as the following materials:

1) *Claimant's Reply Memorial, Track 2* dated June 5, 2013
2) *Annex A, Track 2 Reply Memorial* to the LBG February 2013 Expert Report dated June 5, 2013
3) *Expert Report of John A. Connor, P.E., P.G., B.C.E.E.*, June 3, 2013
4) *Expert Report of Robert E. Hinchee, Ph.D., P.E.*, May 31, 2013
5) *Expert Report of Gregory S. Douglas, Ph.D.*, June 1, 2013
6) *LBG's* investigations in Ecuador conducted between July and October, 2013
7) Documents produced in discovery from Chevron's experts, GSI Environmental Inc., and Stratus Consulting, Inc. through the §1782 subpoena process
8) Data found in additional databases that were obtained from Chevron through the §1782 process, including the April 2007 Chevron's Ecuador Oriente Region Environmental Database (Clickable Database) and the August 2013 Chevron's Ecuador Oriente Region Non-Analytical and Analytical Database (Access® Database)
9) Data packages from Alpha Woods Hole Group and Newfields laboratories
10) Exhibits used by Chevron in depositions of experts, Mr. Kenneth J. Goldstein, Dr. Edwin A. Theriot, Dr. Jeffrey W. Short and Dr. Harlee S. Strauss conducted in April and May 2013
11) Exhibits cited in Chevron's Experts' rebuttal reports (June 5, 2103) to the *LBG February 2013 Expert Report* for the BIT arbitration
12) Historical and current regulations pertaining to E&P operations in US oil-producing states;
13) Chevron's Judicial Inspection Playbooks, Oriente Region, for wells and production stations in the Concession Area
14) Information and guidance from various U.S. government websites including USEPA, USGS, ATSDR, etc.
15) Documents and databases from Texas (NEUBUS) and Louisiana (SONRIS) regulatory websites
16) Journal, magazine, and newspaper articles pertaining to issues raised in *Claimants' Reply Memorial*, including *Annex A* and expert reports of Connor, Hinchee, and Douglas
17) Other documents as cited herein

6.2 Summary of Qualifications and Experience

Mr. Goldstein's resume was included in Annex 3 of the *LBG February 2013 Expert Report*. Curricula Vitae for both Mr. Goldstein and for Dr. Garvey are provided in Appendix F of this Rejoinder.

Tables

Table 2.3-1 - Comparison of Waste Management Practices

Texpet Waste Disposal Practice at former Concession Area, Ecuador	Ken Kaigler Waste Disposal Experience	Notes and Comments
Drilling Mud and Cuttings: • Prior to 1990, muds containing lithium sulphate and other heavy metals were disposed of in sump pits.[1] • From 1964 to 1990, drill mud and cuttings were deposed (sic) of in the reserve pits.[2] • Drilling was conducted using water-based mud containing bentonite, polymers, caustic soda, surfactants, and barite at the time of a 1990 Texaco site visit.[3]	Drilling Mud and Cuttings: VARCO (Venezuela); 1952-1956 • Drilling muds collected for reuse or pumped into the well annulus at an appropriate depth for disposal.[4] • Cuttings disposed of in earthen reserve pits that were backfilled and compacted after well completion.[5] Humble Oil and Refining (Texas, U.S.A); 1950-1952 • Drilling mud from circulating and reserve pits was collected and reused at another well site after residing in earthen pits for 30-40 days during drilling.[6] British American Oil (Louisiana, U.S.A.); 1957-1964 • Steel circulation tanks used to contain drilling mud. Mud was collected for reuse at another well site or pumped into a disposal well.[7]	Drilling Mud and Cuttings: • Volume of drilling mud disposed by Texpet from a typical 10,000-foot deep well could be on the order of 500-600 bbls per well.[8] • Leaching of reserve pit constituents into groundwater and soil is a problem in the Texas/Oklahoma zone…When pits are constructed in permeable soil without liners, a higher potential exists for migration of reserve pit constituents into groundwater and soil…Pollutants may include chlorides, sodium, barium, chromium, and arsenic.[9] • The barite additive in drilling mud consists of barium sulfate. [Barium sulfate (barite) acts as a weighting agent to maintain pressure in the well.][10]
Crude Oil from Well Testing: • Excess flow test oil was drummed and shipped for analysis, remainder discharged to surface water…Excess fluids discharged into forest.[11] • An internal memo dated May 16, 1972 contains suggestions which indicate that reserve pits should not be used for well test, rather a small deep slush pit would be dug for well test, and that the slush pit should be filled in and the location graded once well testing was completed.[12]	Crude Oil from Well Testing: VARCO (Venezuela); 1952-1956 • Produced oil stored in tanks and then pumped back into well at the depth of the zone being tested.[13] British American Oil (Louisiana, U.S.A.); 1957-1964 • Produced oil collected in tanks and either hauled off with tanker trucks or pumped through pipelines.[14]	Crude Oil from Well Testing: • Texpet Well Sacha-1 flowed naturally 1,328 bbls per day upon completion in 1969.[15] One to two hours of yield testing from that well and wells with similar flow rates could generate waste crude oil in the amount of approximately 55 to 110 bbls, presumably discharged to an unlined ‘slush’ pit.
Produced Water: • 375 million bbls of produced water generated by Texpet 1964-1990 and disposed to the ground surface and surface water resources in the former Concession Area.[16] • All twenty-two production stations are currently, or have at some time, discharged oily produced water to the environment.[17] All produced water from the production facilities eventually discharged to creeks and streams except for one facility which used a percolation pit.[18] • Produced water is then passed through a series of open, unlined pits. Oil is periodically skimmed off the surface and stored in tanks before reprocessing. The remaining oil emulsion and produced water is discharged into a local creek or river or in some instances directly into the jungle.[19]	Produced Water: VARCO (Venezuela); 1952-1956 • Produced water collected in covered, steel storage tanks and disposed via reinjection for deep well disposal or water flooding project to prevent degradation of local drinking water resources[26] Humble Oil and Refining (Texas, U.S.A); 1950-1952 • Small volumes (less than 15 bbls) allowed to evaporate in pits.[27] • Larger volumes (greater than 15 bbls) reinjected for deep well disposal or water flooding project.[28] British American Oil (Louisiana, U.S.A.); 1957-1964 • Discharge of produced water (a.k.a. salt water waste) into waterways or onto land surface prohibited[29]	Produced Water: • In 1946, Louisiana regulations banned produced water discharges to coastal surface waters because of their adverse impacts to the environment. Texpet’s parent company, Texaco, unsuccessfully contested these regulations to the United States Supreme Court. After the Supreme Court upheld the regulations in 1947, affirming that uncontrolled disposal of produced water caused adverse impacts to flora and fauna, Texaco generally used injection wells, not surface discharge, to dispose of produced or "formation water" in the U.S.A.[30] • Since at least 1982, and probably earlier, Texaco used injection wells for disposal of produced waters at the Erath Field near the Henry Hub Site, Louisiana, U.S.A. Six other Texaco produced water disposal wells in

[1] HBT Agra, 1993, p. 5-14
[2] Fugro-McClelland, 1992, p. 3-3
[3] Henderson et al, 1990, p. 3
[4] Kaigler, 2013, p. 11
[5] Kaigler, 2013, p. 11
[6] Kaigler, 2013, p. 10
[7] Kaigler, 2013, p. 12
[8] Kaigler, 2013, p. 14
[9] EPA, 1987, Volume 1, p. IV-52
[10] EPA, 1987, Volume 1, p. III-6
[11] HBT Agra, 1993, Table 4-3, Columns “1964 to 1969”; “1970, 71, 72 and 73”; and “1984, 85 and 86”
[12] Fugro-McClelland, 1992, p. 6-32
[13] Kaigler, 2013, p. 11
[14] Kaigler, 2013, p. 13
[15] Canfield, 1991, p. 285
[16] HBT Agra, 1993, p. 5-6
[17] HBT Agra, 1993, p. 5-6
[18] Fugro-McClelland, 1992, p. E-2
[19] HBT Agra, 1993, p. 5-14

Texpet Waste Disposal Practice at former Concession Area, Ecuador	Ken Kaigler Waste Disposal Experience	Notes and Comments
• Use of pits to remove oil from the produced water cannot be considered "good practice"…they do not permit clean and efficient recovery of the separated oil…the saline produced water may percolate through the pit beds into the groundwater.[20] • Fugro-McClelland detected total petroleum hydrocarbons (TPH) in produced water effluent and downstream samples. • HBT Agra detected TPH in produced water effluent.[21] "Produced water is being discharged to the environment in all cases. Contamination of soil and water below the discharge pipe was noted in all cases."[22] • Impacts to receiving water quality due to produced water disposal documented, *e.g.*, Rio Nutshinac changed from calcium bicarbonate water to sodium chloride water.[23] • None of Texpet's produced water discharges were registered with the Ecuadorian Institute of Sanitary Works (IEOS), as required by 1989 Ecuadorian regulations.[24] • Texpet did not use produced water for its water flooding projects, which began in the 1980s. Instead, water was pumped from local streams, cleaned and treated prior to injection.[25]		different Texas fields are documented during the period 1937-1965.[31] • Reports released by the API Central Committee on Drilling and Production Practice in 1942 and 1944 recommended tanks and injection wells for the disposal of produced water.[32] • API's 1974 document, *API Recommended Onshore Production Operating Practices for Protection of the Environment*, noted that "the handled fluids might have an adverse effect on the environment if discharged onto vegetation or allowed to seep into potable water sources or irrigation waters."[33] • "Governor Carruthers….states that "Unlined pits in fresh water areas in Southeast New Mexico were banned beginning in 1956, with a general prohibition adopted in 1967"."[34]
<u>Workover Wastes</u>: • Workover, completion wastes, salt solutions, and oil/water emulsions have historically been disposed of in well site pits…Previously, [the acid water produced from workovers] was disposed of in the well site pits.[35] • Current government regulations require a pit at each well for the purpose of receiving spent workover and stimulation fluids. In February, 1986, Texaco requested permission to close these pits. A formal response has not been received to date. These pits contain oil, produced water, workover brines, spent acid, and treatment solvents. Fluids are not generally recovered from these pits, since in many cases they are inaccessible.[36]	<u>Workover Wastes</u>: VARCO (Venezuela); 1952-1956 • The fluid from a well workover was picked up and temporarily stored for either reuse of disposal into an injection well.[37] Humble Oil and Refining (Texas, U.S.A); 1950-1952 • Workover wastes contained in steel aboveground storage tanks instead of unlined pits.[38] British American Oil (Louisiana, U.S.A.); 1957-1964 • The fluid from the workover operations was either picked up and stored for reuse or disposed of in a disposal well.[39]	<u>Workover Wastes</u>: • API's 1974 document, *API Recommended Onshore Production Operating Practices for Protection of the Environment*, stated the following regarding waste pits: "Necessary precautions should be taken to protect streams and potable water. Many state regulatory agencies require that pits be lined and assigned permit numbers. Utilize pits in accordance with existing regulations, with their use being minimized and alternate means considered where feasible."[40] • Texpet's parent company Texaco employed concrete-lined pits at its Louisiana Henry Hub operation in 1986 (and earlier).[41]

[20] Henderson et al, 1990, p. 2-3
[21] HBT Agra, 1993, Table 7-2
[22] HBT Agra, 1993, p. 6-20
[23] HBT Agra, 1993, p. 7-6
[24] Fugro-McClelland, 1992, p. E-2
[25] Fugro-McClelland, 1992, p. 6-1
[26] Kaigler, 2013, p. 12
[27] Kaigler, 2013, p. 10
[28] Kaigler, 2013, p. 10
[29] Kaigler, 2013, p. 13
[30] Templet, 2013, p. 17
[31] Templet, 2013, p. 9
[32] Templet, 2013, p. 22
[33] Templet, 2013, p. 20
[34] EPA, 1987, Volume 1, p. IV-63, Footnote 73
[35] HBT Agra, 1993, pgs. 5-14 and 5-15
[36] Henderson et al, 1990, p. 4
[37] Kaigler, 2013, p. 10
[38] Kaigler, 2013, p. 10
[39] Kaigler, 2013, p. 13
[40] Templet, 2013, p. 20
[41] Templet, 2013, p. 9

TABLE 4.1-1: Historical Document Inconsistencies: Observations vs. Conclusions

Document and Author	Observations	Conclusions	Recommendations	LBG Evaluation
Memorandum to W. C. Benton titled "*Environmental Assessment – Consortium Operations in Ecuador*" U.V. Henderson, Jr. et al. November 14, 1990	• "The stations with significant produced water generally had three pits in series. With only one exception, oil completely covered the surface of all the pits in the system; however, there was no evidence of significant oil content in any of the discharges from the final ponds (there were occasional blooms observed in one or two discharges)." (p. 2) • "Use of pits to remove oil from the produced water cannot be considered 'good practice' for several reasons. The first is that they do not permit clean and efficient recovery of the separated oil…In the fourth place, the saline produced water may percolate through the pit beds into the groundwater." (p. 2-3) • Current government regulations require a pit at each well for the purpose of receiving spent workover and stimulation fluids…These pits contain oil, produced water, workover brines, spent acid, and treatment solvents. Fluids are not generally recovered from these pits, since in many cases they are inaccessible." (p. 4) • "Unused chemicals are dumped into the produced water pits or into the wash tank for inclusion in the oil stream." (p. 5)	"Our general impression is that petroleum operations have had a relatively insignificant impact on the environment outside of facility sites. It is our opinion that the impact within facilities is mainly an esthetic impact." (p. 1) "We are inclined to believe that impact [*to groundwater*] would be slight…" AND "We cannot determine by inspection whether saline contamination of the groundwater has actually occurred." (both p. 3)	• "…produced water should be treated in steel skin tanks…If the salinity or hydrocarbon content of the discharged produced water substantially impacts the quality of the receiving water, produced water should be injected into underground formations." (p. 6) • "Drilling reserve pits should be reduced in size or replaced with tanks…This will help eliminate possible ground water impacts." (p. 6) • "Workover pits should be closed…replaced with steel tanks…This will reduce the perception of contamination recover oil for product, and protect wildlife." (p. 7) • "Consideration should be given to groundwater sampling upgradient and downgradient from produced water pits to determine whether saline contamination has occurred. If such contamination is found, the pits should be closed to prevent further irreversible contamination." (p. 7)	The memo's content is contradictory and not scientifically credible because contaminant impacts are dismissed as aesthetic and transitory without any characterization sampling. The memo closes with a recommendation for "groundwater sampling upgradient and downgradient from produced water pits to determine whether saline contamination has occurred." The memo also describes such potential contamination as "irreversible" (p. 7). It is conspicuous that both Texpet and Chevron avoided conducting a robust groundwater investigation (specifically, installation and sampling of groundwater monitoring wells) from the RAP throughout the JIs. The potential impacts that are attached to the recommendations (*e.g.*, impacts to groundwater) are clearly also associated with the observed activities; therefore, the memo is internally inconsistent in concluding that "petroleum operations have had a relatively insignificant impact…" The conclusions should have been withheld pending representative data.

TABLE 4.1-1: Historical Document Inconsistencies: Observations vs. Conclusions

Document and Author	Observations	Conclusions	Recommendations	LBG Evaluation
Final Environmental Field Audit for Practices 1964-1990, Petroecuador-Texaco Consortium Fugro-McClelland, Inc. October 1992	• "The audit identified hydrocarbon contamination requiring remediation at all production facilities and a majority of the drill sites. Seventy percent of the 158 drill sites audited had drilling or production pits. Approximately 50 percent of those pits contained crude oil in them…Hydrocarbon contamination was also observed at the production facilities." (p. E-1 to E-2) • "All produced water from the production facilities eventually discharged to creeks and streams except for one facility which used a percolation pit." (p. E-2) • "From 1964 to 1990, drill mud and cuttings were deposed (*sic*) of in the reserve pits." (p. 3-3) • "Approximately 70 percent of the well sites audited had drilling or production pits…Almost 50% of the pits audited were empty, or contained water. A majority of the remaining pits has 100 percent crude oil cover." (p. 6-9) • Approximately 29 percent of the well sites audited had 5,000 square feet or more of hydrocarbon contamination (p. 6-10). • "The water is then discharged to the produced water pit…The produced water…still contains residual hydrocarbons. Of the 18 production facilities audited, "nine facilities were observed to have final stage pits with a large accumulation of crude oil (greater than 95%)." (p. 6-13 to 6-14). • "Evidence of petroleum releases beyond the final stage pit into a surface drainage feature were (*sic*) observed at Aguarico, Cononaco, Sacha Central, Sacha Norte, and Yuca. The drainage channels at Sacha Central and Yuca were heavily contaminated and contained free standing crude oil which was slightly degraded." (p. 6-23)	TEXPET's operations were acceptable and in compliance with the Ecuadorian law and regulation. Refer to p. 6-29, 6-33, 6-35, and 6-41. "Well sites that contain heavily degraded crude oil in an asphaltic state may not require remediation." (p. 6-33) "In 1980, TEXPET conducted a sampling and analysis program to determine hydrocarbon concentration and to detect toxic substances in the waters downstream of production operations. The only area of concern identified in that report was the high levels of hydrocarbons and sulfates at Sacha Central." (p. 6-35) "…the ability for fluids to migrate from the surface pit into the groundwater is relatively low…" (p. 6-38)	"Several areas were identified during the environmental audit that, pursuant to Ecuadorian laws and regulations in effect from 1964 to 1990, will require either changes in operational procedures and/or site restoration/remediation. These areas included: • Clean up of spills associated with base camp activities. • Proper closure of pits at well sites. • Cleanup of spills associated with well site activities. • Cleanup of spills associated with production facilities. • Remediation or correction of produced water discharge. • Cleanup of spills from pipeline leaks." (p. 7-2) The total volume of soil requiring remediation from well site pads, well site pits, tank berms, miscellaneous spills, and pipelines was estimated as 109,700 cy (refer to Table 7-1, Estimate of Soil Requiring Remediation). "The discharge of produced water to surface streams…is…acceptable…provided there is sufficient dilution to meet the established water quality standards…Based on the alternatives presented, discharge to surface waters and underground injection are the only viable and cost effective methods of produced water disposal." (p. 7-10)	The assertion that Texpet complied with regulations, even those broadly prohibiting adverse impacts to flora or fauna, is based on a unsupportable rationale that in the absence of numerical discharge limits, the most rudimentary treatment, *e.g.*, settling ponds to remove oil and emulsions – acknowledged as not permitting "clean and efficient recovery of the separated oil" (Henderson et al., 1990) – represents compliance. No basis was provided for the assertion that degraded crude oil could be present in an 'inert,' asphaltic state that might not require remediation. No documentation was provided for the 1980 sampling program that reportedly ruled out impacts from produced water disposal in streams. Rationale that contamination is not migrating to groundwater is based on an inadequate sampling program of existing wells and seeps and no knowledge of groundwater flow direction (p. 6-22).

TABLE 4.1-1: Historical Document Inconsistencies: Observations vs. Conclusions

Document and Author	Observations	Conclusions	Recommendations	LBG Evaluation
Draft Environmental Assessment of the Petroecuador-Texaco Consortium Oil Fields – Vol. I Environmental Audit Report HBT Agra Limited October 1993	• "All twenty-two production stations are currently, or at some time, have discharged oily produced water to the environment and flared excess gas." (p. 5-6) • "Oil is periodically skimmed off the surface and stored in tanks before reprocessing. The remaining oil emulsion and produced water is discharged into a local creek or river or in some instances directly into the jungle." (p. 5-14) • "Prior to 1990, muds containing lithium sulphate and other heavy metals were disposed of in sump pits." (p. 5-14) • "Workover, completion wastes, salt solutions and oil/water emulsions have historically been disposed of into well site pits." (p. 5-14) • "Well site spills have occurred at 158 of the 163 assessed sites. The majority of these spills were small and affected the area immediately around the wellhead…Contaminant migration from these well site spills into the highly plastic red clays was generally observed to be minimal." (p. 6-13) • "The use of well site pits to contain oily waste fluids was observed at 125 of the assessed well sites…A total of 126 open or closed pits contain oily waste. Oily waste is confined within 50 of the pits and was found to be migrating in 76 cases…Evidence of seepage was noted at 69 of the pits. The presence of oily soil at covered pits, evidence of lateral migration of contaminants and oily discharge from siphons were considered to be indicators of seepage. Seepage or pit discharge to streams was observed to have occurred at 28 pit locations…Of the 46 covered pits, 33 were found to have oily waste present in soil in, or beyond the former confines of the pit." (p. 6-14 to 6-15) • At the twenty-two production stations visited during Phase I, it was observed that "Spills were identified around manifolds and separators, wash and surge tanks, pumps and compressors, fuel and chemical tanks, flare lines and flare stacks, process area drains and sumps, generators, vehicle maintenance areas, and pits." (p. 6-16) • "Fuel spills have contaminated groundwater at the Shushufindi Central Station. Groundwater exhibiting hydrocarbon odors was encountered in a hole hand augured to a depth of 2 metres in this area." (p. 6-18) • Regarding produced water pits at the production stations, "Fifty-four of the pits are used as holding and separation ponds for the disposal of produced water. Crude oil is present in the produced water discharged to these pits…The thickness of oil present on the surface of the water in these separation pits ranged from a thin film to several centimetres. Oily sludge is present in all of these pits…Produced water is being discharged to the environment in all cases. Contamination of soil and water below the discharge pipe was noted in all cases." (p. 6-20)	"In all cases, activities likely to cause contamination were identified from pre-1990 operational practices." (p. 5-16) Regarding impacts to surface water from discharge of oily produced water, "All concentrations of total petroleum hydrocarbons (TPH) and phosphorous in the effluents were within their respective criteria." (p. 7-18) "Based on the results of our investigation, we have found little evidence of significant subsurface contaminant migration beyond the boundaries of the production stations and well sites. At most sites, there was little evidence of contamination migrating beyond the margins of the "high risk" features such as mud pits and ponds." (p. 8-25) "Three exploration sites (Shushufindi-Central Station and Aguarico Well Sites 3 and 9) were characterized by oil on the surface of the water table in excavations close to oily, open pits. In each case, contamination was found to diminish with a few tens of meters." (p. 8-25)	"The extent of contamination within the large stained areas should be confirmed by further assessment particularly at sites where spills have migrated off-site or impacted surface waters." (p. 10-1) "It is recommended that all well site pits be properly remediated and closed as soon as is practically possible." (p. 10-10) "Those (*production station pits*) that are currently in use should be phased out and ultimately closed. This will necessitate the prior implementation of other means of produced water disposal (e.g., deep well injection)." (p. 10-10) "The practice of burying drilling sumps without assessment, treatment and remediation should be discontinued." (p. 10-12) "A waste management program needs to be introduced." (p. 10-12)	Without a robust investigation of sediment quality due to the chronic discharge of oily produced water to the receiving streams and wetlands, the conclusions regarding impacts to surface water in the HBT Agra report are incomplete and technically inadequate. HBT Agra's conclusion regarding limited contaminant migration is based on a screening investigation and analysis that relies on rudimentary groundwater sampling techniques consisting of sample collection from test pits, hand auger borings, water wells and springs. These types of groundwater grab sampling techniques are only adequate to establish presence vs. absence of crude oil contamination; and given that crude oil was observed on the groundwater table, and oil and grease was detected in groundwater samples (presence of groundwater contamination established), a robust groundwater investigation program including installation and sampling of appropriately-designed groundwater monitoring wells should have been recommended to resolve the question of subsurface contaminant nature and extent and transport.

TABLE 4.ρ-1: Historical Document Inconsistencies: Observations vs. Conclusions

Document and Author	Observations	Conclusions	Recommendations	LBG Evaluation
Remedial Action Project, Oriente Region, Ecuador, Final Report – Volume I of II Woodward-Clyde International May 2000	• The RAP Report describes the well site pits as follows: "The pits are typically open excavations of approximately 1 to 2 meters depth and not lined…The pits typically contained a variety of materials, which included debris, crude oil, rainwater , and sludges…Because of the oil contained in the pits, the soil around the pits was often contaminated with oil. However, because of the fine-grained clay that underlies this region, vertical and horizontal migration of the oil was very limited. Most lateral migration was seen along the root canals, etc. and around the oil layer (bath tub ring)." (p. 3-4) • "In certain instances, roots of some secondary growth located along the perimeter provided avenues for the degraded hydrocarbons to migrate; in these instances, the vegetation was removed along with its root systems." (p. 3-5) • The volume of hydrocarbons removed from the remediated pits totaled "An estimated 34,000 bbl of pumpable hydrocarbon material that resulted from the remediation and closure of pits…" (p. 4-1)	• Describes environmental impacts of former Texpet activities as "localized" (p. 1-3). • Relies on TCLP extraction and analysis of the extract for TPH to confirm efficacy of remediation. At Auca-17, post-remediation samples were apparently tested for both TPH and TCLP-TPH, and the TPH results from the pre- and post-remediation samples were similar. "The aggressive extraction and preparation procedure for TPH analysis breaks down the encapsulation around the soil particles. Therefore, the prior and post remediation TPH concentrations are similar, but the TCLP results demonstrate that the TPH which is encapsulated is not available as leachable TPH, and that there is not a migration path to groundwater" (p. 3-18).	• Some soils were treated with an encapsulating agent, "or chemical (generally silica-based) until the additive encapsulates the hydrocarbon molecules, making it (sic) unavailable for subsequent leaching by percolating water or exposure to receptors via the groundwater pathway." (p. 3-9). • "…the TCLP results demonstrate that the TPH which is encapsulated is not available as leachable TPH, and that there is not a migration path to groundwater…" (see, for example, p. 3-18 and p. 3-19)	The RAP Report contradicts itself by stating that certain remedial activities were specifically conducted to prevent future migration of contaminants to groundwater, while simultaneously asserting that there was no pathway for migration of contaminants to groundwater during the decades that the pits contained crude oil wastes and produced water. EPA states in the "Report to Congress: Management of Wastes from the Exploration, Development and Production of Crude Oil, Natural Gas and Geothermal Energy" that the TCLP test may underestimate the leaching potential of petroleum wastes due to a "procedural problem in the filtration step of the TCLP…Some production wastes contain materials that may clog the filter, indicating that the waste contains little or no mobile fraction. In an actual disposal environment, however, the liquid may migrate" (EPA, 1987, Vol. 1, pg. II-42). Essentially, the TCLP test procedure was not developed to assess oilfield wastes and may exclude non-aqueous phase oily product from the final extract, such that TPH results obtained from analysis of the extract would be biased low. Given EPA's admonition against using TCLP to characterize oil wastes, TCLP is unlikely to be a reliable measure of whether or not the remediation activities achieved cleanup objectives; it is unclear that Texpet can claim remediation to a 5,000 ppm TPH level for which testing was never performed prior to March 1997. The most appropriate 'proof' of remedial effectiveness would have included an appropriately-designed groundwater monitoring program, which was not conducted.

Figures

77°0'0"W
76°50'0"W
76°40'0"W
76°30'0"W
0°20'0"N
0°10'0"N
0°0'0"
0°10'0"S
0°20'0"S
0°30'0"S
0°40'0"S
315000
317250
317300
317350
317400
302900
303000
9945700
9945950
9970900
9970600
9970300
9970750

Pipe outfall
Pit 2
Pit 3
Pit 1
Residence
Oil Water Separator
LA-02 Wellhead

Adapted from Figure 3.5-1B (Pit Locations), Site Investigation Report, Appendix B

Pit 3
Pit 2
Pit 1

Adapted from Figure 3.6-1, Site Investigation Report, Appendix B

Pit A

Adapted from Figure 3.7-1B, Site Investigation Report, Appendix B

Pit 2
Pit A
Pit 1
Pit B

Adapted from Figure 3.9-1, Site Investigation Report, Appendix B

Pit 2
Pit 1
Pit 4

Adapted from Figure 3.8-1, Site Investigation Report, Appendix B

Lago Agrio 02
Lago Agrio PS
Lago Agrio 11
LAGO AGRIO
Dureno 1
Guanta 7
Guanta 06
Aguarico 02
Aguarico 3
Shushufindi 18
SHUSHUFINDI
Shushufindi 4
Shushufindi 45A
Shushufindi 69
Shushufindi 48
Shushufindi 25
Shushufindi Suroeste PS
SACHA
Sacha 14
Sacha Central PS
Sacha 57
Sacha Norte 2 PS
Sacha 65
Yuca 2B

General Farfan
Sucumbios
Dureno
Shushufindi
Siete de Julio
San Sebastian del Coca
La Joya de Los Sachas
San Roque
Tarapoa
Sevilla
Santa Cecilia
Rio Aguarico
335 m
310 m

0 2.5 5 10
Kilometers

Candidate site
- Reconnaissance conducted July 2013, selected for investigation
- Reconnaissance conducted July 2013, not selected
- Candidate site, reconnaissance not conducted
- Major Pipeline
- Stream

- City
- Parish
- Province
- Concession Area
- Residence

Location Type
- Monitoring Well
- Soil Boring
- Sediment/Surface Water
- Piezometer

Production Area
- Platform

PitStatus
- RAP - Remediated
- RAP - No Further Action
- Unconfirmed
- Non RAP - Not Remediated
- Closed Prior to RAP

Area Location

FIGURE 2.2-1

Candidate and Selected Investigation Sites

December 2013

Path: S:\Projects\C\F500A17 - WASM\aoDocuments\SI_Report_Nov1815-Analytical Results\AreaLocation_11x17_ALA.mxd

All data boundary failure

* > 1000 ppm point on the perimeter.

JI data boundary failure

* > 1000 ppm point on the boundary.
* Perimeter includes pit samples.
* Perimeter crosses pits.
* Perimeter does not include all pit area.

300
300
300
310
300
300

Platform
LA-15
Pit A
Pit B

Legend
- Oil Well Location
- Pit
- Platform
- Elevation (m)
- River
- Roads
- Pipeline

Investigation Source
- Preliminary Inves igation
- Judicial Inspection
- Rebuttal
- Phase 2
- Court Expert Site

Result
- Detect
- Non-detect

Distance from Pit Boundary
- Inside Pit
- 10 m
- 50 m
- 200 m
- 500 m
- 1000 m
- 5000 m

Streams
- 10 m Stream Buffer

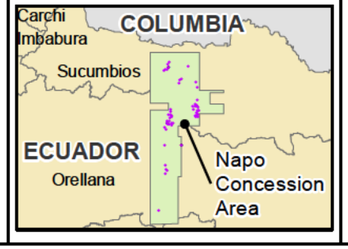
TPH Concentration (mg/kg) Method 8015B
- < 100
- 100.1 - 300
- 300.1 - 1,000
- 1,000.1 - 3,000
- 3,000.1 - 10,000
- >10,000.1

Sample Depth
- Surface
- Subsurface

Boundary Type
- All Samples
- JI Samples

0 12.5 25 Meters

Notes:
- Surface sample concentration is the average of top 0.3 m segments, while subsurface sample concentration is the average of all segments below 0.3 m
- Duplicate samples were averaged prior to plotting.
- A non-detect sample concentration is represented by its reporting limit as an upper bound.



"Clean Perimeter" Assessment
TPH Data
Lago Agrio 15
Figure 4.2-1
December 2013

Document Path: P:\CJF500A7 - W&SGIS\MapDocuments\SamplesRepresentativeness\SampleRep_PitBufferZones_TopBottomAve.mxd

All data boundary failure

* > 1000 ppm point on or within 10 m of perimeter.
* Perimeter includes pit samples.
* Perimeter crosses pit.
* Perimeter does not include all pit area.

JI data boundary failure

* > 1000 ppm point on or within 10 m of perimeter.
* Perimeter includes pit samples.
* Perimeter crosses pit.
* Perimeter does not include all pit area.

Pit 1
Pit 2
Pit 3
Pit 4
Platform SA-053

Legend
- Oil Well Location
- Pit
- Platform
- Elevation (m)
- River
- Roads
- Pipeline

Investigation Source
- Preliminary Inves igation
- Judicial Inspection
- Rebuttal
- Phase 2
- Court Expert Site

Result
- Detect
- Non-detect

Distance from Pit Boundary
- Inside Pit
- 10 m
- 50 m
- 200 m
- 500 m
- 1000 m
- 5000 m

Streams
- 10 m Stream Buffer

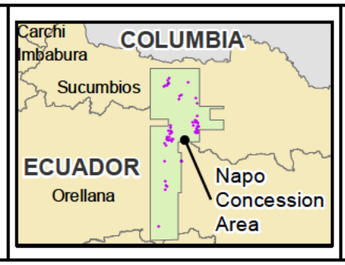
TPH Concentration (mg/kg) Method 8015B
- < 100
- 100.1 - 300
- 300.1 - 1,000
- 1,000.1 - 3,000
- 3,000.1 - 10,000
- >10,000.1

Sample Depth
- Surface
- Subsurface

Boundary Type
- All Samples
- JI Samples

0 12.5 25 Meters

Notes:
- Surface sample concentration is the average of top 0.3 m segments, while subsurface sample concentration is the average of all segments below 0.3 m
- Duplicate samples were averaged prior to plotting.
- A non-detect sample concentration is represented by its reporting limit as an upper bound.



"Clean Perimeter" Assessment
TPH Data
Sacha 53
Figure 4.2-2
December 2013

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