La Sentencia de Lago Agrio no se condice con el derecho ecuatoriano y la práctica actual; asimismo refleja un tratamiento diferenciado de Chevron frente a Petroecuador

Por Pedro J.J. Alvarez, Ph.D., P.E., BCEE

Resumen de formación y experiencia

El Dr. Alvarez es profesor de la cátedra George R. Brown y titular de cátedra de Ingeniería Civil y Ambiental en Rice University. Tiene un título de grado (B. Ing.) en Ingeniería Civil de McGill University y una maestría (M.S.) y un doctorado (Ph.D.) en Ingeniería Ambiental de University of Michigan. El Dr. Alvarez posee más de 20 años de experiencia en investigación aplicada y fundamental en relación con el destino y el transporte de contaminantes ambientales y la limpieza de sitios contaminados. Junto con el Dr. Walter Illman, escribió el libro *Bioremediation and Natural Attenuation of Groundwater Contaminants: Process Fundamentals and Mathematical Models,* publicado por John Wiley & Sons.

Entre sus actividades de campo internacionales en biorremediación y atenuación natural de derrames de hidrocarburos se encuentran las siguientes: (1) estudio de atenuación natural de 10 años realizado en el sitio experimental Fazenda Ressacada en Florianópolis, Brasil (Corseuil HX, A.L. Monier, M. Fernandes, M.R. Schneider, C. Nunes, M. do Rosario y P.J.J. Alvarez, 2011. BTEX Plume Dynamics Following an Ethanol Blend Release: Geochemical Footprint and Thermodynamic Constraints on Natural Attenuation. *Environ. Sci. Technol.* 45(8), 3422–3429); (2) estudios de campo de biorremediación anaeróbica realizados con diferentes plumas en el mismo sitio (Toledo-Ramos D., M.L.B. da Silva, H.S. Chiaranda, P.J.J. Alvarez y H.X. Corseuil (2013). Biostimulation of Anaerobic BTEX Biodegradation under Fermentative Methanogenic Conditions in Groundwater Contaminated with a Biodiesel Blend (B20). *Biodegradation* (en prensa); Corseuil HX, A.L. Monier, A.P.N. Gomes, M. do Rosario y P.J.J. Alvarez (2011). Biodegradation of soybean and castor oil biodiesel: Implications on the natural attenuation of monoaromatic hydrocarbons in groundwater. *Ground Water Monitoring and Remediation.* 31(3):111-118.); y (3) ex miembro del Comité de Expertos del Programa de Biotecnología del Instituto Mexicano del Petróleo 2/00-2/04.

El Dr. Alvarez es ingeniero ambiental certificado por la American Academy of Environmental Engineers y miembro de la American Academy for the Advancement of Sciences (AAAS), la American Society of Civil Engineers (ASCE), la International Water Association (IWA), la Water Environment Federation (WEF) y la Leopold Leadership Foundation. Entre los reconocimiento recibidos se encuentran el Athalie Richardson Irvine Clarke Prize (2012); el Malcom Pirnie-AEESP Frontiers in Research Award (2008); la WEF McKee Medal for Groundwater Protection (2007), Presidente de la Association of Environmental Engineering and Science Professors (AEESP) (2006); el Cleanup Project of the Year Award de SERDP (2002); el Botón de la Ciudad de Valencia (2000); el Collegiate Excellence in Teaching Award de University of Iowa (1997); la Medalla Alejo Zuloaga Medal de la Universidad de Carabobo, Venezuela (1996); el Career Award de la National Science Foundation (1995); el Outstanding Achievement Award in Environmental Engineering de University of Michigan (1991); y varios premios a los mejores trabajos con sus estudiantes. Actualmente, el Dr. Alvarez se desempeña como

miembro del Consejo Asesor Científico de la EPA y en la revista ambiental líder *Environmental Science and Technology*. Además, es profesor honorario de las Universidades Nankai y Kunming de China y profesor adjunto de la Universidad Federal de Santa Catarina de Florianópolis, Brasil. En el Anexo A se adjunta una copia de su currículum vitae.

El Dr. Alvarez es independiente de King & Spalding, Chevron Corporation y del tribunal de arbitraje. Dr. El Dr. Alvarez ha sido contratado por King & Spalding y Chevron para evaluar la Sentencia del 2011 y las pericias ofrecidas por Kenneth Goldstein y Jeffrey Short en relación con el asunto de Chevron Corporation y Texaco Petroleum Company contra la República de Ecuador. Además de este arbitraje, el Dr. Alvarez ha sido contratado por los abogados de Chevron Corporation a fin de realizar una pericia en *Chevron Corporation v. Donziger* (1:11-cv-00691-LAK-JCF), en la Corte de Distrito Federal de Nueva York.

El Dr. Alvarez visitó el área de la concesión en tres oportunidades y observó personalmente las Inspecciones Judiciales. Primero participó como observador independiente en la Inspección Judicial de la Estación de Producción Suroeste de Shushufindi, realizada entre el 10 y el 15 de octubre del 2004. Durante la semana del 23 de abril del 2006, realizó una revisión independiente del programa de muestreo y análisis. Finalmente, el 24 de septiembre del 2007, participó como observador independiente de una Inspección Judicial de Fase 2 realizada por el perito judicial Richard Cabrera. Como consultor independiente de Chevron, el Dr. Alvarez fue coautor de 3 informes relacionados con las operaciones de Texpet en el área de la concesión, que se presentaron en el tribunal de Lago Agrio.

Introducción

La Sentencia del 2011 del tribunal ecuatoriano contra Chevron fue consecuencia de una serie de irregularidades que llevaron a un cálculo irrazonable y exagerado de los daños. Este informe pericial distingue entre inconsistencias claves relacionadas con la presente Sentencia y refiere supuestos errores y exageraciones de los peritos del Gobierno de Ecuador sobre el alcance y los efectos de la contaminación hidrocarburífera en la región del Oriente en relación con las prácticas de gestión de residuos de pozos petrolíferos y operaciones de Texpet.

Opinión 1. La Sentencia contra Chevron no se condice con el derecho ecuatoriano y la práctica actual; asimismo refleja un tratamiento diferenciado de Chevron frente a Petroecuador

La Sentencia del 2011 del tribunal ecuatoriano indica que Chevron es responsable por la remediación del suelo a un estándar de limpieza de 100 ppm de hidrocarburos de petróleo totales (TPH) y estimó un costo de remediación del suelo contra Chevron cercano a los USD5.400 millones. El estándar de limpieza aplicado por esta Sentencia contradice precedentes recientes de Ecuador y prácticas actuales de Petroecuador, la empresa petrolífera estatal. Específicamente:

1A) El estándar de remediación de 100 ppm TPH al que se pretende ajustar a Chevron no concuerda con los estándares legales establecidos en el Decreto Ejecutivo 1215 (y al que se sujeta a Petroecuador actualmente

por el Gobierno ecuatoriano, de conformidad con el derecho de ese país). Esos estándares son entre 10 y 40 veces menos exigentes.

El derecho ecuatoriano (Decreto Ejecutivo 1215 del 2001) establece los estándares de remediación para los hidrocarburos de petróleo totales (TPH). Estos estándares varían según el uso asignado al suelo o el área que se remediará (es decir, < 4.000 ppm para áreas industriales, < 2.500 ppm para áreas agrícolas y < 1.000 ppm para ecosistemas sensibles; nótese que el Anexo 2, Tabla 6 del DE 1215 establece que los "ecosistemas sensibles" están especialmente designados por los estudios ambientales correspondientes). Estos estándares de limpieza del suelo actualmente son aplicados por el Gobierno ecuatoriano a la limpieza de los sitios de operación petrolífera de Petroecuador, según lo establecido por los registros de DINAPA (es decir, la Dirección Nacional de Protección Ambiental ha sido el organismo de protección ambiental ecuatoriano que supervisó la remediación). El estándar de limpieza que la Sentencia aplica a Chevron es de 100 ppm, que representa un estándar 25 veces más exigente que el estándar de suelo agrícola que se ha aplicado a la mayor parte de los sitios de producción petrolífera de Petroecuador en la región del Oriente. Diferentes actas de cierre aportan prueba de que Petroecuador recibió resoluciones para que no se tomara ninguna acción adicional, para indicar que la remediación estaba totalmente realizada a este nivel de 2.500 ppm. Ejemplos de esas actas están incluidos en la "Evaluación de la Remediación de Piscinas del Programa PEPDA de Petroecuador, María Aguinda y Otros contra Chevron-Texaco Corporation, Juicio No. 002-2003, Corte Superior de Justicia, Nueva Loja, Ecuador"[1]; específicamente en:

- Adjunto H: Informe Final, Eliminación de la Piscina SA-15-1, PEPDA, 2006, p.61
- Adjunto I: Informe Final, Eliminación de la Piscina SA-32-1, PEPDA, 2006, p.60, p.57
- Adjunto J: Informe Final, Eliminación de la Piscina SA-32-2, PEPDA, 2006, p. 57
- Adjunto K: Informe Final, Eliminación de la Piscina SA-78, PEPDA, 2006, P.66
- Adjunto L: Presentación PowerPoint para SSF-50-2, PEPDA, sin fecha, pp. 43-51
- Adjunto M: Presentación PowerPoint para SA-78, PEPDA, sin fecha, pp. 71-79
- Adjunto N: Informe Final, Eliminación de la Piscina SA-14-1, PEPDA, 2006, p. 90

Aprobación gubernamental del estándar de limpieza de 2.500 ppm continúa en el área de concesión a un número de sitios remediados más recientemente.[2]

---

[1] Baca E., Respuesta a Cabrera sobre su evaluación del Programa de Remediación de Piscinas de PETROECUADOR (PEPDA), Maria Aguinda *et al.* c. Chevron-Texaco Corp., Tribunal Superior de Justicia, Nueva Loja, Caso de Ecuador No. 002-2003, confeccionado por: GSI Environmental Inc., 5 de septiembre del 2008. **(Anexo 1)**

[2] Acta Entrega-Recepción de Piscina Eliminada Sacha-118-1, con fecha 26 de octubre de 2007, firmada por El Propietario (Lozada Benavides Luis Humberto), Jefe de Área Campo Sacha (Ing. Roberto Collaguazo), DEREPA-AMA (Ing. Alexander Paredes), Coordinador Proyecto PEPDA (Ing. Jorge Vivanco) **(Anexo 2)**; Acta Entrega-Recepción de Piscina Eliminada Sacha-118-2, con fecha 26 de octubre del 2007, firmada por El Propietario (Lozada Benavides Luis Humberto), Jefe de Área Campo Sacha (Ing. Roberto Collaguazo), Delegado DEREPA-AMA (Ing. Alexander Paredes), Coordinador Proyecto PEPDA (Ing. Jorge Vivanco) **(Anexo 3)**; Acta Entrega-Recepción de Piscina Eliminada Sacha-118-3, con fecha 26 de octubre de 2007, firmada por El Propietario (Lozada Benavides Luis Humberto), Jefe de Área Campo Sacha (Ing. Roberto Collaguazo), Delegado Regional DINAPA (Ing. Alexander Paredes), Coordinador Proyecto PEPDA (Ing. Jorge Vivanco) **(Anexo 4)**; Acta Entrega-Recepción de Piscina Eliminada SA-123-1, con fecha 12 de mayo del 2007, firmada por El Propietario (Jorge Renelmo Vera Villegas), Jefe de Área Campo

Además, las recientes iniciativas de remediación de derrames de Petroecuador en Lago Agrio 11B el 14 de octubre del 2006[3] y en Sacha 36 el 9 de octubre del 2007[4] fueron sujetas por el Gobierno ecuatoriano al estándar de remediación de suelo industrial (< 4.000 ppm TPH) establecido en el DE 1215, Tabla 6.

Como se explicó anteriormente, el estándar de remediación de TPH al que se sujetó a Chevron en la Sentencia ecuatoriana no concuerda con (y es mucho más exigente que) los estándares que el Gobierno de Ecuador exige a Petroecuador, otras empresas petrolíferas y sus contratistas de remediación a fin de cumplir con el derecho ecuatoriano.

1B) La Sentencia refleja el tratamiento diferencial de Chevron frente a Petroecuador.

Las prácticas de gestión de residuos de Texpet eran similares, si no virtualmente idénticas, a las prácticas utilizadas actualmente por Petroecuador, las cuales son aprobadas por el Gobierno de Ecuador. Sin embargo, la Sentencia y los peritos de Ecuador critican a Chevron por práctica que Ecuador aprueba constantemente para Petroecuador e ignoran las actuales operaciones de Petroecuador en la región, que son mucho más amplias que las de Texpet.

Pozos petrolíferos

Texpet dejó de operar en la región en 1990 y cumplió con su responsabilidad de remediación (conforme a lo dispuesto por el Plan de Acción de Remediación (RAP, por sus siglas en inglés))[5] en 1998, lo que fue confirmado y aprobado por el Gobierno ecuatoriano y partes neutrales.[6] Desde ese entonces, Petroecuador y otros operadores han perforado muchos más pozos petrolíferos que Texpet.

Sacha (Ing. Patricio López), Coordinador DEREPA-AMA (Ing. Alexander Paredes), Coordinador Proyecto PEPDA (Ing. Jorge Vivanco) **(Anexo 5)**; Acta Entrega-Recepción de Piscina Eliminada SA-123-2, con fecha 12 de mayo del 2007, firmada por El Propietario (Jorge Renelmo Vera Villegas), Jefe de Área Campo Sacha (Ing. Patricio López), Coordinador DEREPA-AMA (Ing. Alexander Paredes), Coordinador Proyecto PEPDA (Ing. Jorge Vivanco) **(Anexo 6)**; Acta Entrega-Recepción de Piscina Eliminada SA-123-3, con fecha 12 de mayo del 2007, firmada por El Propietario (Jorge Renelmo Vera Villegas), Jefe de Área Campo Sacha (Ing. Patricio López), Coordinador DEREPA-AMA (Ing. Alexander Paredes), Coordinador Proyecto PEPDA (Ing. Jorge Vivanco) **(Anexo 7)**; Acta Entrega-Recepción de Piscina Eliminada SSFD-17-1, con fecha 18 de septiembre del 2007, firmada por El Propietario (Aura del Carmen Torres Suin), Jefe de Área Campo Shushufindi (Ing. Lex Montaño), Coordinador DEREPA-AMA (Ing. Alexander Paredes), Coordinador Proyecto PEPDA (Ing. Jorge Vivanco) **(Anexo 8).**

3 Petroproduccion Oficio No. 0923 PPR-OPE-AMB-2008, con fecha 9 de febrero del 2008, del Ing. Leoncio Villacís V., Subgerente de Operaciones, al Dr. Rolando Del Pozo V., Director Nacional de Protección Ambiental, Enc., Ministerio de Minas y Petróleos en relación con la remediación del 14 de octubre del 2006 de un derrame en un pozo de Lago Agrio 11-B a estándares de uso industrial de tierra del DE 1215, Anexo 2, Tabla 6. **(Anexo 9)**

4 Petroproducción Oficio No. 7812 PPR-SGI-2008, con fecha 9 de septiembre del 2008, del Ing. Patricio Viteri D., Subgerente de Gestión Integral al Ingeniero Danny Yánez C., Director Nacional de Protección Ambiental Hidrocarburífera, Enc., Ministerio de Minas y Petróleos en relación con la remediación de un derrame del 9 de octubre del 2007 en la estación Sacha 36 a los estándares de uso industrial del DE 1215, Anexo 2, Tabla 6. **(Anexo 10)**

5 Woodward-Clyde International, Inc. y Smith Environmental Technologies Corp., Remedial Action Plan for the Former Petroecuador-Texpet Consortium, 8 de septiembre de 1995. **(Anexo 11)**

6 Liberación final entre el Gobierno de Ecuador, Petroecuador, Petroproducción y Texaco Petroleum Company, 30 de septiembre de 1998. **(Anexo 12)**

Según Information Handling Services, Inc. (IHS, empresa que suministra datos sectoriales), mapas de Petroecuador y otros informes,[7] 3.169 pozos han sido perforados por empresas petrolíferas en todo Ecuador, y 2.788 de estos fueron perforados en el Oriente. De los 2.788 pozos perforados en el Oriente, Petroecuador y otros operadores han perforado 2.452 pozos, mientras que Texpet solo perforó 336 pozos. 739 pozos han sido perforados por Petroecuador y sus contratistas en la concesión después de 1990.

Los pozos petrolíferos requieren reparaciones periódicas. Sobre la base de información 2006-2012, la cantidad promedio de reparaciones promedio realizadas cada año por Petroecuador dentro del área de concesión es de 338.[8]

---

[7] Base de datos IHS, www.ihs.com/Products (IRIS21: International E&P Database: Energy Information, Software & Solutions); diciembre del 2012; PETROPRODUCCION Mapa Vial Auca http://www.eppetroecuador.ec/idc/groups/public/documents/archivo/001377.pdf **(Anexo 13)**; PETROPRODUCCION Mapa Vial Cononaco http://www.eppetroecuador.ec/idc/groups/public/documents/archivo/001380.pdf **(Anexo 14)**; PETROPRODUCCION Mapa Vial Lago – Guanta - Parahuacu http://www.eppetroecuador.ec/idc/groups/public/documents/archivo/001383.pdf **(Anexo 15)**; PETROPRODUCCION Mapa Vial Sacha http://www.eppetroecuador.ec/idc/groups/public/documents/archivo/001386.pdf **(Anexo 16)**; PETROPRODUCCION Mapa Vial Shushufindi http://www.eppetroecuador.ec/idc/groups/public/documents/archivo/001387.pdf **(Anexo 17)**; PETROPRODUCCION Mapa Vial Yuca Yulebra Culebra http://www.eppetroecuador.ec/idc/groups/public/documents/archivo/001392.pdf **(Anexo 18)**; Secretaría de Hidrocarburos Ecuador. Bloques Región Oriente. CEPHI – 18 Región Amazónica. Enero-2012 http://www.eppetroecuador.ec/idc/groups/public/documents/archivo/001375.pdf **(Anexo 19)**; Comunicación - Operaciones Rio Napo CEM. Operaciones Río Napo inicia Perforación de Pozo Sacha 206 D http://rionapocem.com.ec/comunicacion/132-operaciones-rio-napo-inicia-perforacion-pozo-sacha-206-d.html **(Anexo 20)**; EP PETROECUADOR. Informe de Gestión 2010-2011. Quito, 7 abril 2011 **(Anexo 21)**; Abrus Cía. Ltda. 2011. Estudio de Impacto Ambiental y Plan de Manejo Ambiental para el Desarrollo de la Plataforma Sacha 300, para la perforación de los Pozos e Desarrollo Sacha 300D, 301D, 304H, 305D, 306H 302D, 307H, 303D. **(Anexo 22)**; HBT AGRA Limited. Environmental Audit and Assessment of the Petroecuador-Texaco Consortium Oil Fields Until June 30, 1990. Volumen I: Environmental Audit Report. Confeccionado para: Consorcio Petroecuador-Texaco. Octubre de 1993 **(Anexo 23)**; Woodward-Clyde International, Inc. Smith Environmental Technologies Corporation. Plan de Acción de Reparación Medioambiental para el Antiguo Consorcio Petroecuador-Texpet. Texaco Petroleum Company (Texpet) 09/08/95 **(Anexo 11)**; Woodward-Clyde. Proyecto de Acción de Remediación. Región Oriente, Ecuador. Informe Final. Volumen I de II. Confeccionado para Texaco Petroleum Company. Mayo del 2000. **(Anexo 24)**

[8] Datos de reparación del 2006 obtenidos del Informe Estadístico 1972-2006, Exploración **(Anexo 25)**; 2007 Datos de reparación del Informe Estadístico de la Industria Hidrocarburífera, 2007, Actividades de Exploración en el Año 2007 **(Anexo 26)**; 2009 Datos de reparación obtenidos de la Empresa Petróleos del Ecuador, Informe Estadístico Gerencial diciembre 2009, 15 enero 2010 **(Anexo 27)**; 2010 Datos de reparación obtenidos de EP Petroecuador, Informe Estadístico 2010, Cifras provisionales enero 2010 [2011] **(Anexo 28)**; 2011 Datos de reparación obtenidos de EP Petroecuador, Informe Cifras Petroleras, Período enero - diciembre 2011, Cifras provisionales febrero de 2012 **(Anexo 29)**; 2012 Datos de reparación de EP Petroecuador, Informe Cifras Petroleras, Período enero - diciembre 2012, Cifras provisionales febrero de 2013. **(Anexo 30)**

Piscinas de desechos

La Sentencia y los peritos de Ecuador reprueban el uso de Texpet de piscinas sin revestimiento. Sin embargo, Petroecuador continúa utilizando piscinas sin revestimiento para albergar y desechar sobrantes y lodo de perforación de pozos petrolíferos,[9] y del mismo modo (al igual que Texpet) utiliza un procedimiento de lixiviación característico de toxicidad (Toxicity Characteristic Leaching Procedure, TCLP) para probar los materiales de desechos.[10] Nótese que el uso de piscinas sin revestimiento para almacenar y desechar sobrantes y lodo de perforaciones de pozos petrolíferos está aprobado por las autoridades del Gobierno de Ecuador, ya que esto dispone el derecho ecuatoriano, DE 1215 (Tabla 7a).

Ya que las piscinas son el principal medio para desechar sobrantes de perforaciones de pozos petrolíferos en la región del Oriente, la mayor cantidad de pozos perforados por Petroecuador en relación con el consorcio implica que la cantidad de piscinas asociadas perforadas por Petroecuador en esta región también son mayores. La operación de estas piscinas por Petroecuador es similar a la operación de piscinas por el consorcio en tanto que las piscinas son típicamente sin revestimiento; albergan los mismos tipos de desechos de perforación y se utilizaron los mismos tipos de criterios (TCLP) para determinar si las piscinas habían sido cerradas adecuadamente (es decir, se cumplieron los criterios TCLP para evaluar el potencial de lixiviación de la piscina).

Petroecuador ha excavado y enterrado al menos 1.000 piscinas de tierra[11] para tirar los desechos de la perforación; construyó muchas de sus piscinas de desechos en sitios antes remediados por Texpet. Por ejemplo, el

---

9 Véase, por ejemplo, los documentos relacionados con el desecho de Petroecuador de los residuos en piscinas ubicadas en la plataforma del pozo Sacha-60: Acta de Toma de Muestras de Ripios y Cortes de Perforación de las Celdas del Pozo Sacha 140D Correspondiente a los 180 Días de su Disposición Final, Ubicación: Plataforma Pozo Sacha 60, Fecha: 13 de abril de 2008, firmada por representantes de SINOPEC, DINAPA, Protección Ambiental Petroproducción, LABPAM Petroproducción, Brandt **(Anexo 31)**; Acta de Toma de Muestros de Ripios y Cortes de Perforación de las Celdas del Pozo Sacha 147D/147D ST-1 Correspondiente a los 7 Días de su Disposición Final, Ubicación: Plataforma Pozo Sacha 60, Fecha: 30 de enero del 2008, firmada por representantes de SINOPEC, DINAPA, Protección Ambiental Petroproducción, LABPAM Petroproducción, Brandt **(Anexo 32)**; Acta de Toma de Muestras de Ripios y Cortes de Perforación de las Celdas del Pozo Sacha 147D/147D ST-1 Correspondiente a los 90 Días de su Disposición Final, Ubicación: Plataforma Pozo Sacha 60, Fecha: 13 de abril del 2008, firmada por los representantes de SINOPEC, DINAPA, Protección Ambiental Petroproducción, LABPAM Petroproducción, Brandt **(Anexo 33)**; Acta de Toma de Muestras de Ripios y Cortes de Perforación de las Celdas del Pozo Sacha 147D/147D ST-1 Correspondiente a los 180 Días de su Disposición Final, Ubicación: Plataforma Pozo Sacha 60, Fecha: 15 de julio del 2008, firmada por representantes de SINOPEC, DINAPA, Protección Ambiental Petroproducción, LABPAM Petroproducción, Brandt **(Anexo 34)**; fotografías de Sacha-60. **(Anexo 35).**

10 Véase, por ejemplo: Petroproduccion Laboratorio Ambiental, IE/LABPAM/05 345, Fecha/hora de Muestreo: 7 de noviembre del 2005, Fecha de emisión: 15 de noviembre del 2005 que muestra "Tipo de muestra" como "lixiviado" para muestras recolectadas en Sacha 14, Sacha 50 y Sacha 77 **(Anexo 36)**; Petroproducción Laboratorio Ambiental (LABPAM), IE/LABPAM/08 185, Fecha/hora de Muestreo: 23/02/2008, Fecha de emisión: 13/03/2007 [2008] que muestra "Límites máximos permisibles aplicados" del DE 1215 Tabla 7a (sin impermeabilización de la base) para muestras recolectadas de lodo y restos de Cononaco 30 D desechadas en Cononaco 11. **(Anexo 37)**

11 Las piscinas sin revestimiento de Petroecuador se observaron en la Inspección Judicial de Auca 19 en el 2009. Desde entonces, los documentos, mapas, imágenes aéreas y fotos confirmaron el amplio uso de nuevas piscinas de desechos en el área de la concesión.

el pozo Sacha 60 tiene dos piscinas del consorcio que fueron remediadas a mediados de la década de 1990.[12] Petroecuador construyó 99 piscinas adicionales en la misma ubicación para desechar lodo de perforación y otros desechos del pozo petrolífero.[13] De manera similar, Petroecuador excavó más de cien nuevas piscinas en SSF-40, sitio para el que no se exigía remediación conforme al RAP.[14] Como se mencionó, estas piscinas de desechos están permitidas conforme al DE ecuatoriano 1215 y deben cumplir con los requisitos TCLP de la Tabla 7.

Derrames

Petroecuador también tuvo varios derrames. El Ministerio de Ambiente de Ecuador informó en su base de datos del Sistema de Información de Pasivos Ambientales (SIPAS) que 524 derrames que totalizan cerca de 125.000 barriles (bbl) fueron asociados con operaciones de pozos de Petroecuador en el área de la concesión entre 1990 y 2009.[15] La base de datos SIPAS parece subinformar la cantidad de derrames, según sugieren varios cientos de derrames informados por el diario ecuatoriano "El Universo" que no están documentados en el SIPAS (se informaron 1415 derrames en el período 2000-2008).[16]

La base de datos SIPAS registra cerca de 90 derrames en la región entre 1972 y 1990.[17] Incluso si todos estos estuvieran relacionados con las operaciones del consorcio, esta cantidad es significativamente menor que los más de 500 derrames registrados y relacionados con las operaciones (a mayor escala) de Petroecuador. En suma, estos datos indican que Petroecuador es responsable por la mayor cantidad acumulada de petróleo derramado en la región.

A pesar de los pozos, las piscinas de desechos y los derrames de Petroecuador, no encontré pruebas de que el Gobierno ecuatoriano haya exigido a Petroecuador cumplir el estándar de remediación TPH de 100 ppm. Dado que Petroecuador generó una cantidad mayor de desechos similares y los gestionó utilizando piscinas sin revestimiento, con aprobación del Gobierno de Ecuador, los estándares diferenciales a los que se sujeta a Chevron parecen contradictorios, si no sesgados. Es claro que Chevron y Petroecuador no están siendo medidos con la misma vara.

> *1C) El dictamen pericial del Gobierno de Ecuador de que "La evaluación de daños de la Sentencia parece cuanto menos razonable" es superficial porque indirectamente aprueba la exagerada evaluación de los costos de remediación del tribunal sin considerar la base para dicha estimación.*

---

12 Acta Entrega-Recepción de Piscina Eliminada SA-60, con fecha 24/7/1996 **(Anexo 38)**; Acta-Entrega-Recepción de Piscina Eliminada SA-60, con fecha 22/11/1996 **(Anexo 39)**; Acta Entrega-Recepción de Piscina Eliminada SA-60, con fecha 20/3/1997. **(Anexo 40)**

13 *Véase* nota 9.

14 *Véase* nota 10.

15 http://www.sipas-pras.gob.ec/sipasweb/# **(Anexo 44)**; hoja de cálculo "Derrames.xlsx" descargada el 11 de noviembre del 2012. Refiérase a la pestaña "DERRAMES>5bbl OS" para seleccionar los sitios de derrame ubicados dentro del área de la concesión que ocurrieron después de 1990. **(Anexo 41)**

16 "Petroecuador Diagnostica Los Daños Ambientales Por Crudo", El Universo, 28 de febrero del 2009. **(Anexo 42)**

17 http://www.sipas-pras.gob.ec/sipasweb/# **(Anexo 44)**

El informe pericial del Gobierno de Ecuador escrito por The Louis Berger Group, Inc. (LBG) y JWS Consulting, titulado "Expert opinion of Kenneth J. Goldstein, MA, CGWP, and Jeffrey W. Short, PhD, Regarding the Environmental Contamination from Texpet's E&P, Activities in the Former NAPO Concession Area, Oriente Region, Ecuador" indica en la opinión n.º 7 que *"la evaluación de daños de la Sentencia parece cuanto menos razonable"*. Para formular una opinión profesional sobre la razonabilidad de la Sentencia, uno debe considerar la magnitud y la razonabilidad del costo de remediación evaluado en relación con las prácticas actuales, los costos reales y la coherencia con los estándares de limpieza aplicables. LBG ignoró todos estos factores críticos, no consideró la cantidad de suelo que exige remediación y ofreció esta opinión vaga y superficial sin suministrar respaldo de evidencias alguno. Como se explicó anteriormente, la Sentencia es irrazonable porque (1) se basa en un estándar de limpieza que no está contemplado en el derecho ecuatoriano ni utilizado en la región del Oriente ni en la práctica usual internacional, y (2) contradice la práctica actual de Petroecuador, que está siendo sujetada por el Gobierno de Ecuador a un estándar de limpieza que es 25 veces menos exigente, conforme a lo pautado en el DE 1215 (Tabla 6).

Opinión 2. El muestreo de los peritos de Chevron durante las inspecciones judiciales es válido y no estuvo sesgado para evitar la contaminación

Los peritos del Gobierno de Ecuador han repetido en varias oportunidades que el programa de muestreo que realizaron deliberadamente los peritos de Chevron encubrió o minimizó los riesgos asociados y la contaminación existente. Consideré este tema en otra oportunidad, como se resumió en un informe anterior del 2006, titulado "Evaluation of Chevron's Sampling and Analysis Methods" de P.J.J. Alvarez, D. McKay y R. Hinchee. En ese informe, concluimos que las afirmaciones no estaban "*sustentadas por información publicada alguna que hayamos revisado a la fecha ni por acciones o circunstancias que hayamos observado personalmente durante el trabajo de muestreo en las Inspecciones Judiciales en la estación de producción de Shushufindi SW (octubre del 2004) y la estación de producción Sacha Norte 1 (abril del 2006), ni durante nuestras propias inspecciones en mayo de 2006 de Shushufindi-004, Shushufindi-013, Sacha-06, Sacha-51, Sacha-53 y Sacha-Central".*[18]

Además, según lo que me consta, ninguno de los peritos del Gobierno de Ecuador que hicieron estas manifestaciones asistieron a ninguna inspección judicial, no respetaron el proceso de toma de decisiones utilizado durante las inspecciones judiciales para establecer las ubicaciones de toma de muestras conforme a control mutuo, ni respetaron los métodos de muestreo utilizados por los peritos judiciales. Dado que no se presentó ningún enfoque novedoso en el informe LGB para reconsiderar mi opinión, sostengo que las críticas de los peritos del Gobierno de Ecuador respecto de la investigación del sitio del equipo de Chevron durante las inspecciones judiciales son incorrectas e infundadas.

18 P.J.J. Alvarez, D. McKay y R. Hinchee. "Evaluation of Chevron's Sampling and Analysis Methods". 9 de agosto del 2006, en la pág. 2. **(Anexo 43)**

Personalmente, observé una falta de transparencia deliberada de Cabrera (el perito de los Demandantes que lideró su inspección judicial de fase II) durante la inspección judicial de Shushufindi 35 el 24 de septiembre del 2007. Específicamente, (a) descartó muestras que tomó que no mostraban signos visuales de decoloración relacionada con los hidrocarburos (es decir, muestras limpias), y (b) se negó a delinear la región de influencia de la migración de los hidrocarburos y a determinar si se estaban afectando los receptores (por ejemplo, los pozos de agua potable de los colonos cercanos), lo que indica que se trató de una inspección viciada. Esto resulta contrario al enfoque de los peritos de Chevron, que tomaron muestras de agua potable de pozos cercanos.

Conclusiones

- El estándar de remediación de 100 ppm TPH al que se está sujetando a Chevron en la sentencia del tribunal se contradice que los estándares jurídicos establecidos por el DE 1215 (y a los que aún Petroecuador se encuentra sujeto por el Gobierno ecuatoriano, conforme al derecho ecuatoriano); esos estándares aplicados a Petroecuador son entre 10 y 40 veces menos exigentes que el estándar de remediación aplicado a Chevron por la Sentencia ecuatoriana.
- La Sentencia responsabiliza a Chevron por las operaciones y prácticas de gestión de residuos que son casi idénticas a las prácticas actuales de Petroecuador, aprobadas por el Gobierno de Ecuador al considerarlas coherentes con el derecho ecuatoriano.
- Petroecuador duplicó el número de pozos petrolíferos en la antigua área de la concesión, con derrame de cerca de 125.000 bbl de crudo, y excavó al menos 1.000 piscinas de tierra nuevas para residuos de perforación. La sentencia ecuatoriana ignoró todos los impactos operativos de Petroecuador y los requisitos regulatorios aplicados a estas operaciones.
- El programa de muestreo y los métodos utilizados por los peritos de Chevron durante las inspecciones judiciales fueron apropiados.
- El dictamen pericial de los Demandantes de Lago Agrio (LBG y JWS) de que "el cálculo de daños de la Sentencia parece, al menos, razonable" es superficial e incorrecto porque ignora la evaluación exagerada e irrazonable de los costos de remediación y no considera las prácticas actuales y las contradicciones con los estándares de limpieza aplicables y las prácticas de gestión de residuos conforme a las regulaciones y aplicaciones del Gobierno de Ecuador.

Certificación

Este informe refleja de manera precisa mis opiniones, según mi leal saber y entender, sobre este asunto.

[firma]

Pedro J.J. Alvarez, Ph.D.

31 de mayo del 2013
Fecha

MERRILL
CORPORATION
Merrill Communications LLC
225 Varick Street
New York, NY 10014 • (212) 620-5600

State of New York)
Estado de Nueva York
) ss:
) a saber:
County of New York)
Condado de Nueva York

Certificate of Accuracy
Certificado de Exactitud

This is to certify that the attached translation is, to the best of our knowledge and belief, a true and accurate translation from English into Spanish of the attached document.
Por el presente certifico que la traducción adjunta es, según mi leal saber y entender, traducción fiel y completa del idioma inglés al idioma español del documento adjunto.

Dated: September 19, 2013
Fecha: 19 de septiembre de 2013

Kate Alexander
Project Manager – Legal Translations
Merrill Brink International/Merrill Corporation

[firmado]
Kate Alexander
Gerente de Proyecto – Traducciones Legales
Merrill Brink International/Merrill Corporation

Sworn to and signed before
Jurado y firmado ante
Me, this 19th day of
mí, a los 19 días del
September 2013
mes de septiembre de 2013

ROBERT J. MAZZA
Notary Public, State of New York
No. 01MA5057911
Qualified in Kings County
Commission Expires April 1, 2

Notary Public
Notario Público

[firmado]
[sello]

The Lago Agrio Judgment is Inconsistent with Ecuadorian Law and Current Practice and Reflects Differential Treatment of Chevron versus Petroecuador

By Pedro J.J. Alvarez, Ph.D., P.E., BCEE

Summary of Qualifications and Experience

Dr. Alvarez is the George R. Brown Professor and Chair of Civil and Environmental Engineering at Rice University. He received a bachelor of engineering (B. Eng.) degree in Civil Engineering from McGill University, and Master of Science (M.S.) and doctor of philosophy (Ph.D.) degrees in Environmental Engineering from the University of Michigan. Dr. Alvarez has over 20 years of experience in applied and fundamental research associated with the fate and transport of environmental pollutants and the cleanup of contaminated sites. He co-authored with Dr. Walter Illman the textbook, *Bioremediation and Natural Attenuation of Groundwater Contaminants: Process Fundamentals and Mathematical Models*, published by John Wiley & Sons.

Recent international field experience in bioremediation and natural attenuation of hydrocarbon spills includes (1) a 10-year natural attenuation study conducted at the Fazenda Ressacada experimental site in Florianopolis, Brazil (Corseuil HX, A.L. Monier, M. Fernandes, M.R. Schneider, C. Nunes, M. do Rosario and P.J.J. Alvarez, 2011. BTEX Plume Dynamics Following an Ethanol Blend Release: Geochemical Footprint and Thermodynamic Constraints on Natural Attenuation. *Environ. Sci. Technol.* 45(8), 3422–3429); (2) anaerobic bioremediation field studies conducted with different plumes at the same site (Toledo-Ramos D., M.L.B. da Silva, H.S. Chiaranda, P.J.J. Alvarez, and H.X. Corseuil (2013). Biostimulation of Anaerobic BTEX Biodegradation under Fermentative Methanogenic Conditions in Groundwater Contaminated with a Biodiesel Blend (B20). *Biodegradation* (In press); Corseuil HX, A.L. Monier, A.P.N. Gomes, M. do Rosario and P.J.J. Alvarez (2011). Biodegradation of soybean and castor oil biodiesel: Implications on the natural attenuation of monoaromatic hydrocarbons in groundwater. *Ground Water Monitoring and Remediation.* 31(3):111-118.); and (3) Former member of the Expert Committee for the Biotechnology Program of the Mexican Petroleum Institute 2/00-2/04.

Dr. Alvarez is a Board Certified Environmental Engineer by the American Academy of Environmental Engineers and a Fellow of the American Academy for the Advancement of Sciences (AAAS), the American Society of Civil Engineers (ASCE), the International Water Association (IWA), the Water Environment Federation (WEF), and of the Leopold Leadership Foundation. Past honors include the Athalie Richardson Irvine Clarke Prize (2012); the Malcom Pirnie-AEESP Frontiers in Research Award (2008); the WEF McKee Medal for Groundwater Protection (2007), President of the Association of Environmental Engineering and Science Professors (AEESP) (2006); the Cleanup Project of the Year Award from SERDP (2002); the Button of the City of Valencia (2000); the Collegiate Excellence in Teaching Award from the University of Iowa (1997); the Alejo Zuloaga Medal from the Universidad de Carabobo, Venezuela (1996); a Career Award from the National Science Foundation (1995); the Outstanding Achievement Award in Environmental Engineering from the University of Michigan (1991); and several best paper awards with his students. Dr. Alvarez currently serves

on the EPA's Science Advisory Board and the editorial board of the leading environmental journal *Environmental Science and Technology*. Additionally, he serves as honorary professor at Nankai and Kunming Universities in China and as adjunct professor at the Universidade Federal de Santa Catarina in Florianopolis, Brazil. A copy of his *curriculum vitae* is attached as Appendix A.

Dr. Alvarez is independent from King & Spalding, Chevron Corporation, and the arbitration tribunal. Dr. Alvarez has been retained by King & Spalding and Chevron to evaluate the 2011 Judgment and the expert opinions offered by Kenneth Goldstein and Jeffrey Short concerning the matter of Chevron Corporation and Texaco Petroleum Company versus the Republic of Ecuador. In addition to this arbitration, Dr. Alvarez has been retained by counsel for Chevron Corporation to provide an expert opinion in *Chevron Corporation v. Donziger* (1:11-cv-00691-LAK-JCF), in the U.S. District Court for the Southern District of New York.

Dr. Alvarez has visited the concession area three times and has personally observed the Judicial Inspections. He first participated as an independent observer in the Shushufindi Southwest Production Station Judicial Inspection, conducted during October 10 through 15, 2004. During the week of April 23, 2006, he conducted an independent review of the sampling and analysis program. Finally, on September 24, 2007, he participated as an independent observer of a Phase 2 Judicial Inspection conducted by the court-appointed expert Mr. Richard Cabrera. As an independent consultant for Chevron's, Dr. Alvarez has co-authored 3 reports relating to Texpet operations in the concession area, which were submitted to the Lago Agrio court.

Introduction

The 2011 Judgment by the Ecuadorian court against Chevron was the result of irregularities that were conducive to an unreasonable and exaggerated assessment of damages. This expert report discerns critical inconsistencies associated with this Judgment and points to apparent misconceptions and exaggerations by the Government of Ecuador's experts about the extent and impacts of hydrocarbon contamination in the Oriente Region associated with Texpet operations and oil-well waste management practices.

Opinion 1. The Judgment against Chevron is inconsistent with Ecuadorian law and current practice, and reflects differential treatment of Chevron versus Petroecuador

The 2011 Judgment by the Ecuadorian court indicates that Chevron is responsible for soil remediation to a cleanup standard of 100 ppm of total petroleum hydrocarbons (TPH), and assesses against Chevron a soil remediation cost of about $5.4 billion. The cleanup standard applied by this Judgment is inconsistent with recent precedents in Ecuador and with current practice of Petroecuador, the state-owned oil company. Specifically:

1A) The 100 ppm TPH remediation standard to which Chevron is being held is inconsistent with legal standards stipulated by Decreto Ejecutivo 1215 (and to which Petroecuador is

currently held by the Ecuadorian Government, consistent with Ecuadorian Law). Those standards are 10- to 40-fold less stringent.

Ecuadorian Law (Decreto Ejecutivo 1215 of 2001) stipulates remediation standards for residual total petroleum hydrocarbons (TPH). These standards vary according to the designated use of the soil or area to be remediated (i.e., <4,000 ppm for industrial areas, <2,500 ppm for agricultural areas, and <1,000 ppm for sensitive ecosystems; note that Appendix 2, Table 6 of DE 1215 states that "sensitive ecosystems" are specially designated by the corresponding environmental studies). These soil cleanup standards are currently applied by the Ecuadorian Government to the cleanup of oil operation sites by Petroecuador, as indicated by DINAPA records (i.e., the Dirección Nacional de Protección Ambiental has been the Ecuadorian environmental protection agency overseeing remediation). The cleanup standard that the Judgment applies to Chevron is 100 ppm, which is 25 times more stringent than the agricultural soil standard that has been applied to the majority of Petroecuador's remediation of oil production sites in the Oriente region. Numerous closure "Actas" provide evidence that Petroecuador received "no further action" resolutions, to indicate that the remediation was fully completed at this 2,500 ppm level. Examples of such "Actas" are included in the "Evaluación de la Remediación de Piscinas del Programa PEPDA de Petroecuador, María Aguinda y Otros contra Chevron-Texaco Corporation, Juicio No. 002-2003, Corte Superior de Justicia, Nueva Loja, Ecuador[1]; specifically in:

- Adjunto H: Informe Final, Eliminación de la Piscina SA-15-1, PEPDA, 2006, p.61
- Adjunto I: Informe Final, Eliminación de la Piscina SA-32-1, PEPDA, 2006, p.60, p.57
- Adjunto J: Informe Final, Eliminación de la Piscina SA-32-2, PEPDA, 2006, p. 57
- Adjunto K: Informe Final, Eliminación de la Piscina SA-78, PEPDA, 2006, P.66
- Adjunto L: Presentación PowerPoint para SSF-50-2, PEPDA, sin fecha, pp. 43-51
- Adjunto M: Presentación PowerPoint para SA-78, PEPDA, sin fecha, pp. 71-79
- Adjunto N: Informe Final, Eliminación de la Piscina SA-14-1, PEPDA, 2006, p. 90

Government approval of the 2,500 ppm cleanup standard continues in the concession area at a number of more recently remediated sites.[2]

---

[1] Baca E., Response to Mr. Cabrera Regarding His Evaluation of PETROECUADOR's Pit Remediation Program (PEPDA), Maria Aguinda *et al.* vs. Chevron-Texaco Corp., Superior Justice Court, Nueva Loja, Ecuador Case No. 002-2003, Prepared by: GSI Environmental Inc., September 5, 2008. **(Exhibit 1)**

[2] Acta Entrega-Recepcion de Piscina Eliminada Sacha-118-1, dated 26 de Octubre de 2007, signed by El Propietario (Lozada Benavides Luis Humberto), Jefe de Área Campo Sacha (Ing. Roberto Collaguazo), DEREPA-AMA (Ing. Alexander Paredes), Coordinador Proyecto PEPDA (Ing. Jorge Vivanco) **(Exhibit 2)**; Acta Entrega-Recepcion de Piscina Eliminada Sacha-118-2, dated 26 de Octubre de 2007, signed by El Propietario (Lozada Benavides Luis Humberto), Jefe de Área Campo Sacha (Ing. Roberto Collaguazo), Delegado DEREPA-AMA (Ing. Alexander Paredes), Coordinador Proyecto PEPDA (Ing. Jorge Vivanco) **(Exhibit 3)**; Acta Entrega-Recepcion de Piscina Eliminada Sacha-118-3, dated 26 de Octubre de 2007, signed by El Propietario (Lozada Benavides Luis Humberto), Jefe de Área Campo Sacha (Ing. Roberto Collaguazo), Delegado Regional DINAPA (Ing. Alexander Paredes), Coordinador Proyecto PEPDA (Ing. Jorge Vivanco) **(Exhibit 4)**; Acta Entrega-Recepcion de Piscina Eliminada SA-123-1, dated 12 de Mayo de 2007, signed by El Propietario (Jorge Renelmo Vera Villegas), Jefe de Área Campo

Furthermore, recent spill remediation efforts by Petroecuador at Lago Agrio 11B on October 14, 2006[3], and at Sacha 36 on October 9, 2007[4] were held by the Ecuadorian Government to the industrial soil remediation standard (< 4,000 ppm TPH) stipulated in the DE 1215, Table 6.

As stated above, the TPH remediation standard to which Chevron is held in the Ecuadorian Judgment is inconsistent with (and far more stringent than) the standards the Government of Ecuador requires Petroecuador, other oil companies, and their remediation contractors to meet under Ecuadorian law.

1B) The Judgment reflects differential treatment of Chevron versus Petroecuador.

Texpet's waste management practices were similar if not virtually identical to practices currently used by Petroecuador, which are approved by the Government of Ecuador. Yet the Judgment and Ecuador's experts criticize Chevron for practices that Ecuador routinely approves for Petroecuador and ignores Petroecuador's current and ongoing operations in the region, which are far more extensive than Texpet's.

Oil Wells

Texpet terminated operations in the region in 1990 and complied with its remediation responsibility (as mandated by the Remedial Action Plan (RAP))[5] in 1998, which was confirmed and validated by the Ecuadorian Government and by independent parties[6]. Since that time, Petroecuador and other operators have drilled significantly more oil wells than Texpet.

Sacha (Ing. Patricio López), Coordinador DEREPA-AMA (Ing. Alexander Paredes), Coordinador Proyecto PEPDA (Ing. Jorge Vivanco) **(Exhibit 5)**; Acta Entrega-Recepcion de Piscina Eliminada SA-123-2, dated 12 de Mayo de 2007, signed by El Propietario (Jorge Renelmo Vera Villegas), Jefe de Área Campo Sacha (Ing. Patricio López), Coordinador DEREPA-AMA (Ing. Alexander Paredes), Coordinador Proyecto PEPDA (Ing. Jorge Vivanco) **(Exhibit 6)**; Acta Entrega-Recepcion de Piscina Eliminada SA-123-3, dated 12 de Mayo de 2007, signed by El Propietario (Jorge Renelmo Vera Villegas), Jefe de Área Campo Sacha (Ing. Patricio López), Coordinador DEREPA-AMA (Ing. Alexander Paredes), Coordinador Proyecto PEPDA (Ing. Jorge Vivanco) **(Exhibit 7)**; Acta Entrega-Recepcion de Piscina Eliminada SSFD-17-1, dated 18 de Septiembre de 2007, signed by El Propietario (Aura del Carmen Torres Suin), Jefe de Área Campo Shushufindi (Ing. Lex Montaño), Coordinador DEREPA-AMA (Ing. Alexander Paredes), Coordinador Proyecto PEPDA (Ing. Jorge Vivanco) **(Exhibit 8)**

[3] Petroproduccion Oficio No. 0923 PPR-OPE-AMB-2008, dated 09 Feb. 2008, from Ing. Leoncio Villacís V., Subgerente de Operaciones, Enc. to Dr. Rolando Del Pozo V., Director Nacional de Protección Ambiental, Enc., Ministerio de Minas y Petróleos concerning the remediation of a October 14, 2006 spill at well Lago Agrio 11-B to industrial land use standards of DE 1215, Annex 2, Table 6. **(Exhibit 9)**

[4] Petroproduccion Oficio No. 7812 PPR-SGI-2008, dated 09 Set. 2008, from Ing. Patricio Viteri D., Subgerente de Gestión Integral to Ingeniero Danny Yánez C., Director Nacional de Protección Ambiental Hidrocarburífera, Enc., Ministerio de Minas y Petróleos concerning the remediation of a October 09, 2007 spill at Mini-station Sacha 36 to industrial land use standards of DE 1215, Annex 2, Table 6. **(Exhibit 10)**

[5] Woodward-Clyde International, Inc. and Smith Environmental Technologies Corp., Remedial Action Plan for the Former Petroecuador-Texpet Consortium, Sept. 8, 1995. **(Exhibit 11)**

[6] Final Release between the Government of Ecuador, Petroecuador, Petroproducción, and Texaco Petroleum Company, Sept. 30, 1998. **(Exhibit 12)**

According to Information Handling Services, Inc. (IHS, a company that provides industry data), Petroecuador maps, and other reports,[7] 3,169 wells have been drilled by oil companies throughout Ecuador, and 2,788 of these were drilled in the Oriente. Of the 2,788 wells drilled in the Oriente, Petroecuador and other operators have drilled 2,452 wells, while Texpet drilled only 336 of the wells. There have been 739 wells drilled by Petroecuador and its contractors inside the concession after 1990.

Oil wells require periodic workovers. Based on 2006 – 2012 information, the average number of workovers performed each year by Petroecuador inside the concession area is 338.[8]

---

[7] IHS Database, www.ihs.com/Products (IRIS21: International E&P Database: Energy Information, Software & Solutions); December, 2012; PETROPRODUCCION Mapa Vial Auca http://www.eppetroecuador.ec/idc/groups/public/documents/archivo/001377.pdf **(Exhibit 13)**; PETROPRODUCCION Mapa Vial Cononaco http://www.eppetroecuador.ec/idc/groups/public/documents/archivo/001380.pdf **(Exhibit 14)**; PETROPRODUCCION Mapa Vial Lago – Guanta - Parahuacu http://www.eppetroecuador.ec/idc/groups/public/documents/archivo/001383.pdf **(Exhibit 15)**; PETROPRODUCCION Mapa Vial Sacha http://www.eppetroecuador.ec/idc/groups/public/documents/archivo/001386.pdf **(Exhibit 16)**; PETROPRODUCCION Mapa Vial Shushufindi http://www.eppetroecuador.ec/idc/groups/public/documents/archivo/001387.pdf **(Exhibit 17)**; PETROPRODUCCION Mapa Vial Yuca Yulebra Culebra http://www.eppetroecuador.ec/idc/groups/public/documents/archivo/001392.pdf **(Exhibit 18)**; Secretaría de Hidrocarburos Ecuador. Bloques Región Oriente. CEPHI – 18 Región Amazónioca. Enero-2012 http://www.eppetroecuador.ec/idc/groups/public/documents/archivo/001375.pdf **(Exhibit 19)**; Comunicación - Operaciones Rio Napo CEM. Operaciones Río Napo inicia Perforación de Pozo Sacha 206 D http://rionapocem.com.ec/comunicacion/132-operaciones-rio-napo-inicia-perforacion-pozo-sacha-206-d.html **(Exhibit 20)**; EP PETROECUADOR. Informe de Gestión 2010-2011. Quito, 7 Abril 2011 **(Exhibit 21)**; Abrus Cía. Ltda. 2011. Estudio de Impacto Ambiental y Plan de Manejo Ambiental para el Desarrollo de la Plataforma Sacha 300, para la perforación de los Pozos e Desarrollo Sacha 300D, 301D, 304H, 305D, 306H 302D, 307H, 303D. **(Exhibit 22)**; HBT AGRA Limited. Environmental Audit and Assessment of the Petroecuador-Texaco Consortium Oil Fields Until June 30, 1990. Volume I: Environmental Audit Report. Prepared For: Petroecuador-Texaco Consortium. October, 1993 **(Exhibit 23)**; Woodward-Clyde International, Inc. Smith Environmental Technologies Corporation. Plan de Acción de Reparación Medioambiental para el Antiguo Consorcio Petroecuador-Texpet. Texaco Petroleum Company (Texpet) 08/09/95 **(Exhibit 11)**; Woodward-Clyde. Remedial Action Project. Oriente Region, Ecuador. Final Report Volume I of II. Prepared for Texaco Petroleum Company. May 2000. **(Exhibit 24)**

[8] 2006 Workover data obtained from Informe Estadístico 1972-2006, Exploración **(Exhibit 25)**; 2007 Workover data obtained from Informe Estadístico de la Industria Hidrocarburifera, 2007, Actividades de Exploración en el Año 2007 **(Exhibit 26)**; 2009 Workover data obtained from Petroecuador Empresa Petróleos del Ecuador, Informe Estadístico Gerencial Diciembre 2009, 15 Enero 2010 **(Exhibit 27)**; 2010 Workover data obtained from EP Petroecuador, Informe Estadistico 2010, Cifras provisionales Enero 2010 [2011] **(Exhibit 28)**; 2011 Workover data obtained from EP Petroecuador, Informe Cifras Petroleras, Periodo Enero - Diciembre 2011, Cifras provisionales febrero de 2012 **(Exhibit 29)**; 2012 Workover data obtained from EP Petroecuador, Informe Cifras Petroleras, Periodo Enero - Diciembre 2012, Cifras provisionales Febrero de 2013. **(Exhibit 30)**

Waste Pits

The Judgment and Ecuador's experts chastise Texpet for the use of unlined pits. However, Petroecuador continues to use unlined pits to store and dispose of oil-well drill cuttings and muds,[9] and similarly (as Texpet did) uses a Toxicity Characteristic Leaching Procedure (TCLP) to test waste materials.[10] Note that the use of unlined pits to store and dispose of oil well drill cuttings and muds is approved by the Government of Ecuador's authorities, as this is consistent with Ecuadorian law, DE 1215 (Table 7a).

Since pits are the main means to dispose of oil well drill cuttings in the Oriente region, the significantly larger number of wells drilled by Petroecuador relative to the consortium implies that the number of associated pits dug by Petroecuador in this region is also larger. The operation of these pits by Petroecuador is similar to the operation of pits by the consortium in that the pits are typically unlined; they store the same types of drilling wastes, and the same type of criteria (TCLP) was used to determine whether the pits were properly closed (i.e., meeting TCLP criteria to assess the potential for leaching from the pit).

Petroecuador has dug and buried at least 1,000 earthen pits[11] to dispose of drilling wastes; it has constructed many of its waste pits at sites formerly remediated by Texpet. For example, the

---

9 See for example, documents related to Petroecuador's disposal of drilling wastes in pits located at the Sacha-60 well platform: Acta de Toma de Muestros de Ripios y Cortes de Perforacion de las Celdas del Pozo Sacha 140D Correspondiente a los 180 Dias de su Disposicion Final, Locacion: Plataforma Pozo Sacha 60, Fecha: 13 de Abril de 2008, signed by Representatives of SINOPEC, DINAPA, Protección Ambiental Petroproducción, LABPAM Petroproducción, Brandt **(Exhibit 31)**; Acta de Toma de Muestros de Ripios y Cortes de Perforacion de las Celdas del Pozo Sacha 147D/147D ST-1 Correspondiente a los 7 Días de su Disposicion Final, Locacion: Plataforma Pozo Sacha 60, Fecha: 30 de Enero del 2008, signed by Representatives of SINOPEC, DINAPA, Protección Ambiental Petroproducción, LABPAM Petroproducción, Brandt **(Exhibit 32)**; Acta de Toma de Muestros de Ripios y Cortes de Perforacion de las Celdas del Pozo Sacha 147D/147D ST-1 Correspondiente a los 90 Días de su Disposicion Final, Locacion: Plataforma Pozo Sacha 60, Fecha: 13 de Abril del 2008, signed by Representatives of SINOPEC, DINAPA, Protección Ambiental Petroproducción, LABPAM Petroproducción, Brandt **(Exhibit 33)**; Acta de Toma de Muestros de Ripios y Cortes de Perforacion de las Celdas del Pozo Sacha 147D/147D ST-1 Correspondiente a los 180 Días de su Disposicion Final, Locacion: Plataforma Pozo Sacha 60, Fecha: 15 de julio del 2008, signed by Representatives of SINOPEC, DINAPA, Protección Ambiental Petroproducción, LABPAM Petroproducción, Brandt **(Exhibit 34)**; photographs from Sacha-60. **(Exhibit 35)**

10 See for example: Petroproduccion Laboratorio Ambiental, IE/LABPAM/05 345, Fecha/hora de Muestreo: 7 de Noviembre del 2005, Fecha de emission: 15 de Noviembre del 2005 showing "Tipo de muestra" as "lixiviado" for samples collected at Sacha 14, Sacha 50 and Sacha 77 **(Exhibit 36)**; Petroproduccion Laboratorio Ambiental (LABPAM), IE/LABPAM/08 185, Fecha/hora de Muestreo: 23/02/2008, Fecha de emission: 13/03/2007 [2008] showing "Limites maximos permisibles aplicados" from DE 1215 Table 7a (sin impermeabilización de la base) for samples collected from mud and cuttings of Cononaco 30 D disposed of at Cononaco 11. **(Exhibit 37)**

11 Petroecuador's unlined pits were observed at the Auca 19 Judicial Inspection in 2009. Since that time, DINAPA documents, maps, aerial images, and photos have confirmed the widespread use of new disposal pits within the concession area.

Sacha 60 well site has two consortium pits which were remediated in the mid- 1990s[12]. Petroecuador subsequently has built 99 additional pits at the same location for the disposal of drilling mud and other oil well waste.[13] Similarly, Petroecuador has dug more than one hundred new pits at SSF-40, a site for which no remediation was required under the RAP.[14] As noted, these waste pits are allowed under current Ecuadorian DE 1215 and must meet the TCLP requirements in Table 7.

Spills

Petroecuador has also had numerous spills. The Ministry of the Environment of Ecuador reports in its Sistema de Información de Pasivos Ambientales (SIPAS) database that 524 spills totaling about 125,000 barrels (bbl) were associated with Petroecuador well operations inside the concession area between 1990 and 2009.[15] The SIPAS database seems to underreport the number of spills, as suggested by several hundred spills reported by the Ecuadorian newspaper "El Universo" that are not documented in SIPAS (1415 spills reported for 2000-2008)[16].

The SIPAS database records about 90 spills in the region from 1972 to 1990.[17] Even if all of these were associated with the consortium operations, this number is significantly smaller than the more than 500 recorded spills associated with (the larger scale) Petroecuador operations. Overall, these data indicate that Petroecuador is responsible for the greatest cumulative amount of oil spilled in the region.

Despite the additional wells, waste pits, and spills by Petroecuador, I found no evidence that the Ecuadorian Government has ever required Petroecuador to meet a 100 ppm TPH remediation standard. Because Petroecuador generated a larger amount of similar wastes and managed them also using unlined pits, with approval from the Government of Ecuador, the differential standards to which Chevron is being held by the Judgment seem inconsistent if not biased. Clearly, Chevron and Petroecuador are not being measured with the same yardstick.

> *1C) The Government of Ecuador's expert opinion that "The Judgment's assessment of damages appears at least reasonable" is superficial because it indirectly endorses the exaggerated assessment of remediation costs by the court without considering the basis for that estimation.*

---

12 Acta Entrega-Recepcion de Piscina Eliminada SA-60, dated 7/24/1996 **(Exhibit 38)**; Acta-Entrega-Recepcion de Piscina Eliminada SA-60, dated 11/22/1996 **(Exhibit 39)**; Acta Entrega-Recepcion de Piscina Eliminada SA-60, dated 3/20/1997. **(Exhibit 40)**

13 *See* Footnote 9.

14 *See* footnote 10

15 http://www.sipas-pras.gob.ec/sipasweb/# **(Exhibit 44)**; spreadsheet "Derrames.xlsx" downloaded on November 11, 2012. Refer to tab "DERRAMES>5bbl OS" to select the spill sites located inside the concession area that occurred after 1990. **(Exhibit 41)**

16 "Petroecuador Diagnostica Los Danos Ambientales Por Crudo," El Universo, Feb. 28, 2009. **(Exhibit 42)**

17 http://www.sipas-pras.gob.ec/sipasweb/# **(Exhibit 44)**

The Government of Ecuador's expert report authored by The Louis Berger Group, Inc. (LBG) and JWS Consulting, entitled "Expert opinion of Kenneth J. Goldstein, MA, CGWP, and Jeffrey W. Short, PhD, Regarding the Environmental Contamination from Texpet's E&P, Activities in the Former NAPO Concession Area, Oriente Region, Ecuador," states in Opinion #7 that *"The Judgment's assessment of damages appears at least reasonable."* To formulate a professional opinion about the reasonableness of the Judgment, one must consider the magnitude and reasonableness of the assessed remediation cost in relation to current practice, actual costs, and consistency with applicable cleanup standards. LBG ignored all of these critical factors, did not consider the amount of soil requiring remediation, and offered this vague and superficial opinion without providing any specific supporting evidence. As explained above, the Judgment is in fact unreasonable because (1) it is based on a cleanup standard that is not contemplated by Ecuadorian law or used in the Oriente region or in common international practice, and (2) it is inconsistent with current practice by Petroecuador, which is being held by the Government of Ecuador to a cleanup standard that is 25-fold less stringent, as stipulated by DE 1215 (Table 6).

Opinion 2. Sampling by Chevron's experts during Judicial Inspections is valid and was not biased to avoid contamination

The Government of Ecuador's experts have repeatedly made the allegation that the sampling program that Chevron's experts conducted deliberately hid or minimized the existing contamination and associated risks. I considered this issue before, as summarized in a previous 2006 report, entitled "Evaluation of Chevron's Sampling and Analysis Methods" by P.J.J. Alvarez, D. McKay and R. Hinchee. In that report, we concluded that these allegations are *"not supported by any published information we have reviewed to date; or by any actions or circumstances that we have witnessed first-hand during sampling efforts for the Judicial Inspections of the Shushufindi SW production station (October 2004) and the Sacha Norte 1 production station (April 2006), or during our own site inspections in May 2006 of Shushufindi-004, Shushufindi-013, Sacha-06, Sacha-51, Sacha-53, and Sacha-Central."*[18]

Furthermore, to my knowledge, the Government of Ecuador's experts making these allegations did not attend any Judicial Inspections, did not observe the decision-making process used during the Judicial Inspections to establish the sampling locations under mutual oversight, and did not observe the sampling methods used by the court-appointed experts. Given that no new insight was presented by the LGB report to reconsider my opinion, I maintain that the Government of Ecuador's experts' criticisms of the Chevron team's site investigation during judicial inspections are incorrect and unfounded.

---

[18] P.J.J. Alvarez, D. McKay, and R. Hinchee. "Evaluation of Chevron's Sampling and Analysis Methods." August 9, 2006, at pg. 2. **(Exhibit 43)**

I personally observed a deliberate lack of transparency by Mr. Cabrera (the Plaintiffs' expert who led their Phase II judicial inspection) during the Judicial Inspection of Shushufindi 35 on September 24, 2007. Specifically, he (a) discarded samples that he took that showed no visual signs of hydrocarbon-related discoloration (i.e., clean samples), and (b) refused to delineate the region of influence of hydrocarbon migration and determine whether receptors were being impacted (e.g., the drinking water wells of nearby "colonos"), suggesting that his was a biased inspection. This is contrary to the Chevron's experts approach, as they sampled the neighboring drinking water wells.

Conclusions

- The 100 ppm TPH remediation standard to which Chevron is being held in the court Judgment is inconsistent with legal standards stipulated by DE 1215 (and to which Petroecuador is currently held by the Ecuadorian Government, consistent with Ecuadorian Law); those standards applied to Petroecuador are between 10 and 40-fold less stringent than the remediation standard applied to Chevron by the Ecuadorian Judgment.
- The Judgment holds Chevron liable for operations and waste management practices that are virtually identical to the current practices of Petroecuador, which are approved by the Ecuadorian Government as consistent with Ecuadorian law.
- Petroecuador has doubled the number of oil wells in the former concession area, spilled about 125,000 bbl of crude oil, and has dug at least 1,000 new earthen pits for drilling waste disposal. The Ecuadorian judgment ignored all of Petroecuador's operational impacts and the regulatory requirements applied to those operations.
- The sampling program and methods used by Chevron's experts during Judicial Inspections were appropriate.
- Lago Agrio Plaintiffs' (LBG and JWS) expert opinion that "The Judgment's assessment of damages appears at least reasonable," is superficial and incorrect because it ignores the court's exaggerated and unreasonable assessment of remediation costs and does not consider current practice and inconsistencies with applicable cleanup standards and waste management practices as currently regulated and enforced by the Government of Ecuador.

Certification

This report accurately reflects my honest and genuine opinions on this matter.

Pedro J.J. Alvarez, Ph.D.

May 31, 2013
Date

Appendix A
Curriculum Vitae

PEDRO J. J. ALVAREZ, Ph.D., P.E., DEE

Dept. of Civil & Environmental Eng. ♦ Rice University ♦ Houston, TX 77251-1892
Tel: (713) 348-5903 ♦ FAX: (713) 348-5268 ♦ e-mail: alvarez@rice.edu

GENERAL

Prof. Alvarez's research focuses on environmental sustainability through bioremediation of contaminated aquifers, fate and transport of toxic chemicals, water footprint of biofuels, microbial-plant interactions, water treatment and reuse, and environmental implications and applications of nanotechnology.

EDUCATION

B.Eng.	1982	Civil Engineering	McGill University, Montréal
Certif.	1988	Haz. Waste Mgmt.	U. of California, Riverside
M.S.E	1989	Environmental Engrg.	University of Michigan, Ann Arbor
Ph.D.	1992	Environmental Engrg.	University of Michigan, Ann Arbor

POSITIONS

2005-present	CEE Dept. Chair	Rice University, Houston, TX
2004-present	G.R. Brown Professor	Rice University, Houston, TX
2001-2003	Professor	The University of Iowa, Iowa City
1999	Visiting Professor	EAWAG, Switzerland
1998-2003	Associate Director	Center for Biocatalysis & Bioprocessing
1997-2001	Associate Professor	The University of Iowa, Iowa City
1993-1997	Assistant Professor	The University of Iowa, Iowa City
1985-1988	Environ. Engineer	Tetratech Inc., San Bernardino, CA

EDITORIAL

2007-Present	Associate Editor, *Environmental Science and Technology*
2005-2006	Associate Editor, *ASCE J. Environ. Engrg*.
2003-2006	Field Editor, *European Journal of Soil Biology*
2002-2006	Editorial Board, *Biodegradation*
1998-2002	Editorial Board, *Journal of Environmental Science and Health*
1996-2002	Editorial Advisory Board, *Advances in Environmental Research*

SELECTED ACTIVITIES

- Registered Professional Engineer, MI License # 6201035419, IA License # 12575, TX License # 110611; Registered Groundwater Professional, Iowa # 1681
- Conference Chair, Leading Edge Technologies for Water and Wastewater Treatment, International Water Association (IWA), 7/11 (Amsterdam) and 7/10 (Phoenix).
- National Academy of Sciences: NRC CLEANER committee 12/05; Delegate to US-Iran Engagement in Science, Engineering and Health 9/09; Chemical Sciences Roundtable on Challenges in Characterizing Small Particles 10/10; Pueblo Chemical Agent Pilot Plant Committee 05/12.
- Delegate to COP15 (Global Climate Forum in Copenhagen), 12/09
- Member, Academic Relations Committee, Water Environment Federation (WEF)
- Member, Publications Committee, American Academy of Environ. Engineers (AAEE)
- Member, Hazard Assessment and Control of Toxic Substances in Water Committee, also Nanomaterials in the Environment Committee; IWA, 7/00-present.
- Panel member, NCEES Environ. Engrg. minimum competency requirements, 11/04.
- Expert Committee, Mexican Petroleum Institute, Biotechnology Program, 2/00-2/04.
- AWWARF Project Advisory Committee, 1998, 2010
- Advisor, State of Iowa Brownfields Committee,1997; UST Committee, 1993, 1995.
- Consultant, Government of the Commonwealth of Dominica, Roseau, 1991
- Consultant, The City of Ann Arbor, MI, 1991
  (Designed and implemented a landfill groundwater monitoring plan)

SELECTED HONORS AND AWARDS

2012	The Athalie Richardson Irvine Clarke Prize
2012	South Texas Section AIChE's Best Fundamental Paper Award
2011	Science Advisory Board to the US Environmental Protection Agency (EPA)
2011	Dean of Engineering's Lecture, Columbia University
2010	Most cited paper in the past 5 year, Water Research (Wat. Res. 40(19):3527-3532
2010	Top-10 most read paper, ACS nano (*ACS Nano*, **2010**, *4* (7), pp 3580–3590).
2010	Honorary Professor, Kunming University of Science and Technology, Kunming, China
2009	Professor of the Year, ASCE & Chi Epsilon Student Chapters, Rice University
2008	Frontier in Research Award, Assoc. of Environmental Engineering and Science Professors
2008	Founding Member, Nicaraguan National Academy of Sciences
2008	John Henske Distinguished Lecture, Yale University
2007	McKee Medal for Groundwater Protection, Restoration or Sustainable Use (WEF)
2006	Board of Directors, Strake Jesuit College Preparatory
2006	Honorary Professor, Nankai University, Tianjin, China
2005-2006	President, Association of Environmental Engineering and Science Professors
2003-2006	Board of Directors, Nicaragua's Water Management Agency (ENACAL)
2003	Consul of Nicaragua for Iowa (*ad honorem)*
2002	Research project of the year award, SERDP cleanup division, Department of Defense.
2002	Editorial Board Member of Bioremediation and Bioavailability, The Scientific World
2000	Awarded the Button of the City of Valencia, Venezuela, by the Mayor of the City
1998	The UI Collegiate Excellence in Teaching Award, University of Iowa
1997	Participant, National Academy of Engineering's Symposium: Frontiers of Engrg.
1997	Appointed Adjunct Professor, Universidad Autónoma de México, Mexico, D.F.
1996	Awarded the Alejo Zuloaga Medal by the Universidad de Carabobo, Venezuela
1995	Inducted into the American Academy of Environmental Engineers, Diplomate Status
1995	Career Award, National Science Foundation.
1995	Appointed Adjunct Professor, Universidade Federal de Santa Catarina, Brazil
1994, 2002	Elected to the University of Iowa Faculty Senate
1992	Outstanding Presentation Award, AIChE Summer Meeting, Minneapolis, MN
1992	The Rackham Predoctoral Fellowship, The University of Michigan, Ann Arbor, MI
1991	The Outstanding Achievement Award in Environmental Engineering, U. of Michigan

Fellow of American Academy for the Advancement of Science (AAAS, 2012); American Society of Civil Engineers (ASCE, 2005), American Leadership Forum (ALF, 2008), Leopold Leadership Foundation (LLF, 2008), Water Environment Federation (Founding Fellow, WEF, 2011), and International Water Association (IWA, 2011)

Best student papers: Battelle 8th International Conf. on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, 2012 (Jie Ma); San Diego, 2000 (Todd Dejournett); Battelle 6th Bioremediation Symposium, San Diego, 2000 (Todd Dejournett); WEF 70th Annual Meeting, Chicago (Eric Aitchison), 1997; EPA HSRC for Regions 7&8, Kansas City, 1993 (Brad Helland)

Other student awards: ACS Environmental Chemistry Graduate Student Award, 2011 (Li Dong); best poster at IWA Leading Edge Technologies, Zurich, 2008 (Katherine Zodrow); best dissertation from Brown School of Engineering, 2007 (Del Lyon); best poster at EPA International Applied Phytotechnologies Conference, Chicago, 2003 (Roopa Kamath)

AFFILIATIONS

AAAS, AAEE, ACS, AEESP, ASCE, ASM, IWA, Leopold LF, SHPE, WEF, Chi Epsilon, and Tau Beta Pi.

COURSES TAUGHT

Environmental Biotechnology
Foundations of Bioremediation
Environmental Microbiology and Microbial Ecology
International Perspectives in Water Resources Planning
Integrated Approaches to Sustainable Development
Environmental Molecular Biology
Intl Perspectives in Climate Change: COP15
Principles of Environmental Engineering
Engineering I
Experiments in Environmental Eng.

SELECTED PUBLICATIONS

A. Textbooks and Other Books

1. Alvarez P.J.J. and W. Illman (2006). Bioremediation and Natural Attenuation of Groundwater Contaminants: Process Fundamentals and Mathematical Models. John Wiley & Sons. ISBN No. 0-471-65043-9. 608 pages.
2. Alvarez P.J.J and E. Guevara (2003). Biorremediación y Atenuación Natural de Acuíferos Contaminados por Sustancias Químicas Peligrosas. Consejo del Desarrollo Científico y Humanístico, Universidad de Carabobo, Valencia, Venezuela. ISBN No.980-233-360-3.
3. Kalogerakis N., E. Psillakis and P.J.J. Alvarez (editors) (2005). Recent Advances in Bioremediation: a special issue. *Environment International*. 31 (2) 147-312.
4. Leeson, A., B.C. Alleman, P.J. Alvarez, and V.S. Magar (editors) (2001). Bioaugmentation, Biobarriers, and Biogeochemistry. Proceedings of the Sixth International In Situ and On-Site Bioremediation Symposium, Vol 6(9). Battelle Press, Columbus, OH, 2001.
5. Loucks D.P., P.J. Alvarez, M.J. Baedecker, J.W. Boyd, R.A. Conway, J.W. Day, C.T Driscoll, T.R. Fountain, E.H.. Herricks, R.J.. Huggett, T.K. Kratz, J.M. Lauria, J.L. Meyer, T.O. Najarian, C.R. O'melia, S.D. Parker, and D.K. Weir (2006). CLEANER and NSF's Environmental Observatories. National Research Council of the Academies. National Academy Press. ISBN No.0-309-10229-4.

B. Journal Publications (ISI Web of Science h index = 41)

1. Domınguez-Faus R., C. Folberth, J. Liu, A.M. Jaffe, and P. J.J. Alvarez (2013). Climate change would increase the water footprint of corn ethanol in the USA. Environ. Sci. Technol. (Submitted).
2. Wang J., Y. Koo, A. Alexander, Y. Yang, S. Westerhof, Q. Zhang, J.L. Schnoor, V.. Colvin, J. Braam, and P.J.J. Alvarez (2013). Phyto-Stimulation of Poplars and Arabidopsis Exposed to Silver Nanoparticles and Ag^{+} at Sub-Lethal Concentrations. Environ. Sci. Technol. (Submitted).
3. Ma J., C,W, Nossa, Z-M Xiu, W.R. Rixey W. and P.J.J. Alvarez (2013). Adaptive responses of the microbial community structure of an aquifer to a continuous ethanol blend release increases potential for natural attenuation. Environmental Pollution. (Submitted).
4. Yang Y., J. Wang, H. Zhu, Vicki L. Colvin and P.J.J. Alvarez (2013). Impacts of silver nanoparticles on cellular and transcriptional activity of nitrogen cycling bacteria. Environ. Toxicol. Chem. (Submitted)**.**
5. Ma J., C.W. Nossa, Z. Xiu, W.G. Rixey and P.J.J. Alvarez (2013). Adaptive changes in microbial community structure in response to a continuous pilot-scale release of an ethanol blend. Environmental Pollution. (Submitted).
6. Liao Y., J. Brame, W. Que**Error! Bookmark not defined.**, Z. Xiu, H. Xie, Q. Li, M. Fabian, and P.J.J Alvarez (2013). Low Temperature Crystallization of Anodic TiO_2 Nanotube Array in Water: Synthesis, Performance and Mechanistic Insight. Energy & Environmental Science (Submitted).
7. Zhao Z., Y-L Fang, P.J.J. Alvarez, and M. S. Wong (2013). Perchloroethene hydrodechlorination using Pd-on-Au nanoparticle catalysts. ACS Catalysis Today (Submitted).
8. Rysz M., W. Mansfield and P.J.J. Alvarez (2013). Tetracycline Resistance Gene Maintenance under varying Bacterial Growth Rate, Substrate And Oxygen Availability, and Tetracycline Concentration. Environ. Sci. Technol. (In press).
9. Qu X., P.J.J. Alvarez and Q. Li (2013). Applications of Nanotechnology in Water and Wastewater Treatment. Water Research. (In press).

10. Ma J., W.G. Rixey, and P.J.J. Alvarez (2013). Microbial Processes Influencing the Transport, Fate and Groundwater Impacts of Fuel Ethanol Releases. Curr. Opin. Biotechnol. (In Press).
11. Toledo-Ramos D., M.L.B. da Silva, H.S. Chiaranda, P.J.J. Alvarez, and H.X. Corseuil (2013). Biostimulation of Anaerobic BTEX Biodegradation under Fermentative Methanogenic Conditions in Groundwater Contaminated with a Biodiesel Blend (B20). Biodegradation (In press).
12. Brame J., S.W. Hong, J. Lee and P.J.J. Alvarez (2013). Photocatalytic pre-treatment with food-grade TiO_2 increases the bioavailability and bioremediation potential of weathered oil from the Deepwater Horizon oil spill in the Gulf of Mexico. Chemosphere 90: 2315–2319.
13. Da Silva M.B., D. Gomez and P.J.J. Alvarez (2013). Analytical model for BTEX natural attenuation in the presence of fuel ethanol and its anaerobic metabolite acetate. J. Contam. Hydrol. 146: 1–7.
14. Qu X., P.J.J. Alvarez and Q. Li (2012). Impact of Sunlight and Humic Acid on the Deposition Kinetics of Aqueous Fullerene Nanoparticles (nC_{60}). Environ. Sci. Technol. 46 (24):13455–13462.
15. Kim H., Kim W., Mackeyev Y., Lee G-S., Kim H-J., Tachikawa T., Hong S. Lee S., Kim J., Wilson L., Majima T., Alvarez P.J.J., Choi W., and Lee J. (2012). Selective Oxidative Degradation of Organic Pollutants by Singlet Oxygen-Mediated Photosensitization: Tin Porphyrin versus C60 Aminofullerene Systems. Environ. Sci. Technol. 46, 9606−9613.
16. Xiu Z., Q. Zhang, H.L. Puppala, V.L. Colvin, and P.J.J. Alvarez (2012). Negligible Particle-Specific Antibacterial Activity of Silver Nanoparticles. Nanoletters. 12, 4271−4275.
17. Yang Y., J.M. Mathieu, S. Chattopadhyay, J.T. Miller, T.Wu, T. Shibata, W. Guo and P.J.J. Alvarez (2012). Microbial Defense Mechanisms against Quantum Dots and Their Released Heavy Metals. ACS Nano. doi:10.1021/nn3011619.
18. Qu X., J. Brame, Q. Li and P.J.J. Alvarez (2012). Nanotechnology for Safer Water Supply: Enabling Integrated Water Treatment and Reuse. Acc. Chem. Res. doi:10.1021/ar300029v
19. Ma J., W.G. Rixey, G.E. DeVaull, B.P. Stafford, and P.J.J. Alvarez (2012). Bioattenuation of Methane along the Groundwater to Soil Surface Pathway in a Pilot-Scale Aquifer Impacted by Fuel Ethanol and Implications for Explosion Risk Reduction. Environ. Sci. Technol. *46* (11), 6013–6019.
20. Mathieu J., F. Wang, L. Segatori and P.J.J. Alvarez (2012), Attenuation of oxysterol-induced cytotoxicity using a lysosomal-associated membrane protein 1 (LAMP1)-cholesterol oxidase fusion that targets the lysosome. Biotechnol. Bioeng. 109(9): 2409-2415.
21. Yang Y., J. Wang, H. Zhu, Vicki L. Colvin and P.J.J. Alvarez (2012). Relative Susceptibility and Transcriptional Response of Nitrogen Cycling Bacteria to Quantum Dots. Environ. Sci. Technol. 46(6): 3433−3441.
22. Lee J., S. Hong, Y. Mackeyev, C. Lee, L.J. Wilson, J-H Kim and P.J.J. Alvarez (2011). Photosensitized Oxidation of Emerging Organic Pollutants by Tetrakis C_{60} Aminofullerene-Derivatized Silica under Visible Light Irradiation. Environ. Sci. Technol. *45* (24): 10598–10604.
23. Xiu Z., J. Ma and PJJ. Alvarez (2011). Differential Effect of Common Ligands and Molecular Oxygen on Antimicrobial Activity of Silver Nanoparticles versus Silver Ions. Environ. Sci. Technol. 45 (20): 9003–9008.
24. Li D and P.J.J. Alvarez (2011). Avoidance, weight loss and cocoon production assessment for *Eisenia fetida* exposed to C_{60} in soil. Environ. Toxicol. Chem. 30(11):2542-2545.
25. Li M., S. Fiorenza, P. Conlon, S. Mahendra, and P.J.J. Alvarez (2011). Rapid analysis of 1, 4-dioxane in water by frozen micro-extraction with gas chromatography/mass spectrometry. Ground Water Monitoring and Remediation. 31(4):70-76.
26. Ma J., Z. Xiu, A.L. Monier, I. Mamonkina, Y. Zhang, B.P. Stafford, W.G. Rixey, and P.J.J.

Alvarez (2011). Aesthetic groundwater quality impacts of a continuous pilot-scale release of an ethanol blend. Ground Water Monitoring and Remediation. 31(3):47-54.

27. Corseuil HX, A.L. Monier , A.P.N. Gomes , M. do Rosario and P.J.J. Alvarez (2011). Biodegradation of soybean and castor oil biodiesel: Implications on the natural attenuation of monoaromatic hydrocarbons in groundwater. Ground Water Monitoring and Remediation. 31(3):111-118.
28. Raciny I., K.R. Zodrow, D. Li, Q. Li, and P. J. J. Alvarez (2011). Addition of a magnetite layer onto a polysulfone water treatment membrane to enhance virus removal. Wat. Sci. Technol. 63.10: 2346-2352.
29. Brame J., Q. Li and P.J.J. Alvarez (2011). Nanotechnology-enabled water treatment and reuse: emerging opportunities and challenges for developing countries. Trends in Food Science and Technology 22:618-624.
30. Li D., W.C. Hockaday, C.A. Masiello, and P.J.J. Alvarez (2011). Earthworm avoidance of biochar can be mitigated by wetting. Soil Biol. Biochem. 43(8): 1732-1737.
31. Yang Y., H. Zhu, V.L. Colvin and P.J.J. Alvarez (2011). Cellular and transcriptional response of *Pseudomonas stutzeri* to quantum dots under aerobic and denitrifying conditions. Environ. Sci. Technol. 45: 4988–4994.
32. Corseuil HX, A.L. Monier, M. Fernandes, M.R. Schneider, C. Nunes, M. do Rosario and P.J.J. Alvarez (2011). BTEX Plume Dynamics Following an Ethanol Blend Release: Geochemical Footprint and Thermodynamic Constraints on Natural Attenuation. Environ. Sci. Technol. 45(8), 3422–3429.
33. Aiken G.,H. Hsu-Kim, J. Ryan, and P.J.J Alvarez (2011). Guest Comment: Nanoscale Metal-Organic Matter Interactions. Environ. Sci. Technol. 45(8), 3194–3195.
34. Yi L., L. Xu, M. Rysz, Y. Wang, H. Zhang, and P.J.J. Alvarez (2011). Occurrence and transport of tetracycline, sulfonamide, quinolone and macrolide antibiotics in the Haihe River basin, China. Environ. Sci. Technol. 45 (5): 1827–1833.
35. Chen J., Z. Xiu, G. V. Lowry and P.J. J. Alvarez (2010). Effect of natural organic matter on toxicity and reactivity of nano-scale zero-valent iron. Wat. Res. 45: 1995-2001.
36. Fang Y-L, J.T. Miller, N. Guo, K.N. Heck, P.J.J. Alvarez, and M.S. Wong (2011). Kinetics analysis of palladium/gold nanoparticles as colloidal hydrodechlorination catalysts. ACS Catalysis Today 1:128-138.
37. Lee J., Y. Mackeyev, M. Cho, L.J. Wilson, J-H. Kim and P.J.J. Alvarez (2010). C_{60} aminofullerene immobilized on silica as a visible-light-activated photocatalyst. Environ. Sci. Technol. 44: 9488–9495.
38. Li D., J.D. Fortner, D.R. Johnson, C. Chen, Q. Li and P.J.J. Alvarez (2010). Bioaccumulation of $^{14}C_{60}$ by the earthworm *Eisenia foetida.* Environ. Sci. Technol. 44: 9170-9175.
39. Ji L., W. Chen, S. Zheng, Z. Xu, P.J.J. Alvarez and D. Zhu (2010). Adsorption of tetracycline on single-walled and multi-walled carbon nanotubes as affected via aqueous solution chemistry. Environ. Toxicol. Chem. 29(12): 2713-2719.
40. Fang Y-L, J.T. Miller, N. Guo, K.N. Heck, P.J.J. Alvarez, and M.S. Wong (2010). Structural analysis of palladium-decorated gold nanoparticles as colloidal bimetallic catalysts. Catalysis Today 160(1) 96-102.
41. Qu X., Y-S Hwang, P.J.J. Alvarez, D. Bouchard and Q. Li (2010). UV Irradiation and humic acid mediate aggregation of aqueous fullerene (nC_{60}) nanoparticles. Environ. Sci. Technol. 44: 7821–7826.
42. Xiu Z., K.B. Gregory, G.V. Lowry, and P.J.J. Alvarez (2010). Effect of bare and coated nano-scale zero-valent iron on *tceA* and *vcrA* gene expression in *Dehalococcoides* spp. Environ. Sci. Technol. 44: 7647–7651.
43. Cho M., J, Lee, Y. Mackeyev, L.J. Wilson, P.J.J. Alvarez, J.B. Hughes and J-H. Kim (2010).

Visible light sensitized inactivation of MS-2 bacteriophage by novel amine-functionalized C_{60} derivative. Environ. Sci. Technol. 43: 7410-7415.

44. Yi L., M. Daqing, M. Rysz, Z. Hongjie, X. Lin, and P.J.J. Alvarez (2010). Trends in antibiotic resistance genes occurrence in the Haihe River, China. Environ. Sci. Technol. 44: 7220–7225.

45. Lee J., S. Mahendra, and P.J.J. Alvarez (2010). Nanomaterials in the construction industry: a review of their applications and environmental health and safety considerations. ACS Nano. 4(7): 3580-3590.

46. Kazy S., A. Monier, and P.J.J. Alvarez (2010). Assessing the correlation between anaerobic toluene degradation activity and *bssA* concentrations in hydrocarbon-contaminated aquifer material. Biodegradation. DOI10.1007/s10532-010-9344-1.

47. Lee J., W. Song, S.S. Jang, J.D. Fortner, P.J.J. Alvarez, W.J. Cooper and J-H Kim (2010). Stability of water-stable C_{60} cluster (nC_{60}) to OH radical oxidation and hydrated electron reduction. Environ. Sci. Technol. 44(10): 3786-3792.

48. Li Z., K. Greden, P.J.J. Alvarez, K. Gregory, and G.V. Lowry (2010). Adsorbed organic macromolecules limits adhesion and toxicity of nano scale zero valent iron (NZVI) to *E. coli*. Environ. Sci. Technol. 44 (9):3462–3467.

49. Li M., S. Fiorenza, J. Chatham, S. Mahendra, and P.J.J. Alvarez (2010). 1,4-Dioxane biodegradation at low temperatures in Arctic groundwater samples. Water Research 44:2894-2900.

50. Da Silva MLB and P.J.J. Alvarez (2010). Indole-based assay to assess the effect of ethanol on *Pseudomonas putida F1* dioxygenase activity. Biodegradation. 21:425-430.

51. Gomez D. and P.J.J. Alvarez (2010). Comparison of the effects of various fuel alcohols on the natural attenuation of benzene plumes: a simulation analysis using RT3D with the general substrate interaction module. J. Contam. Hydrol. 113:66-76.

52. Powers S.E., Dominguez R., and P.J.J. Alvarez (2010). The water footprint of biofuel production in the USA. Biofuels. 1(2):255-260, 2010.

53. Schloendorn, T. Webb, K. Kemmish, M. Hamalainen, D. Jackemeyer, L. Jiang, J. Mathieu, J. Rebo, J, Sankman, L. Sherman, L. Tontson, A. Qureshi, P.J.J. Alvarez, and B. Rittmann (2010). Medical Bioremediation – a concept moving towards reality. Ageing Research. (12(6)411-419.

54. Lee C-W, S. Mahendra, K. Zodrow, D. Li, Y-C Tsai, J. Braam and P. J.J. Alvarez (2010). Developmental phytotoxicity of metal oxide nanoparticles to *Arabidopsis thaliana.* Environ. Toxicol. Chem. 29:669-675.

55. Mathieu J., W.W. Mohn, L.D. Eltis, J. LeBlanc, G. Stewart, C. Dresen, K. Okamoto and P.J.J. Alvarez (2010). 7-Ketocholesterol catabolism by *Rhodococcus jostii* RHA1. Appl. Environ. Microbiol. 76(1):352-355.

56. Xiu Z., Z-H Jin, T-L Li, S. Mahendra, G.V. Lowry, and P.J.J Alvarez (2010). Effect of nano-scale zero-valent iron particles on a mixed culture dechlorinating trichloroethylene. Bioresource Technology 101: 1141–1146.

57. Xiu Z., Z-H Jin, T-L Li and P.J.J Alvarez (2009). Microbial reductive dechlorination of TCE with nano iron serving as electron donor, Environmental Science (in Chinese), 2009, 30(6): 229-234.

58. Lee J., Y. Mackeyev, M. Cho, D. Li, J-H. Kim, L.J. Wilson, and P.J.J. Alvarez (2009). Photochemical and Antimicrobial Properties of Novel C_{60} Derivatives in Aqueous Systems. Environ. Sci. Technol. 43(17):6604-6610.

59. Heck K.N., M.O. Nutt, P.J.J. Alvarez, and M. S. Wong (2009). Deactivation resistance of Pd/Au nanoparticle catalysts for water-phase hydrodechlorination. J. Catal. 267, 97-104.

60. Alvarez P.J.J., V. Colvin, J. Lead and V. Stone (2009). Research priorities to advance eco-

responsible nanotechnology. ACS Nano 3(7): 1616-1619.

61. Stafford B., N. Capiro, P.J.J. Alvarez and W. Rixey (2009). Pore water characteristics following the release of neat ethanol onto pre-existing NAPL. Groundwater Monitoring and Remediation. 29(3): 93-104.
62. Goyal A. , A. Kumar, P. K. Patra, S. Mahendra, P. J. J. Alvarez, G. John, and P.M. Ajayan (2009). In-situ synthesis of silver nanoparticles-PDMS composite films. Macromol. Rapid Commun. 30: 1116–1122.
63. Durnin G. J. Clomburg, Z. Yeates, P.J.J. Alvarez, K. Zygourakis, P. Campbell, and R. Gonzalez (2009). Understanding and harnessing the microaerobic metabolism of glycerol in *Escherichia coli.* Biotechnol. Bioeng.103(1) 148-161.
64. Parisi V.A., G.R. Brubaker, M.J. Zenker, R.C. Prince, L.M. Gieg, M.L.B. da Silva, P.J.J. Alvarez, and J.M. Suflita (2009). Field metabolomics and laboratory assessments of anaerobic intrinsic bioremediation of hydrocarbons at a petroleum-contaminated site. Microbial Biotechnology. 2(2), 202–212.
65. Dominguez R., S.E. Powers, J.G. Burken and P.J.J. Alvarez (2009). The water footprint of biofuels: a drink or drive issue? Environ. Sci. Technol. 43 (9), 3005-3010.
66. Mathieu J.M., J. Schloendorn, B.E.Rittmann and P.J.J. Alvarez (2009). Medical bioremediation of age-related diseases. Microbial Cell Factories. 8:21 (9 April 2009).
67. Gomez D. and P.J.J. Alvarez (2009). Modeling the Natural attenuation of benzene in groundwater impacted by ethanol-blended fuels: effect of ethanol content on the lifespan and maximum length of benzene plumes. Wat. Resour. Res., 45, W03409, doi:10.1029/2008WR007159.
68. Brunet L., Lyon D.Y., Hotze E.M., Alvarez P.J.J., and Wiesner M.R. (2009). Comparative photoactivity of fullerenes and titanium dioxide: mechanisms, implications on antimicrobial activity and applications. Environ. Sci. Technol. 43, 4355–4360.
69. Illman W. and P.J.J. Alvarez (2009). Performance assessment of bioremediation and natural attenuation. Crit. Rev. Environ. Sci. Technol. 39 (4): 209 – 270.
70. Zodrow K., L. Brunet, S. Mahendra, Q. Li, and P.J.J. Álvarez (2009). Polysulfone ultrafiltration membranes impregnated with silver nanoparticles show improved biofouling resistance and virus removal. Wat. Res. 43:715-723.
71. Mahendra S., H. Zhu, V. Colvin and P. J. J. Alvarez (2008). Quantum dot weathering results in microbial toxicity. Environ. Sci. Technol. 42 (24), 9424-9430.
72. Lyon D.Y. and P.J.J. Alvarez (2008). Fullerene water suspension (nC_{60}) exerts antibacterial effects via ROS-independent protein oxidation. Environ. Sci. Technol. 42:8127-8132.
73. Li Q., M. B. Tomson, M.S. Wong, and P. J.J. Alvarez (2008). Nanotechnology: one answer to the global challenge of clean water. Water 21. August. pp. 26-28.
74. Wong M.S., P.J.J. Alvarez, Y.L. Fang, N. Akçin, M.O. Nutt, and K.H. Heck. (2008). Cleaner Water using Bimetallic Nanoparticle Catalysts. J. Chem. Technol. Biotechnol. 84:158-166.
75. Li Q., S. Mahendra, D. Y. Lyon, L. Brunet, M. V. Liga, D. Li and P. J.J. Alvarez (2008). Antimicrobial Nanomaterials for Water Disinfection and Microbial Control: Potential Applications and Implications. Wat. Res. 42:4591-4602.
76. Klaine S.J., P.J.J. Alvarez, G.E. Batley, T.F. Fernandes, R.D. Handy, D.Y. Lyon, S. Mahendra, M.J. McLaughlin, and J.R. Lead (2008). Critical review of Nanomaterials in the Environment. Environ. Toxicol. Chem. 27(9):1825-1851.
77. Cápiro N.L, M.L. Da Silva, B. P. Stafford, W.G. Rixey, and P.J.J. Alvarez (2008). Microbial community response to a release of neat ethanol onto residual hydrocarbons in a pilot-scale aquifer tank. Environmental Microbiology. 10(9), 2236–2244.
78. Mathieu J., J. Schloendorn, B.E. Rittmann and P. J.J. Alvarez (2008). Microbial degradation

of 7-ketocholesterol. Biodegradation. 19:807-813.

79. Li D., Lyon D.Y., Q. Li, and P.J.J. Alvarez (2008). Effect of natural organic matter on the antibacterial activity of a fullerene water suspension. Environ. Toxicol. Chem. 27(9):1888-1894.

80. Lyon D.Y., L. Brunet, G.W. Hinkal, M.R. Wiesner, and P.J.J. Alvarez (2008). Antibacterial activity of fullerene water suspensions (nC_{60}) is not due to ROS-mediated damage. Nanoletters. 8(5**):** 1539-1543.

81. Gomez D., P. Leblanc P. Bedient. W. Rixey and P.J.J. Alvarez (2008). Modeling benzene plume elongation mechanisms exerted by ethanol using RT3D with a general substrate interaction module. Wat. Resour. Res. 44(5), W05405, doi:10.1029/2007WR006184.

82. Sawvel R., B. Kim and P.J.J. Alvarez (2008). Removal of volatile organic compounds at extreme shock loading using a scaled-up pilot rotating drum biofilter. J. Air & Waste Mngmt. Assoc. 58:1407-1414.

83. Lyon D.Y., D, Brown, E. Sundstrom, and P. J.J. Alvarez (2008). Assessing a fullerene water suspension as an antibiofouling surface treatment. Int. Biodeterior. Biodegrad. 62:475-478.

84. Da Silva M.L.B. and P.J.J. Alvarez (2008). Exploring the correlation between halorespirer biomarker concentrations and TCE dechlorination rates. J. Environ. Engrg. 134(11)895-901.

85. Hotze M., J. Labille, P.J.J. Alvarez and M. Wiesner (2008). Mechanisms of photochemistry and reactive oxygen production by fullerene suspensions in water. Environ. Sci. Technol. 42, 4175–4180.

86. Lyon, D.Y., D.A. Brown and P J.J. Alvarez (2008).Implications and Potential applications of bactericidal fullerene water suspensions: effect of nC_{60} concentration, exposure conditions and shelf life. Wat. Sci. Technol. 57(10): 1533-1538.

87. Dominguez R., M.L.B. da Silva, T.M. McGuire, D.A. Adamson, C.J. Newell, B.S. Yare and P.J.J. Alvarez (2008). Source zone bioremediation of chlorobenzene DNAPLs: performance assessment using real time quantitative polymerase chain reaction. Biodegradation. 19(4):545-553.

88. Rentz J.A., P.J.J. Alvarez, and J. L. Schnoor (2008). Salicylate induced benzo[a]pyrene co-metabolism by *Sphingomonas yanoikuyae* JAR02. Environmental Pollution 151:669-677.

89. Hotze M., A.R. Badireiddy, S. Chelam, P.J.J.Alvarez and M. Wiesner (2007). Toxicity of fullerol nanoparticles to bacteriophages. Environ. Sci. Technol. 41(18): 6627-6632.

90. Vázquez-Morillas A., M. Vaca-Mier, M. Beltrán-Villavicencio, R. López-Callejas, y P.J.J. Alvarez (2007). Reducción de percloroetileno y cromo hexavalente mediante Fe(0) y bioestimulación de microorganismos anaerobios. Rev. Int. Contam. Ambient. 23 (2) 51-58.

91. Brunet L., D.Y Lyon., K. Zodrow, J-C Rouch, B. Caussat, P.Serp, J-C Remigy, M.R Wiesner, P.J.J. Alvarez (2007). Properties of membranes containing semi-dispersed carbon nanotubes. Environ. Engrg. Sci. 24(8): 1122-1127.

92. Fang J., D.Y. Lyon, M Wiesner, J. Dong and P.J.J. Alvarez (2007). Effect of a fullerene water suspension on bacterial phospholipids and membrane phase behavior. Environ. Sci. Technol. 41(7): 2636-2642.

93. Zhu X., L. Zhu, Y. Li, Z. Duan, Chen and P. J. J. Alvarez (2007). Developmental Toxicity in Zebrafish Embryos After Exposure to Manufactured Nanomaterials: Buckminsterfullerene Aggregates (nC_{60}) and Fullerol. Environ. Toxicol. Chem. 26(5):976-979.

94. Da Silva M.L.B., R.L.. Johnson, and P.J.J. Alvarez (2007). Microbial characterization of a subsurface undergoing treatment with a permeable reactive iron barrier. Environ. Engrg. Sci. (24(8) 1122-1127.

95. Cápiro N.L, B. P. Stafford, W.G. Rixey, P.B. Bedient, and P.J.J. Alvarez (2007). Fuel-grade ethanol transport at the water table interface in a pilot-scale aquifer tank. Water Research. 41(3):656-664.

96. Da Silva M.L.B. and P.J.J. Alvarez (2007). Quantification of anaerobic benzene degraders using real-time PCR. Environ. Microbiol. 9 (1): 72-80.

97. O. Nut M., K. N. Heck, P.J.J. Alvarez, and M. S. Wong* (2006). Improved Pd-on-Au bimetallic nanoparticle catalysts for aqueous-phase trichloroethene hydrodechlorination. Appl. Catal. B: Environ. 69:115-125.

98. Da Silva M.L.B., R.C. Daprato, D.E. Gomez, J.B. Hughes, C.H. Ward, and P.J.J. Alvarez (2006). Comparison of bioaugmentation and biostimulation for the enhancement of DNAPL source zone bioremediation. Water Environment Research. 78 (13): 2456-2465.

99. Melendez-Estrada J., M.A. Amezcua-Allieri, P.J.J. Alvarez and R. Rodriguez-Vazquez (2006). Phenanthrene removal by *Penicillium frquentans* grown on a solid state culture: effect of oxygen concentration. Environmental Technology: 27: (10): 1073-1080.

100. Wiesner M. R., G. V. Lowry, P.J.J. Alvarez, D. Dionysiou, and P. Biswas (2006). Assessing the risks of manufactured nanomaterials. Environ. Sci. Technol. 40 (14):4337-4445.

101. Lyon D. Y., L. K. Adams, J. C. Falkner, and P.J.J. Alvarez (2006). Antibacterial activity of fullerene water suspensions: effect of preparation method and particle Size. Environ. Sci. Technol. 40 (14):4360-4366.

102. Adams L.K. D. Y. Lyon and P.J.J. Alvarez (2006). Comparative toxicity of nano-scale TiO_2, SiO_2 and ZnO water suspensions. Wat. Res. 40(19):3527-3532.

103. Rysz M. and P.J.J. Alvarez (2006). Transport of antibiotic resistant bacteria and resistance carrying plasmids through porous media. Wat. Sci. Technol. 164(11):363-370.

104. Da Silva M.L.B., Kamath R., and P.J.J. Alvarez (2006). Effect of simulated rhizodeposition on the relative abundance of polynuclear aromatic hydrocarbon catabolic genes in a contaminated soil. Environ. Toxicol. Chem. 25(2): 386–391.

105. Vazquez-Morilla A., M, Vaca-Mier and P.J.J. Alvarez (2006). Biological activation of ferric oxide for reduction of hexavalent chromium in presence of different anions. Eur. J. Soil Biol. 42:99-106.

106. Alvarez P.J.J. (2006). Nanotechnology in the environment – the good, the bad and the ugly. ASCE. J. Environ. Engrg. (editorial). 132(10)1233.

107. Kamath R., J.L. Schnoor, and P.J.J. Alvarez (2005). A model for the effect of simulated rhizodeposition on the fate of phenanthrene in aged contaminated soils. Environ. Sci. Technol. 39:9669-9675.

108. De Grey A.D.N.J., P.J.J. Alvarez, R.O. Brady, A.M. Cuervo, J. Jerome, P.L. McCarty, R.A. Nixon, B.E. Rittmann, J.R. Sparrow (2005). Medical bioremediation: prospects for the application of microbial catabolic diversity to several major age-related diseases Ageing Research Reviews. 4:315-338.

109. Da Silva M.L.B., G.M. Ruiz-Aguilar, and P.J.J. Alvarez (2005). Enhanced anaerobic biodegradation of BTEX-ethanol mixtures in aquifer columns amended with sulfate, chelated ferric iron or nitrate. Biodegradation 16: 105-114.

110. Shrout J., P. Larese-Casanova,' M.M. Scherer, and P.J.J. Alvarez (2005). Sustained and complete hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) degradation in zero-valent iron simulated barriers under different microbial conditions. Environmental Pollution 12: 1115-1126.

111. Rentz J.A., P.J.J. Alvarez, and J. L. Schnoor (2005). Benzo[a]pyrene co-metabolism in the presence of plant root extracts and exudates: Implications for phytoremediation. Environmental Pollution 136:477-484.

112. Da Silva M.L.B. and P.J.J. Alvarez (2004). Enhanced anaerobic biodegradation of BTEX-ethanol mixtures in bioaugmented aquifer columns. Appl. Environ. Microbiol. 70(8):4720-4726.

113. Sherburne L.A, J.D. Shrout, and P.J.J. Alvarez (2004). Hexahydro-1,3,5-trinitro-1,3,5-triazine

(RDX) degradation by *Acetobacterium paludosum*. Biodegradation 3:1-9.

114. Meléndez-Estrada J., M. A. Amezcua-Allieri, P.J.J. Alvarez and R. Rodríguez-Vázquez (2004). Phenanthrene removal by *Penicillium frequentans* grown on a solid-state culture: effect of oxygen concentration. Environmental Technology (In press).
115. Rysz M. and P.J.J. Alvarez (2004). Amplification and Attenuation of Tetracycline Resistance in Soil Bacteria: Aquifer Column Experiments. Wat. Res. 38: 3705-3712.
116. Kamath R., J.L. Schnoor, and P.J.J. Alvarez (2004). Effect of root-derived substrates on the expression of *nah-lux* genes in *Pseudomonas fluorescens* HK44 implications for PAH biodegradation in the rhizosphere. Environ. Sci. Technol. 38:1740-1745.
117. Lovanh N. and P.J.J. Alvarez* (2004). Effect of ethanol, acetate, and phenol on toluene degradation activity and *tod-lux* expression in *Pseudomonas putida* TOD102: an evaluation of the metabolic flux dilution model. Biotechnol. Bioeng. 86(7):801-808.
118. Oh B-T and P.J.J. Alvarez (2004). Removal of explosives using an integrated Fe^0-microbial treatment in flow-through columns. Bull. Environmental Contamination and Toxicology 73:1-8.
119. Rentz J.A., P.J.J. Alvarez, and J.L. Schnoor (2004). Repression of *Pseudomonas putida* phenanthrene degrading activity by plant root extracts. Environmental Microbiology 6(6): 574-583.
120. Fang J., N. Lovanh, and P.J.J. Alvarez (2004). The Use of Isotopic and Lipid Analysis Techniques linking Toluene Degradation to Specific Microorganisms: Applications and Limitations. Wat. Res. 38:2529-2536.
121. Ginner J.L., P.J.J. Alvarez, S.L. Smith, and M.M. Scherer (2004). Nitrate and Nitrite Reduction by Fe^0: Influence of Mass Transport, temperature, pH, and Denitrifying Microbes. Environ. Eng. Sci. 21(2): 219-229.
122. Gaddi M., T. Sexton, M. Muste, V.C. Patel, and P.J.J. Alvarez (2003). International Perspectives in Water Resources Management: The Paraná River Watershed. World Transactions on Engineering and Technology Education, v2n3:435-439.
123. Fernandez-Sanchez J.M., Sawvel E.J., and Alvarez P.J.J. (2003). Effect of Fe^0 quantity on microbial processes that enhance the efficacy of permeable reactive barriers. Chemosphere. 54 (7): 923-829.
124. Ruiz-Aguilar G.M, J. M. Fernandez-Sanchez, S. R. Kane, D. Kim and P.J.J. Alvarez (2003). Effect of ethanol and methyl-tert-butyl ether on monoaromatic hydrocarbon biodegradation: response variability for different aquifer materials under various electron-accepting conditions. Environ. Toxicol. Chem. 21(12):2631-2639.
125. Ruiz-Aguilar G.M, K. O'Reilly, and P.J.J. Alvarez (2002). A comparison of benzene and toluene plumes for sites contaminated with regular versus ethanol-amended gasoline. Ground Water Monitoring and Remediation. 23(1):48-53.
126. Rentz J.A., B. Chapman, P.J.J. Alvarez, and J.L. Schnoor (2002). Stimulation of hybrid poplar growth in petroleum contaminated soils through oxygen addition and soil nutrient amendments. Int. J. Phytoremediation 4(1) 57-62.
127. Oh B-T and P.J.J. Alvarez (2002). Hexahydro-1,3,5-Trinitro-1,3,5-Triazine (RDX) degradation in biologically active iron columns. Water, Air Soil and Soil Pollution 141 (1-4): 325-335.
128. Beller H. R., S. R. Kane T.C. C. Legler' and P.J.J. Alvarez (2002). A novel real-time polymerase chain reaction (PCR) method for monitoring anaerobic, hydrocarbon-degrading bacteria. Environ. Sci. Technol. 36(18):3977-3984.
129. Da Silva M.L. and P.J.J. Alvarez (2002). Effects of ethanol versus MTBE on BTEX migration and natural attenuation in aquifer columns. ASCE J. Env. Engrg. 128(9):862-867.
130. Deeb R. A., J. O. Sharp, A. Stocking, S. McDonald, K. A. West, M. Laugier, P. J. J. Alvarez,

M. C. Kavanaugh and L. Alvarez-Cohen (2002). Impact of Ethanol on Benzene Plume Lengths: Microbial and Modeling Studies. ASCE J. Env. Engrg. 128(9):868-875.

131. Lovanh N., C.S. Hunt, and P.J.J. Alvarez (2002). Effect of ethanol on BTEX degradation kinetics: continuous culture experiments. Wat. Res. 36:3739-3746.
132. Gandhi S., B.-T. Oh, J. L. Schnoor, P. J. J. Alvarez. 2002. Degradation of TCE, Cr(VI), sulfate, and nitrate mixtures by granular iron in flow-through columns under different microbial conditions. Water Res. 36(8): 1973-1982.
133. Oh B-T, C.L. Just, and P.J.J. Alvarez* (2001). Hexahydro-1,3,5-Trinitro-1,3,5-Triazine (RDX) mineralization by zero-valent iron and mixed anaerobic cultures. Environ. Sci. Technol. 35(21):4341-4346
134. Kelley S.L., E.W. Aitchison, J.L. Schnoor, and P.J.J. Alvarez (2001). Biodegradation of 1,4-dioxane in planted and unplanted soil: effect of bioaugmentation with *Amycolata* sp. CB1190. Water Research. 35(16):3791-3800.
135. Fernandez-Sanchez J.M, R. Rodriguez-Vazquez, G. Ruiz-Aguilar, and P.J.J. Alvarez (2001). PCB biodegradation in aged contaminated soil: interactions between exogenous *Phanerochaete chrysosporium* and indigenous microorganisms. J. Environ. Sci. Health A36(7):1145-1162.
136. Powers S.E., D.W. Rice, B. Dooher, and P.J.J. Alvarez (2001). Replacing MTBE with ethanol as a gasoline oxygenate – How may groundwater resources be impacted? Environ. Sci. Technol. 35(1):24A-30A.
137. Powers S.E., C.S. Hunt, S.E. Heermann, H.X. Corseuil, D. Rice, and P.J.J Alvarez (2001). The transport and fate of ethanol and BTEX in groundwater contaminated by gasohol. Critical Reviews in Environmental Science and Technology. 31(1):79-123.
138. Egli K., U. Fanger, P.J.J. Alvarez, H. Siegrist, J.R. van der Meer, and A.J.B. Zehnder (2001). Enrichment and characterization of a new anammox-bacterium from a rotating biological contactor treating ammonium-rich leachate. Archives of Microbiology. 175(3): 198-207.
139. Vaca-Mier* M., R. Gehr, B.E. Jimenez-Cisneros, and P.J.J. Alvarez (2001). Heavy metal removal with Mexican clinoptilolite: multi-component ionic exchange. Wat. Res. 35:373-378.
140. Costura R.K. and P.J.J. Alvarez (2000). Expression and longevity of toluene dioxygenase in *Pseudomonas putida* F1 grown at different dissolved oxygen concentrations. Wat. Res. 34: 3014-3018.
141. Dejournett T. and P.J.J. Alvarez (2000) Combined microbial-Fe(0) system to remove nitrate from contaminated groundwater. Bioremediation Journal 4:149-154.
142. Fang J., M. Barcelona and P.J.J. Alvarez (2000). Phospholipids compositional changes of five pseudomonad archetypes grown with and without toluene Applied Microbiology and Biotechnology 54: 382-389.
143. Fang J., M. Barcelona and P.J Alvarez (2000). A direct comparison between fatty acid analysis and intact phospholipid profiling for microbial identification. Org. Geochem. 31: 881-887.
144. Wildman M. J. and P.J.J. Alvarez (2001). RDX degradation using an integrated Fe(0)-microbial treatment approach. Water Science and Technology 43(2): 25-33.
145. Fang J., M. Barcelona and P.J.J. Alvarez (2000) Phospholipids of five pseudomonad archetypes for different toluene degradation pathways. Bioremediation Journal 4(3):181-185.
146. Rojas-Avelizapa N.G., R. Rodríguez-Vázquez, S. Saval- Bohorquez, and P.J.J. Alvarez (2000). Effect of C/N/P ratio and nonionic surfactants on polychlorinated biphenyls biodegradation. World Journal of Microbiology 16(4):319-324.
147. Scherer M.M., S. Richter R.L. Valentine, and P.J.J. Alvarez (2000). Chemistry and microbiology of permeable reactive barriers for in situ groundwater cleanup. Crit. Rev. Environ. Sci. Technol. 30:363-411.

148. Aitchison E., S. Kelley, J.L. Schnoor, and P.J.J. Alvarez (2000). Phytoremediation of 1,4-dioxane by hybrid poplar trees. Water Environment Research. 72: 313-321.

149. Gülensoy N. and P.J.J. Alvarez (1999). Diversity and correlation of aromatic hydrocarbon biodegradation capabilities. Biodegradation. 10:331-340.

150. Alvarez P.J.J., R.C. Heathcote, and S.E. Powers (1998). Caution against interpreting gasoline release dates based on BTEX ratios in ground water. Ground Water Monitoring and Remediation. Fall, 69-76.

151. Till B.A., L.J. Weathers, and P.J.J. Alvarez (1998). Fe(0)-supported autotrophic denitrification. Environmental Science and Technology 32(5) 634-639.

152. Alvarez P.J., L.. Cronkhite, and C. Hunt (1998). Use of benzoate to establish reactive buffer zones for enhanced attenuation of BTX migration. Environ, Sci. Technol. 32(4) 509-515.

153. Corseuil H.X., C.S. Hunt, R. dos Santos Ferreira, and P.J.J. Alvarez (1998). The influence of the gasoline oxygenate ethanol on aerobic and anaerobic BTX biodegradation. Wat. Res. 32(7) 2065-2072.

154. Jordahl J.L., L. Foster, J.L. Schnoor, and P.J.J. Alvarez (1997). Effect of poplar trees (*Populus* spp.) on microbial populations important to hazardous waste bioremediation. Environ. Tox. and Chem. 16(6):1318-1321.

155. Weathers L.J., G.F. Parkin, and P.J.J. Alvarez (1997). Utilization of cathodic hydrogen as electron donor for chloroform cometabolism by a mixed methanogenic culture. Environ. Sci. Technol. 31 (3), 880 -885.

156. Kovacs P.E., P.J.J. Alvarez, and R.L. Valentine (1997). The Effect of static magnetic fields on biological systems: Implications for enhanced biodegradation. Critical Reviews in Environmental Science and Technology. 27(4), 319-382.

157. Schnabel W.E., A.C. Dietz, J.G. Burken, J.L. Schnoor, and P.J.J. Alvarez (1997). Uptake and transformation of TCE by edible garden plants. Water Research, 31 (4) 816-824.

158. Alvarez, P.J.J. (1996). Caution against the inappropriate use of analytical fate and transport models to estimate the age and risk of petroleum product releases. Ground Water Monitoring and Remediation. Spring, 72-76.

159. Vermace M.E., R.F. Christensen, G.F. Parkin, and P.J.J. Alvarez (1996). Relationship between the concentration of denitrifiers and *Pseudomonas* spp. in soil: Implications for BTX bioremediation. Water Research. 30 (12) 3139-3145

160. Miller C.M., R.L. Valentine, M. Roehl, and P.J.J. Alvarez (1996). Chemical and microbiological assessment of pendimethalin contaminated soil after treatment with Fenton's Reagent. Water Research. 30 (11) 2579-2586.

161. Corseuil H.X., J.R. Aires, and P.J.J. Alvarez (1996). Implications of the presence of ethanol on intrinsic bioremediation of BTX plumes in Brazil. Haz. Waste Haz. Mat. 13 (2): 213-221.

162. Corseuil H.X and P.J.J. Alvarez (1996). Natural bioremediation perspective for BTX contaminated groundwater in Brazil. Water Science and Technology. 34(7-8): 311-318.

163. Corseuil, H.X. and P.J.J. Alvarez (1996). Natural bioremediation of aquifer material contaminated with gasoline-ethanol mixtures. Revista de Microbilogia (Journal of the Brazilian Society for Microbiology); 27 (1): 19-26.

164. Helland B.R., P.J.J. Alvarez, and J.L. Schnoor (1995). Reductive dechlorination of carbon tetrachloride with elemental iron. Journal of Hazardous Materials; 41: 205-216.

165. Alvarez, P.J.J. and T.M. Vogel (1995). Degradation of BTEX and their aerobic metabolites by indigenous microorganisms under nitrate reducing conditions. Wat. Sci. Technol.; 31: 15-28.

166. Alvarez, P.J.J., P.J. Anid, and T.M. Vogel (1994). Kinetics of toluene degradation by denitrifying aquifer microorganisms. ASCE J. Environmental Engineering.; 120: 1327-1336.

167. Anid, P.J., P.J.J. Alvarez, and T.M. Vogel (1993). Biodegradation of monoaromatic

hydrocarbons in aquifer columns amended with hydrogen peroxide and nitrate. Water Research; 27: 685-691.

168. Chen, Y.M., L.M. Abriola, P.J.J. Alvarez, P.J. Anid, and T.M. Vogel, (1992). Biodegradation and transport of benzene and toluene in sandy aquifer material: model-experiment comparisons. Water Resources Research; 28: 1833-1847.

169. Alvarez, P.J.J. and T.M. Vogel (1991). Substrate interactions of benzene, toluene and *para*-xylene during microbial degradation by pure cultures and mixed culture aquifer slurries. Applied and Environmental Microbiology; 57: 2981-2985.

170. Alvarez, P.J.J., P.J. Anid, and T.M. Vogel (1991). Kinetics of aerobic biodegradation of benzene and toluene in sandy aquifer material. Biodegradation; 2: 43-51.

171. Anid, P.J., P.J.J. Alvarez, L.M. Abriola, and T.M. Vogel (1990). Biodegradation of benzene, toluene, and xylenes in sandy aquifer material: microcosms and continuous flow column experiments. EOS, Transactions, American Geophysical Union, 71(43): 1323.

C. Book Chapters

172. Nel, D. Grainger, P.J.J. Alvarez, S. Badesha, V, Castranova, M. Ferrari, H. Godwin, P. Grodzinski, J. Morris, N. Savage, N. Scott and M. Wiesner (2010). Chapter 4: Nanotechnology Environmental, Health, and Safety Issues. In: M.C. Rocco, M.A. Mirkin, and M.C. Hersam (eds). Nanotechnology Research Directions for Societal Needs in 2020*,* Springer, Boston and Berlin, 2010.

173. Rittmann B.E. and P.J.J. Alvarez (2010). Bio- and nanoengineering: the future of wastewater treatment. In: A World of Opportunities- working in the international water sector" IWA Publishing. pp. 14-15.

174. Alvarez P.J.J., Q. Li, and J. (2010). Nanotechnology Enabled Water Treatment And Reuse for Developing Countries: Emerging Opportunities and Challenges. In: KC. Ribeiro, O. Garrido de Assis, L. Caparelli Mattoso, and S, Mascarenhas (eds). International Conference on Food and Agriculture Applications of Nanotechnology. FAO Nano Agri 2010, pp. 16-22. ISBN 978-85-63274-02-4.

175. Brame J. and P.J.J. Alvarez (2010). Challenges and Opportunities in the Use of Nanotechnology for Water treatment and Wastewater Reuse. In: K. Korhonen-Kurki and M. Fox (eds). Towards New Solutions in Managing Environmental Crisis. Environmentalica Fenica 27, pp. 84-82.

176. Alvarez P.J.J. , J.G. Burken, J. D. Coan, M. E. Dias de Oliveira, R. Dominguez-Faus, D. E. Gomez, A.M. Jaffe, K. B. Medlock III, S. E. Powers, R. Soligo, L. A. Smulcer (2010), "The Fundamentals of a Sustainable U.S. Biofuels Policy", Research Paper, James A. Baker III Institute for Public Policy, Rice University, Houston, Texas, USA

177. Jaesang Lee, Shaily Mahendra, and P.J.J. Alvarez (2009). Potential Environmental Impacts of Nanomaterials Used in the Construction Industry. Nanotechnology in Construction - 3. Editor(s) name(s): Z. Bittnar, J. Zeman, J. Němeček, V. Šmilauer, P.J.M. Bartos. Springer Verlag: 1-14.

178. Da Silva M.L.B. and P.J.J. Alvarez (2009). Bioaugmentation. In: *K. N. Timmis* (ed.). Handbook of hydrocarbon microbiology: microbial interactions with hydrocarbons oils, fats and related hydrophobic substrates and products**.** Springer Verlag (In press).

179. Mahendra S., Q. Li, D. Y. Lyon, L. Brunet, and P. J.J. Alvarez (2008). Nanotechnology Enabled Water Disinfection and Microbial Control: Merits and Limitations. In: Diallo M. Duncan J., Savage N., Sustich R. and Streeter A. (eds.). Nanotechnology for Water Quality. William Andrew Publishing.

180. Lyon, D.Y., A. Thill, J. Rose, and P J.J. Alvarez (2007). Chapter XII: Ecotoxicological Impacts of Nanomaterials. In: Wiesner M. and Bottero J-Y (eds.). Environmental Nanotechnology. McGraw Hill. pp. 446-479.

181. Kamath R., J. Rentz, J.L. Schnoor, and P.J.J. Alvarez (2004). Phytoremediation of hydrocarbon-cobtaminated soils: principles and applications. In: R. Vazquez-Duhalt and R. Quintero-Ramirez (Eds.). Petroleum Biotechnology, 151. Elsevier, ISBN: 0-444-51699-9.

182. Adriaens P., P.J.J. Alvarez, L. Bastiaans, L. Diels, D. Major, Z. Filip, and D. Springael (2002). Biodegradation and Bioremediation – Principles and Applications. In: D. Reible and K. Demnerova (eds.). Innovative Approaches to On-Site Assessment and Remediation of Contaminated Sites. NATO Science Series, IV. Earth and Environmental Sci., Vol. 15, pp. 67-113., Kluwer Academic Publisher.

183. Mathew J. Wildman, Byung Taek Oh, Andrew Hawkins, and Pedro J.J. Alvarez (2000). RDX Degradation in Combined ZVI-Microbial Systems. In: G.B. Wickamayake, A.R. Gavaskar, and A.S.C. Chen (eds.). Chemical Oxidation and Reactive Barriers. Monterey, CA, May 22-25, 2000. Battelle Press 2(6) 229-346.

184. Kelley S., E. Aitchison, J. Schnoor, and P.J. Alvarez (1999). Bioagumentation of poplar roots with *Amycolata* sp. CB1190 to enhance phytoremediation of 1,4-dioxane; In: B.C. Alleman and A. Leeson (eds.), In Situ and Onsite Bioremediation, Battelle Press, 5(6): 139-144.

185. Dejournett T. and P.J.J. Alvarez (1999) Combined Microbial-Fe(0) System to Treat Nitrate-Contaminated Groundwater; In: B.C. Alleman and A. L. Leeson (eds.), In Situ and Onsite Bioremediation, Battelle Press, 5(4): 79-84.

186. Fang J., M. Barcelona and P.J.J. Alvarez (1999) Phospholipids of Five Pseudomonad Archetypes for Different Toluene Degradation Pathways. In: B.C. Alleman and A. L. Leeson (eds.), In Situ and Onsite Bioremediation, Battelle Press, 5(1): 171-176.

187. Hunt, C.S, dos Santos Ferreira, R., Corseuil, H.X. and Alvarez, P.J.J. (1997). Effect of Ethanol on Aerobic BTX Degradation; In: B.C. Alleman and A. L. Leeson (eds.), In Situ and Onsite Bioremediation, Battelle Press, 4 (1): 49-54.

188. Till B.A., L.J. Weathers, and P.J.J. Alvarez (1997) Fe^0-Based bioremediation of nitrate contaminated waters; In: B.C. Alleman and A. L. Leeson (eds.), In Situ and Onsite Bioremediation, Battelle Press, 4 (3): 367-372.

189. Rotert K.H., L.A. Cronkhite, and P.J.J. Alvarez (1995). Stimulation of BTX biodegradation with benzoate. In: R.E. Hinchee, F.J. Brockman, and C. M. Vogel (eds.), Microbial Processes for Bioremediation, Battelle Press, 3 (8): 161-168.

190. Miller C.M., R.L. Valentine, M. Roehl, and P.J.J. Alvarez (1995). Chemical oxidation and toxicity reduction of pesticide contaminated soils found at agrochemical dealer sites. In: R.E. Hinchee, F.J. Brockman, and C. M. Vogel (eds.), Bioremediation of Recalcitrant Organics, Battelle Press, 3 (7): 175-181.

D. Conference Proceedings and Other Technical Publications

(Stopped keeping track of proceedings in 2004).

Da Silva, Marcio L.B., D.Y. Lyon, and P.J.J. Alvarez (2005). Bioremediation: From Microscopic Observations to Macroscopic Implications. 10th International Symposium on Microbial Ecology. Cancun, Mexico. August 22-27,2004.

Sutton B. and P. J.J. Alvarez (2004). RDX degradation by *Shewanella algae* BrY and by its biogenic iron mineral. Proc. In Situ and On-Site Bioremediation: 4th International Conference of Chlorinated and recalcitrant Compounds, Monterey, CA, May 24-27, 2004.

Shrout J.S., P. Larese-Casanova, M. M. Scherer, and P. J.J. Alvarez (2004). Sustained RDX degradation in bioaugmented, simulated Fe(0) permeable reactive barriers. Proc. In Situ and On-Site Bioremediation: 4th International Conference of Chlorinated and recalcitrant Compounds, Monterey, CA, May 24-27, 2004.

L. Diels, L. Bastiaens, S. O'Hannessin, J. L. Cortina, P. J. Alvarez, M. Ebert, and H. Schad (2003). Permeable Reactive Barriers: a multidisciplinary approach of a new emerging sustainable groundwater treatment technology. Proc. ConSoil2003. Ghent, Belgium, May 12-16, 2003.

Kamath, R., Schnoor,J.L. and Alvarez P.J.J. (2003). Effect of Root Extracts on the Expression of nah-lux Genes in Pseudomonas fluorescens HK44 -Implications for PAH Biodegradation in the Rhizosphere. International Applied Phytotechnologies Conference. US EPA. Chicago, IL. March 3-5 2003.

Lovanh, N. and P.J.J. Alvarez (2003). Effect of ethanol on BTEX biodegradation activity using a bioreporter strain in continous cultures. 225th ACS National Meeting. Volume 43 (No. 1): pp 669-673. New Orleans, LA. March 23-27, 2003.

Da Silva M.L.B., Ulrich A., Edwards E., and P.J.J. Alvarez (2003). Enhanced biodegradation of BTEX-ethanol mixtures through bioaugmentation with competent methanogenic consortia. In Situ and On-Site Bioremediation: The Seventh International Symposium, Orlando, FL, June 2-5, 2003.

Kelvin B. Gregory K.B., A.B. Williams., P.J.J. Alvarez, G.F. Parkin, and *M.M. Scherer* (2003). RDX transformation in the presence of ferrihydrite and *Geobacter metallireducens* GS-15. In Situ and On-Site Bioremediation: The Seventh International Symposium, Orlando, FL, June 2-5, 2003.

Fernández-Sánchez, J. M., Sawvel, E. J. and Alvarez. P.J.J. (2002). Effect of Fe^0 surface area concentration on the efficiency of iron-based biorremediation. VII Latin American Workshop and Symposium on Anaerobic Digestion. IWA-FEMISA. Yucatan, Mexico. October 23-25, 2002.

Kamath R. and Alvarez. P.J.J.(2002). Effect of root exudates on phenantrene degradation by two Hawaiian soil isolates. Abstract. Third International Conference on remediation of Chlorinated and Recalcitrant Compounds. Battelle. Monterey, CA, May 20-23, 2002.

Alvarez P.J.J. (2001). Iron-enhanced bioremediation of RDX in aquifer columns. Partners in Environmental Technology Technical Symposium and Workshop. Strategic Environmental Research and Development Program (SERDP) and Environmental Security Technology Certification Programs (ESTCP). November 27-29, 2001. Washington, D.C.

Kane S. R., H.R. Beller, T.C Legler, and P.J.J. Alvarez (2002). A Real-time PCR Method for *In Situ* Monitoring of Anaerobic, Hydrocarbon-degrading Bacteria Based on *bssA* (a Benzylsuccinate Synthase Gene). Abst. 102nd Gen. Meet. Am. Soc. Microbiol., Salt Lake City, Utah May 19 - 23, 2002

Alvarez P.J.J., G.M.L. Ruiz-Aguilar, H.R. Beller, J.M. Fernandez-Sanchez, N. Lovanh, C.S. Hunt, and M.B. da Silva (2001). Effect of ethanol on BTEX degradation and natural attenuation. *Proc. Petroleum Hydrocarbons and Organic Chemicals in Groundwater: 2001 Conference and Exposition.* NGWA, Houston, TX, November 14-16, 2001, pp.53-54.

Lovanh N., C.S. Hunt, and P.J.J. Alvarez (2001). Effect of ethanol on BTEX degradation kinetics by continuous cultures. Proc. IWA 2nd World Water Congress. Berlin, 15-19 October, 2001.

Powers S.E., P.J.J. Alvarez, and D.W. Rice (2001). Uncertainties about the groundwater Impacts associated with increased use of ethanol in gasoline. In: *Subsurface Fate and Transport of Gasoline Containing Ethanol – Report to the California State Water Resources Control*, D.W. Rice and R.T. Depue (Eds.), Lawrence. Livermore National Laboratory, Livermore, CA, UCRL-AR-145380, Ch. 1.

Alvarez P.J.J., G.M.L. Ruiz-Aguilar, J.M. Fernandez-Sanchez, D. Kim, H.R. Beller, and S.R. Kane (2001). Impact of ethanol on benzene, toluene, ethylbenzene, and xylene groundwater plumes: biodegradation kinetics. In: *Subsurface Fate and Transport of Gasoline Containing Ethanol – Report to the California State Water Resources Control*, D.W. Rice and R.T. Depue (Eds.), Lawrence Livermore National Laboratory, Livermore, CA, UCRL-AR-145380, Ch. 3.

Oh B-T and P.J.J. Alvarez (2001). Iron-based bioremediation of RDX-contaminated groundwater. First European Bioremediation Conference. Chania, Greece, July 2-5, 2001.

Oh B-T and P.J.J. Alvarez (2001). RDX degradation with bioaugmented Fe(0) filings: Implications for enhanced reactive barrier performance. In Situ and On-Site Bioremediation: The Sixth International Symposium, San Diego, CA, June 4-7, 2001.

Gandhi S., Oh B-T, R. Sawvel, J.L. Schnoor, P.J.J. Alvarez (2001). Degradation of TCE, Cr(VI), nitrate and sulfate mixtures in flow-through columns mimicking bioaugmented Fe(0) barriers. In Situ and On-Site Bioremediation: The Sixth International Symposium, San Diego, CA, June 4-7, 2001.

Da Silva M.B. G.M. Ruiz, J.M. Fernandez, H.R. Beller, and P.J.J. Alvarez (2001). Effect of ethanol versus MTBE on BTEX retardation and biodegradation under different electron acceptor conditions. In Situ and On-Site Bioremediation: The Sixth International Symposium, San Diego, CA, June 4-7, 2001. 6(1) 195-202.

Gregory K., M. Von Arb, P.J.J. Alvarez, M. Scherer, and G.F. Parkin, (2001). Biogeochemical removal of RDX using iron oxide and *Geobacter metallireducens* GS-15. In Situ and On-Site Bioremediation: The Sixth International Symposium, San Diego, CA, June 4-7, 2001. Battelle Press, 6(3)1-8.

Gu B, D. B. Watson, D. Phillips, J, Zhou, and P.J.J. Alvarez (2001). Microbiological characteristics in a zero-valent iron reactive barrier. In Situ and On-Site Bioremediation: The Sixth International Symposium, San Diego, CA, June 4-7, 2001.

Alvarez P.J.J. (2001). Principles and applications of BTEX remediation. Proc. Innovative Approaches to the On-Site Assessment and remediation of Contaminated Sites. NATO Advance Studies Institute. Prague, Czech Republic, May 24-June 2, 2001

Oh B-T and P.J.J. Alvarez (2001). RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine) degradation using bioaugmented Fe(0). Q-258 Abst. 101st Annu. Meet. Am. Soc. Microbiol., Orlando, FA, May 20-24, 2001.

Gregory K., B-T Oh, M. Scherer, G,F. Parkin, and P.J.J. Alvarez (2000). Biogeochemical degradation of redox-sensitive compounds using iron oxide and *Geobacter metallireducens* GS-15. 220th ACS National Meeting. Washington, D.C. August 20-25, 2000.

Da Silva M.B. and P.J.J. Alvarez (2000). Effects of ethanol versus MTBE on BTEX natural attenuation. Proc. NGWA/API Petroleum Hydrocarbons Conference. Anaheim, CA, Nov. 16-19, 2000.

Lovanh N., Y-K Zhang, R.C. Heathcote, and P.J.J. Alvarez (2000). Guidelines to Determine Site-Specific Parameters for Modeling the Fate and Transport of Monoaromatic Hydrocarbons in Groundwater. Final Report Submitted to The Iowa Comprehensive Petroleum Underground Storage Tank Fund Board, Des Moines, IA. March, 2000.

Lovanh N., Y-K Zhang, and P.J.J. Alvarez (2000). Biodegradation Rate Coefficient Determination Software (BIRACODES). Submitted to The Iowa Comprehensive Petroleum Underground Storage Tank Fund Board, Des Moines, IA. April, 2000.

Zhang Y-K, B-M Seo, N. Lovanh, and P.J.J. Alvarez (2000). Evaluation of Computer Software Packages for RBCA Tier-3 Analysis.. Submitted to The Iowa Comprehensive Petroleum Underground Storage Tank Fund Board, Des Moines, IA. April, 2000.

Scherer, M.M., J. Ginner, P.J.J. Alvarez, and K. Johnson (2000). Contaminant remediation by iron metal: shifting kinetic regimes. Hazardous Waste Research 2000 Conference. Denver, CO. May 23-25, 2000.

Lovanh N., M. Rysz, and P.J.J. Alvarez* (2000). The Effects of ethanol on toluene degradation by four archetypes under carbon and oxygen limited conditions. Proc. 5th HSRC Research Symposium, Asilomar Conference Grounds, Pacific Grove, CA, July 9-12, 2000.

Da Silva M.B., N. Lovanh, C.S. Hunt, and P.J.J. Alvarez (2000). The Effects of ethanol on BTX natural attenuation: pure culture and aquifer column experiments. hazardous waste research 2000 Conference. Denver, CO. May 23-25, 2000.

D. W. Rice, S.E. Powers, and P.J.J. Alvarez (1999). Potential Scenarios for Ethanol-containing gasoline Released into Surface and Subsurface Waters. In: *Health and Environmental Assessment of the Use of Ethanol as a Fuel Oxygenate – Report to the California Environmental Policy Council in Response to Executive Order D-5-99. Vol. 4, Potential*

Ground and Surface Water Impacts, D.W. Rice and G. Cannon (Eds.), Lawrence Livermore National Laboratory, Livermore, CA, UCRL-AR-135949 Vol. 4, Ch. 1.

Alvarez, P.J.J. and C.S. Hunt (1999). The Effect of Ethanol on BTEX Biodegradation and Natural Attenuation. In: *Health and Environmental Assessment of the Use of Ethanol as a Fuel Oxygenate – Report to the California Environmental Policy Council in Response to Executive Order D-5-99. Vol. 4, Potential Ground and Surface Water Impacts*, D.W. Rice and G. Cannon (Eds.), Lawrence Livermore National Laboratory, Livermore, CA, UCRL-AR-135949 Vol. 4, Ch. 3.

Rice, D.W., P.J.J. Alvarez, S.E. Powers, H.R. Beller, S.R. Kane, J.I. Daniels, D.W. Layton, and B. Dooher (1999). Knowledge Gaps Regarding the Ground and Surface Water Impacts of Ethanol-Containing Gasoline and Recommendations for Future Research. In: *Health and Environmental Assessment of the Use of Ethanol as a Fuel Oxygenate – Report to the California Environmental Policy Council in Response to Executive Order D-5-99. Vol. 4, Potential Ground and Surface Water Impacts*, D.W. Rice and G. Cannon (Eds.), Lawrence Livermore National Laboratory, Livermore, CA, UCRL-AR-135949 Vol. 4, Ch. 9.

G.F. Parkin, P.J. Alvarez, M.M. Scherer, J.L. Schnoor (2000). The Role of Microbes in Remediation with Fe(0) Reactive Barriers. Groundwater Currents; EPA 542-N-00-002. 35:2-3.

Alvarez P.J.J., E. Sawvel, M. Wildman, B. Eberle, K. Gregory, G.F. Parkin, and J.L. Schnoor (1999). Biogeochemical interactions in Reactive Zero-Valent Iron Barriers. Proc. 1999 Bioremediation Research Porgram Review, Nov 3-5, 1999, Bloomingdale, IL EPA/600/R-99/092, p. 14-16.

Sawvel E.J., R. Donald, and P.J.J. Alvarez (1999). Microbial-Fe(0) interactions during treatment of groundwater contaminant mixtures. Proc. 14th HSRC Conference on the Hazardous Waste Remediation, Saint Louis, MO, May 19-21, 1999.

Alvarez*, P.J.J., R.C. Heathcote, and S.E. Powers (1999). Discussion of "Caution against interpreting gasoline release dates based on BTEX ratios in groundwater", Ground Water Monitoring and Remediation, Spring, 155-158.

Lovanh, N., Y.-K. Zhang, and P.J.J. Alvarez* (1999). Statistics and effect of first-order biodegradation rate coefficient on intrinsic remediation of groundwater contamination, Proc. 6th International Petroleum Environmental Conference, Houston, TX, October, 1999.

Ginner G., S. Threkelsen, M. Scherer, and P.J.J. Alvarez (1999). Nitrate reduction by iron metal: the rate limiting step. Proc. 14th HSRC Conference on the Hazardous Waste Remediation, Saint Louis, MO, May 19-21, 1999.

Alvarez P.J.J. Zhang Y-K, and Lovanh N. (1998). Evaluation of the Iowa Tier-2 Model Based on the Benzene Plume Dimensions. Iowa Comprehensive Petroleum Underground Storage Tank Fund Board, Des Moines, IA. December, 1998.

Alvarez P.J.J., G.F. Parkin, J.L. Schnoor, and J. Fang (1998). Biogeochemical Interactions in Zero-Valent Iron Walls. In: USEPA 1996-98 Bioremediation Research Program Review, Sept 23-24, 1998, Washington D.C. EPA/600/F-98/122, p. 32.

Parkin G.F., L.J. Weathers., P.J. Novak, and P.J.J. Alvarez (1998). Enhanced Anaerobic Bioremediation Using Elemental Iron. Proc. of the ASCE 1998 National Conference on Environmental Engineering, Chicago, IL, June 7-10, 1998. pp.128-133.

Dejoutnett T. and P.J.J. Alvarez (1998). Feasibility of Fe(0) Bioaugmentation with Hydrogenotrophic Denitrifiers for Nitrate Removal from Groundwater", Proc. 13th HSRC Conference on the Hazardous Waste Remediation, Salt Lake City, UT, May 19-21, 1998.

Wildman M. and P.J.J. Alvarez (1998). Feasibility of Bioaugmentation of Fe(0) With Anaerobic Sludge to Remove RDX From Soil and Groundwater. Proc. 13th HSRC Conference on the Hazardous Waste Remediation, Salt Lake City, UT, May 19-21, 1998.

Alvarez P.J.J. "Diseño de fitorremediación", Symposium de Biorremediación de Suelos y Acuíferos, XXV Aniversario del Depto. de Biotecnología y Bioingeniería, CIESTAV-IPN. México, D.F., November 7, 1997.

Till B.A., L.J. Weathers, and P.J.J. Alvarez, “Treatment of nitrate contaminated waters using autotrophic denitrifiers and Fe°”, Proc. WEF 70th Annual Meeting. North Chicago, IL, October 18-22, 1997.

Aitchintson, E.W., Kelley, S.L., Schnoor, J.L., and Alvarez, P.J.J., "Phytoremediation of 1,4-Dioxane", Proc. WEF 70th Annual Meeting. North Chicago, IL, October 18-22, 1997.

Gülensoy N. and Alvarez, P.J.J., Substrate specificity of aromatic hydrocarbon degraders. Proc. 12th HSRC Conference on the Hazardous Waste Remediation, Kansas City, KS, May 20-22, 1997.

Gottbrath R. and Alvarez, P.J.J., Toluene degradation activity and longevity of resting PpF1 cells grown under aerobic and hypoxic conditions. Proc. 12th HSRC Conference on the Hazardous Waste Remediation, Kansas City, KS, May 20-22, 1997.

Alvarez, P.J.J. "Fitoremediación", Proc. II Conferencia Latinoamericana Sobre Riesgo Ambiental, Asociación Venezolana de Ingeniería Sanitaria y Ambiental, Valencia, Venezuela, May 14-15, 1997.

Alvarez, P.J.J. "Bioremediación basada en hierro cero-valente", Proc. II Conferencia Latinoamericana Sobre Riesgo Ambiental, Asociación Venezolana de Ingeniería Sanitaria y Ambiental, Valencia, Venezuela, May 14-15, 1997.

Alvarez, P.J.J. "Bioremediación de acuíferos contaminados por gasolina con etanol", Proc. II Conferencia Latinoamericana Sobre Riesgo Ambiental, Asociación Venezolana de Ingeniería Sanitaria y Ambiental, Valencia, Venezuela, May 14-15, 1997.

Hunt, C.S, Cronkhite L.A, R., Corseuil, H.X. and Alvarez, P.J.J., "Effect of ethanol on anaerobic toluene degradation in aquifer microcosms", 213th American Chemical Society National Meeting. San Francisco, CA, April 13-17, 1997.

Schnoor, J.L., Aitchintson, E.W., Kelley, S.L., Alvarez, P.J.J., Wakefield, S., Burken, J.G., and Just. C.L., "Phytoremediation of 1,4-dioxane by hybrid poplars ", 213th American Chemical Society National Meeting. San Francisco, CA, April 13-17, 1997.

Hunt, C.S, dos Santos Ferreira, R., Corseuil, H.X. and Alvarez*, P.J.J., “Effect of ethanol on aerobic BTX degradation”; In Situ and On-Site Bioremediation: The Fourth International Symposium, New Orleans, LA, April 28-May 1, 1997.

Till B.A., L.J. Weathers, and P.J.J. Alvarez, “Fe^0-based bioremediation of nitrate contaminated waters”, In Situ and On-Site Bioremediation: The Fourth International Symposium, New Orleans, LA, April 28-May 1, 1997.

Corseuil, H.X. and P.J.J. Alvarez* (1996). Natural bioremediation perspective for BTX contaminated groundwater in Brazil. Proc. IAWQ 18th Biennial International Conference. Singapore, June 23-28, 1996; (4) 9-16.

Alvarez*, P.J.J., “Microorganisms in activated sludge and biofilm processes”, In: P.L. Bishop (ed.)., Research Developments at Water Quality International ‘96, 18th Bienneial IAWQ International Conference. Submitted to the National Science Foundation. pp. 105-117.

Alvarez*, P.J.J., Discussion of "Caution against the inappropriate use of analytical fate and transport models to estimate the age and risk of petroleum product releases", Ground Water Monitoring and Remediation, (1996) Fall,185

Burken J., A. Dietz, J. Jordahl, W. Schnabel, P. Thompson, L. Licht, P. Alvarez, and J. Schnoor* (1996). Phytoremediation at hazardous waste sites. Proc. WEF 69th Annual Meeting. Dallas, TX, October 5-9, 1996.

Hunt C.S., N.A. Lynch, and P.J.J. Alvarez* (1996). Induction of toluene dioxygenase of *Pseudomonas putida* F1 by various compounds. Abst. 95th Annu. Meet. Am. Soc. Microbiol., New Orleans, LA, May 19-23, 1996.

Vermace M.E., N.A. Lynch, G.F. Parkin, and P.J.J. Alvarez* (1996). Effects of dissolved oxygen concentration on the expression and activity of toluene dioxygenase in *Pseudomonas putida*

F1. Abst. 95th Annu. Meet. Am. Soc. Microbiol., New Orleans, LA, May 19-23, 1996.

Lynch* N.A., P. Svebakken, M.E. Vermace, W. Wilke, C.S. Hunt, P.J.J Alvarez, and D.T. Gibson (1996). An immunoassay for detection and quantification of microbial gene expression in environmental samples ", Abst. 30th North-Central GSA Sectional Meeting, Research Symposium on Geomicrobiology, Ames, IA, May 2-3, 1996.

Vermace M.E., R.F. Christensen , G.F. Parkin, and P.J.J Alvarez*, " Cyclic aerobic and denitrifying conditions to enhance BTX bioremediation", Abst. 30th North-Central GSA Sectional Meeting, Research Symposium on Geomicrobiology, Ames, IA, May 2-3, 1996.

Till B.A., L.J. Weathers, and P.J.J. Alvarez*, "Biological and chemical nitrate removal using autotrophic denitrifiers and zero-valent iron" Proc. HSRC/WERC Joint Conference on the Environment, Albuquerque, NM, May 21-23, 1996.

Foster L., M.E. Vermace, and P.J.J. Alvarez*, "Effect of poplar rhizosphere on microbial populations that degrade priority pollutants" Proc. HSRC/WERC Joint Conference on the Environment, Albuquerque, NM, May 21-23, 1996.

Schnabel W., A. Dietz, J. Burken, Schnoor, and P.J.J. Alvarez*, "TCE uptake by common garden vegetables", Proc. HSRC/WERC Joint Conference on the Environment, Albuquerque, NM, May 21-23, 1996.

Helland, B.R., Alvarez*, P.J.J., and Schnoor, J.L., Dechlorination of CCl_4 with iron: carbon mass balance and effect of oxygen on dechlorination pathways. Proc. HSRC/WERC Joint Conference on the Environment, Albuquerque, NM, May 21-23, 1996.

Cronkhite, L., and Alvarez*, P.J.J., "Enhancement of BTX degradation by the addition of benzoate", 5th Biocatalysis and Bioprocessing Conference. Iowa City, IA, May 13-14, 1996.

Foster, L., Vemace, M.E., and Alvarez*, P.J.J., "Effect of poplar rhizosphere on microbial degradation of priority pollutants", 5th Biocatalysis and Bioprocessing Conference. Iowa City, IA, May 13-14, 1996.

Helland B.R., Alvarez*, P.J.J., and Schnoor, J.L., "Effect of dissolved oxygen on dechlorination pathways of carbon tetrachloride", 5th Biocatalysis and Bioprocessing Conference. Iowa City, IA, May 13-14, 1996.

Schnabel W.E., A.C. Dietz, J.G Burken, J.L Schnoor, and P.J.J. Alvarez* "Uptake of TCE by edible garden vegetables", 5th Biocatalysis and Bioprocessing Conference. Iowa City, IA, May 13-14, 1996.

Till, B.A., Weathers, L.J., and Alvarez*, P.J.J., "Biological and chemical nitrate removal in flow through columns packed with steel wool", 5th Biocatalysis and Bioprocessing Conference. Iowa City, IA, May 13-14, 1996.

Vermace, M.E., Lynch, N.A., Parkin, G.F., and Alvarez*, P.J.J., "Effect of dissolved oxygen concentration on the expression and activity of toluene dioxygenase in *Pseudomonas putida* F1", 5th Biocatalysis and Bioprocessing Conference. Iowa City, IA, May 13-14, 1996.

Alvarez* P.J.J., T.M. Vogel, M.E. Vermace, Gene F. Parkin, R.F. Christensen, K.H. Rotert, and L.A. Cronkhite (1996). BTEX biodegradation by aquifer microorganisms under aerobic and denitrifying conditions. Proc. III Simposio Internacional Sobre Control de Pollución de Aguas por Procesos Biológicos, AVISA, Valencia, Venezuela, February 6-9, 1996.

Alvarez* P.J.J., B.R. Helland, and J.L. Schnoor (1996). Reductive treatment of carbon tetrachloride with zero-valent iron. Proc. III Simposio Internacional Sobre Control de Pollución de Aguas por Procesos Biológicos, AVISA, Valencia, Venezuela, February 6-9, 1996.

Christensen R.F. and P.J.J. Alvarez* (1995). Selection of BTX degraders by stimulation of denitrification. Abst. 94th Annu. Meet. Am. Soc. Microbiol., Washington, DC, May 21-25, 1995.

Vermace M.E., G.F. Parkin, and P.J.J. Alvarez* (1995). Isolation and identification of denitrifiers that degrade alkylbenzenes. Abst. 94th Annu. Meet. Am. Soc. Microbiol., Washington, D.C., May 21-25, 1995.

Weathers L.J., G.F. Parkin*, Novak P.J., and P.J.J. Alvarez (1995). Chloroform comebabolism by a methanogenic consortium utilizing elemental iron as ultimate electron donor. Abst. 94th Annu. Meet. Am. Soc. Microbiol., Washington, D.C., May 21-25, 1995.

Alvarez* P.J.J. (1995). Fundamentos de la microbiología ambiental. Proc. I Conferencia Latinoamericana Sobre Riesgo Ambiental' Asociación Venezolana de Ingenieros Sanitarios y Ambientales, Valencia, Venezuela, May 10-12, 1995.

Alvarez* P.J.J. (1995). Contaminación de acuíferos. Proc. I Conferencia Latinoamericana Sobre Riesgo Ambiental, Asociación Venezolana de Ingenieros Sanitarios y Ambientales, Valencia, Venezuela, May 10-12, 1995.

Alvarez* P.J.J. (1995). Biorremediación de acuíferos. Proc. I Conferencia Latinoamericana Sobre Riesgo Ambiental, Asociación Venezolana de Ingenieros Sanitarios y Ambientales, Valencia, Venezuela, May 10-12, 1995.

Christensen R.F. and P.J.J. Alvarez* (1995). Denitrifying conditions provide a competitive advantage for indigenous microorganisms that degrade BTX. 4th Biocatalysis and Bioprocessing Conference. Iowa City, IA, May 15-16, 1995.

Hunt C.S., N.A. Lynch, and P.J.J. Alvarez* (1995). Enhanced degradation of trace levels of benzene. 4th Biocatalysis and Bioprocessing Conference. Iowa City, IA, May 15-16, 1995.

Rotert K.H., L.A. Cronkhite, and P.J.J. Alvarez* (1995). The use of benzoate to stimulate BTX degradation by indigenous aquifer microorganisms. 4th Biocatalysis and Bioprocessing Conference. Iowa City, IA, May 15-16, 1995.

Vermace M.E., P.J.J. Alvarez*, and G.F. Parkin (1995). *o*-Xylene degradation under denitrifying conditions. 4th Biocatalysis and Bioprocessing Conference. Iowa City, IA, May 15-16, 1995.

Helland R.H., P.J.J. Alvarez*, and J.L. Schnoor (1995). Oxygen control product formation in CCl_4 dechlorination using zero-valent iron. 209th American Chemical Society National Meeting. Anaheim, CA, April 2-7, 1995. Preprints of papers, pp 732-734.

Weathers LJ, GF Parkin*, PJ Novak, and PJJ Alvarez (1995). Methanogens couple anaerobic Fe^0 oxidation and $CHCl_3$ reduction. 209^{th} ACS National Mtng. Anaheim, CA, April 2-7, 1995.

Alvarez*, P.J.J. and T.M. Vogel (1994). Degradation of monoaromatic hydrocarbons and oxygenic metabolites by indigenous microorganisms under denitrifying conditions. Proc. IAWQ Conference on Biological Degradation of Organic Chemical Pollutants in Biofilm Systems. Copenhagen, Denmark, 19-21 May, 1994.

Alvarez*, P.J.J. and T.M. Vogel (1994). Degradation of BTEX and their aerobic metabolites by indigenous microorganisms under denitrifying conditions. Q-339 Abst. 93rd Annu. Meet. Am. Soc. Microbiol., Las Vegas, NV, May 23-27, 1994.

Alvarez*, P.J.J. (1994). Is fingerprinting unequivocally diagnostic of source in cases of fuel released to soil and groundwater? Iowa Groundwater Association Quarterly, 5(3):12.

Helland B.H., P.J.J. Alvarez*, and J.L. Schnoor (1994). Reductive dechlorination of carbon tetrachloride in water using elemental iron. Proc. 9th Annual Conference on Hazardous Waste Remediation. Center for Biofilm Engineering, Montana State University, Bozeman, Montana, June 8-10, 1994.

Helland R.H., P.J.J. Alvarez*, and J.L. Schnoor (1994). Sequential reductive dechlorination of carbon tetrachloride: Potential synergistic effect of microorganisms and zero-valent iron. Proc. 3rd Biocatalysis and Bioprocessing Conference. Iowa City, IA, May 9-10, 1994.

Hunt, C.S. and P.J.J. Alvarez* (1994). Kinetics of benzene degradation as a secondary substrate. Proc. 3rd Biocatalysis and Bioprocessing Conference. Iowa City, IA, May 9-10, 1994.

Rotert, K.H. and P.J.J. Alvarez* (1994). Stimulation of BTEX degradation by the addition of environmentally acceptable structural analogues. Proc. 3rd Biocatalysis and Bioprocessing Conference. Iowa City, IA, May 9-10, 1994.

Vermace M.E., L.A. Cronkhite, P.J.J. Alvarez*, and G.F. Parkin (1994). Isolation, identification, and characterization of a microorganism capable of growth on *o*-xylene. Proc. 3rd Biocatalysis and Bioprocessing Conference. Iowa City, IA, May 9-10, 1994.

Alvarez*, P.J.J. and T.M. Vogel (1992). The role of nitrate as adjunct electron acceptor to O_2 during BTX degradation by indigenous aquifer microorganisms. Gordon Research Conference on Redox Processes in Environmental Science. New Hampton, NH, June 15-18, 1992.

Alvarez, P.J.J. and T.M. Vogel* (1992). Biodegradation of aromatic and aliphatic compounds by indigenous aquifer microorganisms under denitrifying conditions. Proc. American Institute of Chemical Engineers, Summer 1992 Meeting. Minneapolis, MN, August 5-8, 1992.

Alvarez*, P.J.J. (1992). Implicaciones políticas y socioeconómicas del deterioro ambiental en Nicaragua. La Prensa, December 28, 1992.

Alvarez*, P.J.J. (1992). Ph.D. Dissertation. Biodegradation of Monoaromatic Hydrocarbons by Indigenous Aquifer Microorganisms Under Aerobic and Denitrifying Conditions. The University of Michigan, Ann Arbor.

Alvarez, P.J.J. and T.M. Vogel* (1991). Substrate interactions of benzene, toluene and *para*-xylene during microbial degradation by pure cultures and mixed culture aquifer slurries. Q-170 Abst. 91st Annu. Meet. Am. Soc. Microbiol., Dallas, TX, May 5-9, 1991.

Alvarez, P.J.J., P. J. Anid, and T. M. Vogel* (1991). Kinetics of aerobic biodegradation of benzene and toluene in sandy aquifer material. Proc. Five-Centers On-Site Bioremediation Conference. Kellog Biological Station, Battle Creek, MI. May 19-22, 1991.

E. Conferences and Sessions Chaired

2011 8th Leading Edge Conference on Water and Wastewater Technologies, International Water Association (IWA) – Program committee chair. Amsterdam, 6/11
2011 Applications of Nanotechnology in the Water. IWA Specialist group on Nano and Water Sector, Session chair and program committee. Monte Verita, Switzerland, 5/11.
2010 7th Leading Edge Conference on Water and Wastewater Technologies, International Water Association (IWA) – Program committee chair. Phoenix, 6/10
2009 6th Leading Edge Conference on Water and Wastewater Technologies, International Water Association (IWA) – Conference co-chair. Singapore, 6/09.
2009 2nd International Conference on Pollution Control and Resource Reuse – Session chair. Nanjing, China, 4/09.
2009 International Workshop on Priorities to Advance the Eco-Responsible Design and Disposal of Engineered Nanomaterials – Conference chair. Houston, 3/09.
2008 IWA Chemical Industries 2008- Program committee. Beijing, 11/08
2008 5th Leading Edge Conference on Water and Wastewater Technologies, International Water Association (IWA) –Program committee, session and workshop chair. Zurich, 6/08.
2007 4th Leading Edge Conference on Water and Wastewater Technologies, International Water Association (IWA) –Program committee, session and workshop chair. Singapore, 7/07.
2007 Nanotechnology-Enabled Water Treatment (NEWT) Workshop. Co-chair. Houston, 2/07.
2006 22nd Annual International Conference on Soils, Sediments and Water- Oxygenates Session. Amherst, MA 10/06
2006 The Fifth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Reductive treatment with nZVI Session, Monterey**,** CA, 5/06.
2005 3rd European Bioremediation Conference – Chania, Greece, CA, 7/05.
2005 Battelle 8th International Symposium on In Situ and Onsite Bioremediation– Biobarriers, Baltimore, MD, 6/05.
2005 3rd Leading Edge Conference on Water and Wastewater Technologies, International Water Association (IWA) –Program committee, session and workshop chair. Sapporo, Japan 7/05
2004 CONCARIBE 2004 Environmental Engineering and Science Conference –, General Secretary, Cartagena, Colombia, 5/04.

2004 The Tenth International Symposium on Microbial Ecology (ISME-10)- International Convener, Bioremediation Session, Cancun, Mexico, 8/04.
2003 2nd European Bioremediation Conference – Chania, Greece, CA, 6/03.
2003 Battelle 7th International Symposium on In Situ and Onsite Bioremediation– Biobarriers, Orlando, FL, 6/03.
2002 12th International Biodeterioration and Biodegradation Symposium –Biodegradation of persistent compounds session, Prague, Czech Republic, 7/02.
2001 First European Bioremediation Conference– Petroleum hydrocarbons bioremediation session, Chania, Greece, CA, 7/01.
2001 Battelle 6th International Symposium on In Situ and Onsite Bioremediation– Session D-10: Interactions between Microorganisms and Fe(0) in PRBs, San Diego, CA, 5/01.
2000 NGWA/API Petroleum Hydrocarbons Conference – Session II: Gasoline Oxygenates: Ethanol, Anaheim, CA, 11/00.
1998 ASCE Specialty Conference, Technical Session on Reductive Treatment of Hazardous Wastes with Zero-Valent Iron, Chicago, IL, 6/98.
1997 27th IAHR Congress, Technical Session on Groundwater Remediation and Risk Management, San Francisco, CA 8/97.
1997 NSF-CMS Workshop, Group Mentor, for Junior Faculty from Underrepresented Groups, Washington, D.C., 9/97.
1996 North-Central GSA Sectional Meeting, Research Symposium on Geomicrobiology, Ames, IA, 5/96.

F. Environmental Impact Studies

Preliminary Environmental Review and Development of Environmental Evaluation Guidelines for Prince Rupert Bay, Dominica. Prepared for the Department of Regional Development and Environment, Organization of American States. Washington, D.C. May, 1991.

Environmental Impact Statement: Peacekeeper Rail Garrison Program.
Prepared for United States Air Force, Norton AFB, California. June, 1988.

Environmental Planning Technical Report for Water Resources. Small Intercontinental Ballistic Missile Program. Malmstrom Air Force Base, Montana. Prepared for United States Air Force, Norton AFB, California. December, 1987.

G. Patents

Alvarez P.J.J., B.A. Till, L.J. Weathers, G.F. Parkin, and J.L. Schnoor, "Iron-based bioremediation of aquifers contaminated with mixed wastes". **US 6,719,902 B1**, April 13, 2004.

Alvarez P.J.J., K. Zodrow, A. Zhang, S. Mahendra. D. Li and Q. Li. "Silver-Impregnated Polysulfone Ultrafiltration Membranes for Virus Removal" (Pending).

Alvarez P.J.J., J. Lee, L. Wilson, and Y. Mackeyev. "Immobilized Photocatalytic Fullerenes for Water and Wastewater Treatment and Disinfection" **US patent application 13/380606** (Pending).

INVITED LECTURES

Date	Location	Host Organization	Title/Description
12/12	Maiseru, Swaziland	UN Food and Agriculture Organization	Nanotechnology for point of use water treatment
12/12	Washington, D.C.	NSF	Nanomaterials bioavailability and environmental effects
11/12	Phoenix, AZ	Arizona State University	Natural attenuation forensic assessment

11/12	Seoul, South Korea	KAIST	Nanotechnology for biofouling control
11/12	Seoul, South Korea	KIST	Convergence of microbiology and nanotechnology
11/12	Newport Beach, CA	National Water Research Institute	Clarke Prize Lecture
10/12	Florianopolis, Brazil	Universidade Federal de Santa Catarina (Chemistry)	Nanotechnology and water
10/12	Norman, OK	University of Oklahoma	Environmental applications & implications of nanotechnology
9/12	Pretoria, South Africa	Water Research Commission	Nanotechnology-enabled water treatment and reuse
8/12	Managua, Nicaragua	Nicaraguan Academy of Sciences	Ciencia y agua: instrumentos del desarrollo sostenible
7/12	Auckland, New Zealand	University of Auckland	Environmental applications & implications of nanotechnology
5/12	Florianopolis, Brazil	Universidade Federal de Santa Catarina (CEE)	Nano-ecotoxicology
5/12	Maiseru, Swaziland	UN Food and Agriculture Organization	Photocatalysis for safer peri-urban irrigation
4/12	Bologna, Italy	University of Bologna	Potential environmental impacts of nanotechnology
4/12	Dubbendorf, Switzerland	EAWAG	Environmental fate and impacts of nanomaterials
4/12	Houston, TX	BP	Emerging opportunities in bio and nanotechnology
2/12	IN	University of Notre Dame	Environmental applications & implications of nanotechnology
1/12	Merida, Mexico	Universidad de Merida	Quantum dots-microbial interactions
1/12	Beijing, China	China University of Geosiences	Nanomaterial interactions with the environment
12/11	Lyon, France	U de Lyon	Environmental implications & applications of nanotechnology
11/11	Washington DC	AAAS and Georgetown U	Nanotechnology in its teen years
11/11	Tianjin, China	Tianjin University (keynote)	Anaerobic bioremediation of hydrocarbon spills
9/11	Rehoboth Beach, DE	EPA Region 3	Microcospic, macroscopic and thermodynamic implications of fuel ethanol releases
9/11	London, England	The Royal Society	Quantum dots impacts on Nitrogen cycling
7/11	Chania, Greece	TUC	Biomarkers to assess bioremediation performance
6/11	Montreal, Canada	ACS Colloids symposium	Antibacterial mechanisms of silver nanoparticles
6/11	Denver, CO	Water research Foundations	Nanotechnology and water quality
6/11	Amsterdam	IWA	Welcome address for Leading Edge technologies conference
5/11	New Hampshire	Gordon conference	Research priorities in environmental nanotechnology
5/11	Monte Verita, Switzerland	ETH/EAWAG	Nanotechnology in the water sector; opportunities &concerns
4/11	Boston, MA	Harvard University	Environmental implications and applications of nanotechnology

4/11	New York, NY	Columbia University	Environmental implications and applications of nanotechnology
4/11	Mexico City	Tecnologico de Monterrey	Nano-enabled water treatment for developing countries
3/11	Atlanta, GA	Georgia Tech	Nanotechnology for sustainable water management
3/11	Boston, MA	Northeastern University	Environmental nanotoxicology
3/11	Abu Dhabi	Masdar Institute of Science & Technology	Bioremediation: principles and Applications
3/11	Washington DC	NNI US-EU Workshop: Bridging nanoEHS Research	Environmental data needs
2/11	Nanjing, China	Nanjing University	Emerging opportunities for nanotechnology in water
2/11	Managua, Nicaragua	St. Agustin Academy (graduation speech)	Global warming and global whining
11/10	Rome, Italy	FAO	Nano-enabled water treatment for developing countries
11/10	Veracruz, Mexico	PEMEX	Bioremediation of petroleum hydrocarbons
10/10	Washington D.C.	National Academy of Sciences	Fate and transport of engineered nanoparticles
10/10	Jalandhar, India	Kanya Maka Vidyalaya	Environmental challenges: a global concern
10/10	Bilbao, Spain	Labein Tecnalia	Ecotoxicology of engineered nanomaterials
9/10	Montreal, Canada	IWA	Nanotechnology applications in the water treatment sector
9/10	Montreal, Canada	McGill University	Environmental applications and implications of nanotechnology
9/10	Washington DC	NSF	Diversity, integrity and honor (National Hispanic Keynote).
9/10	Stockholm. Sweden	World Water Week	Emerging opportunities and challenges for GW remediation
7/10	Nazareth, Israel	Haiffa University	Photocatalytic disinfection with aminofullerene nanoparticles
6/10	San Carlos, Brazil	FAO, UN	Nano-enabled water treatment: opportunities and challenges
6/10	Johannesburg, South Africa	Mintek Advanced Materials Division	Nano-enabled functionalized water treatment membranes
5/10	Taipei, Taiwan	7th Conf. on Environmental Protection & Nanotechnology	Environmental applications and implications of nanotechnology
5/10	Taipei, Taiwan	National Taiwan University	Phytoremediation: principles and applications
5/10	Tainan,Taiwan	National Cheng Kung University	Bioremediation of hydrocarbon releases
5/'10	Los Angeles, CA	UCLA	Risks of nanomaterials in the environment
5/10	Providence, RI	Brown University	Antimicrobial nanoparticles: implications & applications
4/10	Cairo, Egypt	Ministry of Agriculture	Nanotechnology for sustainable water management
3/10	Panama	Universidad Tecnológica de Panamá	Manejo sostenible de recursos hidricos
3/10	Chicago, IL	National Nanotechnology Initiative	Research priorities in Environmental nanotechnology
3/10	Kunming, China	KUST	Environmental nanotechnology

1/10	Tucson, AZ	University of Arizona	Antimicrobial nanoparticles: implications & applications
9/09	Helsinki, Finland	US National Academies	Environmental nanotechnology
9/09	Copenhagen, DK	Danmarks Naturfredningsforening	Sustainable water under climate change
9/09	Vienna, Austria	Austrian Academy of Sciences and U Vienna	Antimicrobial nanoparticles: implications & applications
8/09	San Antonio, TX	NEMC and EPA	Risks of nanomaterials in the environment
6/09	Aix, France	CEREGE	Environmental nanotechnology
6/09	Singapore	IWA	Antimicrobial nanoparticles: implications & applications
6/09	Prague, CZ	NICOM	Nanomaterials in Construction
5/09	Tunja, Colombia	Universidad de Santo Tomas	Nanotecnologia para manejo sostenible del agua
4/09	Baltimore, MD	Johns Hopkins University	Environmental applications of nanotechnology
4/09	Lansing. MI	Michigan State University	Environmental applications and implications of nanotechnology
3/09	Tianjin, China	Nankai University	Bioremediation: principles and applications
3/09	Nanjing, China	Keynote on Pollution Control and Resource Reuse Conf.	Nano-toxicology
2/09	Mumbai, India	IIT Mumbai	Environmental nanotechnology
2/09	Mangalore, India	NITK (Subba Rau Lecture in Chemical Engineering)	Bioremediation principles and applications
11/08	Baltimore, MD	Johns Hopkins University	Environmental applications and implications of nanotechnology
10/08	New Haven, CT	Yale University, John Henske Distinguished Lecture	Environmental applications and implications of nanotechnology
9/08	Chania, Crete	European Bioremediation Conference (keynote)	Microbial interactions with nanomaterials
8/08	Sidney, Australia	SETAC	Ecotoxicology of nanomaterials
4/08	Iowa City, IA	U Iowa (Caterpillar lecture)	Environmental applications and implications of fullerenes
4/08	Los Angeles, CA	UCLA	Ecotoxicology of nanomaterials
4/08	Amherst, MA	UMass	Environmental nanotechnology
3/08	Beijing, China	Tsinghua University	Environmental nanotechnology
3/08	Hong Kong	Hong Kong University	Sustainable water management
3/08	Monte Verita, Switzerland	EMPA/ETH	Microbial interactions with nanoparticles
12/07	Washington, DC	NSF	Environmental applications and implications of fullerenes
12/07	San Antonio, TX	Texas Water Board	Sustainable water resources management
11/07	South Bend, IN	University of Notre Dame	Environmental applications and implications of nanotechnology
11/07	Rimini, Italy	Ecomondo	Iron-based bioremediation of oxidized pollutants

10/07	Sapporo, Japan	Hokkaido University	Environmental applications of nanomaterials
10/07	Seoul, South Korea	Seoul National University and Gwangju University	Antibacterial mechanisms of fullerenes
10/07	Sao Paulo, Brazil	Acquacon	The water footprint of fuel ethanol
9/07	Riverside, California	UCR	Environmental impacts of fuel alcohols
9/07	Cambridge, England	Cambridge University	Medical bioremediation: targeting 7-ketocholesterol
8/07	Zurich, Switzerland	EAWAG	Environmental applications and implications of nanotechnology
7/07	Bogota, Colombia	Universidad de Los Andes	Decentralized water treatment systems
6/07	Durham, NC	Duke University	Environmental impacts of fuel alcohols
6/07	Singapore	IWA	Environmental applications and implications of nanotechnology
5/07	Seattle, WA	University of Washington	Fuel ethanol and groundwater pollution
4/07	Tempe, AZ	Arizona State University	Nanotechnology and the environment
3/07	San Diego, CA	AEHS	Bacterial-fullerene interactions
2/07	Durham, NC	Duke University	Environmental impacts of fuel alcohols
1/07	Ann Arbor, MI	University of Michigan	Ethanol in fuel: groundwater quality implications
12/06	Managua, Nicaragua	Universidad Centroamericana (UCA)	Nanotecnologia ambiental
11/06	Washington, D.C.	EPA/ORD	Fullerene-bacterial interactions
11/06	Copenhagen, Denmark	Technical University of Denmark	Environmental nanotechnology
10/06	Amherst, MA	U Mass	Microbial impacts of fuel ethanol
9/06	Houston, TX	Baker Institute, Rice	Groundwater impacts of ethanol
9/06	EL Paso, TX	UTEP	Environmental nanotechnology
8/6	Bogotá, Colombia	Universidad de Los Andes	Principles and applications of bioremediation
7/06	Tianjin, China	Nankai University	Fullerene micro-ecotoxicology
6/06	Mexico City	UAM	Nanotechnology and environmental engineering
6/06	New Hampshire	Gordon Conference	Biodegradation of organic compounds
5/06	Medellin, Colombia	Universidad Nacional de Colombia	Fitorremediacion
4/06	Ann Arbor, MI	University of Michigan	Fullerene ecotoxicology
3/06	Valencia, Venezuela	Universidad de Carabobo	Environmental implications and applications of nanotechnology
2/06	Tempe, AZ	Arizona State University	Environmental nanotechnology
11/05	Pachuca, Mexico	Universidad Politecnica de Pachuca	Bioremediation and natural attenuation

10/05	Washington, D.C.	EPA	Nanomaterial-bacterial interactions
9/05	Managua, Nicaragua	MARENA	Cleanup of gasoline contaminated aquifers
9/05	Washington, DC	ESTCP	Bioaugmented iron barriers to treat RDX contaminated aquifers
6/05	Sapporo, Japan	IWA	Emerging pollutants and treatment approaches
5/05	Toulouse, France	Université Paul Sabatier/ Laboratoire de Genie Chimique	Iron-based bioremediation of oxidized groundwater pollutants
5/05	Aix-En-Provence	Centre Européen de Recherche et d'Enseignement des Géosciences de l'Environnement (CEREGE)	Emerging hazards and water treatment needs
3/05	Urbana-Champaign, IL	University of Illinois	Bioremediation: startups and upstarts
2/05	Zurich, Switzerland	EAWAG	Microbial interactions with nanomaterials
1/05	El Paso, TX	UTEP	Natural attenuation of BTEX-ethanol mixtures
11/04	Sao Paulo, Brazil	Instituto Ekos (keynote)	Phytoremediation: principles and applications
11/04	College Station, TX	Texas A&M	Effects of ethanol on BTEX natural attenuation
9/04	Tianjin, China	Nankai University (keynote)	Global changes and industrial ecology
9/04	Venice, Italy	INCA (keynote)	Sustainable chemistry
8/28	Cancun. Mexico	Asociación Mexicana de Microbiología	Biorremediacion de BTEX" principios y aplicaciones
8/04	Cancun. Mexico	ISME	Fate and transport of BTEX-ethanol mixtures
7/04	Irvine, CA	CDM Inc	Effects of ethanol on BTEX natural attenuation: microscopic and macroscopic implications
7/04	Bethesda, MD	NIA	History and epistemology of bioremediation
7/04	Nuevo Vallarta, MX	Mayan Resorts	Civil and environmental engineering at Rice
6/04	Prague, Czech Republic	IWA	Attenuation and amplification of TC resistance genes in soil
5/04	Monterrey California	Battelle	Sustainable RDX degradation in bioagumented iron columns
5/04	Cartagena, Colombia	CONCARIBE	Leapfrogging technologies for Caribbean environmental problems
2/04	Berkeley, CA	UC Berkeley	Groundwater impacts of ethanol
1/04	Washington, DC	NSF, EPA and DOD Interagency meeting	Phytoremediation and Rhizoremediation
11/03	Sao Paulo, Brazil	Instituto Eccos (keynote)	Monitored natural Attenuation
11/03	Mexico City	IMP, keynote	Bioremediation
10/03	Managua, Nicaragua	AIDIS, keynote	Bioremediation

8/03	Costa Mesa, CA	NGWA	Oxygenates workshop
8/03	Kansas City, KS	EPA	Effect of ethanol on BTEX natural attenuation
6/03	Chania, Greece	EU, keynote	Effect of ethanol on BTEX natural attenuation
4/03	West Lafayette	Purdue University	Environmental Impacts of Biofuels
4/03	Gainesville, FLA	University of Florida	Effect of ethanol on BTEX natural attenuation
4/03	Buenos Aires, Argentina	Universidad de Buenos Aires	Sustainable development and industrial ecology
3/03	Cartagena, Colombia	ANEIC, keynote	Phytoremediation principles and applications
2/03	Valencia, Venezuela	AVISA	Permeable reactive barriers for groundwater pollution
1/03	Ames, Iowa	ISU	Effect of ethanol on BTEX attenuation and plume length
12/02	Managua, Nicaragua	Universidad Catolica (UCA)	Bioremediation case studies
11/02	Davis, CA	University of California at Davis	Natural attenuation of gasohol releases
11/02	Valencia, Venezuela	Universidad de Carabobo - keynote	Sustainable Development and Industrial Ecology
9/02	Mexico City, Mexico	Universidad Autónoma de México	Bioremediation (Short Course)
7/02	Prague, Czech Republic	Institute of Chemical Technology	Iron-based bioremediation
5/02	Monterey, CA	Battelle	Biodegradation of ethanol
4/02	Monterrey, Mexico	Mexican Society for Microbiology - keynote	Principles and applications of BTEX bioremediation
3/02	Rio de Janerio, Brazil	Petrobras	Bioremediation an natural attenuation of gasohol spills
2/02	Pomona, CA	NWRI	Life cycle assessment of alternative fuel
12/01	Washington, DC	SERDP	RDX mineralization by Fe(0) and anaerobic sludge
11/01	Houston, TX	NGWA	Effect of ethanol on benzene plume length
10/01	Berlin, Germany	IWA	Effect of ethanol of BTEX degradation kinetics
10/01	Costa Mesa, CA	NWRI	Potential groundwater impacts of the use of methanol as fuel
7/01	Chania, Greece	Technical University of Crete	Fe(0)-based bioremediation of RDX contamination
7/01	Madrid, Spain	European Federation of Biotechnology	Novel trends in in situ bioremediation
5/01	Prague, Czech Republic	NATO Advance Studies Institute	Principles and applications of BTEX remediation
4/01	Seattle, WA	University of Seattle	Global Changes and Sustainable Development
4/01	Oakland, CA	Lawrence Livermore National Laboratory	The effect of ethanol on BTEX degradation kinetics
3/01	Houston, TX	University of Houston and Rice University	Natural attenuation of gasohol releases
3/01	Montreal, Canada	McGill University	Epistemology of bioremediation and natural attenuation

3/01	Guanajuato, Mexico	Mexican Society for Microbiology	Phytoremediation of contaminated soils
12/00	Madison, WI	University of Wisconsin	Biodegradation and bioremediation
11/00	Mexico, D.F.	UAM	Monitored natural attenuation workshop
11/00	Anaheim, CA	API/NGWA	Effects of ethanol versus MTBE on BTX natural attenuation.
10/00	West Lafayette, IN	Purdue University	Xenobiotic recalcitrance mechanisms
10/00	Irvine, CA	NAS/Ford Foundation	Challenges of an academic life in engineering
9/00	Iowa City, IA	ASCE	Merits and limitations of RBCA and natural attenuation
8/00	Managua, Nicaragua	INCAE (a Harvard Satellite)	Industrial ecology and sustainable development
7/00	Managua, Nicaragua	Universidad Centroamericana	Global changes and economic development
6/00	Paris, France	IWA	RDX degradation by an integrated microbial-Fe^0 system
5/00	Valencia, Venezuela	Carabobo Industrial Consortium	Global changes and industrial ecology
5/00	Columbus Ohio	Ohio State University	Bioremediation and natural attenuation
2/00	Cincinnati, OH	API/EPA	Effect of ethanol of natural attenuation of BTEX
11/99	Honolulu, HI	University of Hawaii	Bioremediation Perspectives
11/99	Chicago, IL	EPA	Fe(0)-Based Bioremediation
6/99	Zürich, Switzerland	ETH/ Biotechnology Institute	Intrinsic bioremediation and risk-based corrective action
12/98	Managua, Nicaragua	MARENA/IMPYME	Bioremediation and bioprospecting
11/98	Houston, TX	API/NGWA (keynote speaker)	BTEX degradation kinetics: model vs. field data
8/98	Managua, Nicaragua	PAMIC/INPYME	Green Technologies for sustainable development
7/98	Zürich, Switzerland	EAWAG	Substrate interactions for enhanced BTX biodegradation
5/98	Mexico, D.F.	Universidad Autónoma de México	Site assessment and remediation
3/98	Valencia, Venezuela	AVISA/ U. de Carabobo	Epistemology of environmental engineering
11/97	Caracas, Venezuela	AVISA/AIDIS	Xenobiotic biodegradation in natural systems
9/97	Washington, D.C.	NSF/CMS Workshop	BTPs for groundwater remediation
7/97	Mexico, D.F.	Universidad Autónoma de México	Hazardous waste remediation (Short Course)
6/97	Lincoln, Nebraska	University of Nebraska	Iron-Supported Denitrification
6/97	Florianopolis, Brazil	Universidade Federal de Sta. Catarina	Principles of bioremediation
5/97	Caracas, Venezuela	Ministry of the Environment	Fundamentals of environmental microbiology
5/97	Valencia, Venezuela	Assoc. Venezolana de Ing. Ambientales	Novel approaches to site remediation

4/97	New Orleans, LA	Battelle	Fe(0) based bioremediation of nitrate contaminated waters
4/97	San Francisco, CA	ACS	Effect of ethanol of anaerobic toluene biodegradation
8/96	Mexico, D.F.	Universidad Autónoma de México	Advances in hazardous waste site remediation
6/96	Singapore	IAWQ	Bioremediation perspective for Brazil
5/96	Florianópolis, Brazil	Universidade Federal de Sta. Catarina	Environmental chemodynamics (Short Course)
2/96	Valencia, Venezuela	AVISA (Keynote speaker)	Reductive treatment with Fe°
11/95	Hill AFB, UT	US Air Force and Montgomery Watson	TCE uptake by common garden vegetables
10/95	Iowa City, IA	Iowa Groundwater Association	Enhanced BTX degradation by benzoate
6/95	Florianópolis, Brazil	Universidade Federal de Sta. Catarina	Biotransformations of xenobiotics in soils
6/95	Florianópolis, Brazil	Universidade Federal de Sta. Catarina	Activated sludge design
5/95	Valencia, Venezuela	Assoc. Venezolana de Ing. Ambientales (Keynote spkr)	Contamination and remediation of aquifers
5/95	Valencia, Venezuela	Universidad de Carabobo	Fate and transport of xenobiotics in aquifers
4/95	Champagne, IL	University of Illinois	Nitrate-based bioremediation
12/94	Managua, Nicaragua	Universidad Nacional de Ingeniería	Chemical and microbial degradation of pollutants
12/94	Managua, Nicaragua	Fundación de Desarrollo	Socio-political implications of pollution
5/94	Copenhagen, DK	IAWQ Biofilm Conference	Degradation of BTX and their metabolites

ADVISORY BOARD & REVIEWER OF OTHER CEE PROGRAMS

- Rice University, 2003
- Carnegie Mellon University, 2007
- The University of Kansas, 2008
- The University of Nebraska, 2008
- Central Florida University, 2010
- Seoul National University World Class University program on Chemical Convergence for Energy and the Environment
- Princeton University

FUNDING AS PRINCIPAL INVESTIGATOR

SERDP. Developing and Field-Testing Genetic Catabolic Probes for Monitored Natural Attenuation of 1,4-Dioxane ($150,000). 9/1/2012-8/31-2013

Chevron. In-Situ Remediation of Heavy Hydrocarbons in Impacted Vadose Zone Soils ($5,000,000). 9/1/2012-8/31-2017. (PI; Paul Johnson, ASU).

Honeywell. “1,4-Dioxane Natural Attenuation Potential”. ($115,000) 8/01/12-7/31/13.

U.S. EPA. “Consortium for Manufactured Nanomaterial Bioavailability & Environmental Exposure” ($2,000,000) 1/1/10-1/1/13 (Co-PI’s Vicki Colvin, Steve Klaine and Sam Luoma).

National Science Foundation, “Center for Biological and Environmental Nanotechnology” ($12,110,746) 1/1/07-1/1/12 (PI Vicki Colvin, co-PI Jennifer West and John Hutchinson)

National Science Foundation, “Engineered Nanomaterials and Plant Interactions: Uptake, Biotransformations and Physiological Effects” ($600,000) 9/1/10-8/31/13 (co-PI’s Vicki Colvin, Janet Braam and Jerry Schnoor)

FAO, “Nanotechnology-Enabled Water Treatment for Improved Food Safety and Public Health in Swaziland” ($50,000) 12/12/11-11/30/12 (Co-PI Qilin Li).

National Science Foundation, “Workshop on Applications of Nanotechnology in the Water Sector: Emerging Opportunities and Challenges for Water Treatment and Reuse, Monte Verita, Switzerland” ($27,389) 5/18/11-5/21/11

Water Reuse Foundation, “Review of Nanomaterial Research and Relevance for Water Reuse” ($24,741) 05/01/11-04/01/12 (PI: Qilin Li)

National Science Foundation, “Developing Novel Surface Immobilized Photocatalysts Using Functionalized C_{60}” ($350,000) 8/01/09-8/31/12 (Co-PI: Jaesong Kim)

Korean Institute of Science and Technology, “Application of Nano-sized Photocatalysts for the removal of toxic substances from aqueous solutions“ ($100,000) 06/01/10-05/31/14.

USEPA. “Interactions of Natural Organic Matter with C60 Fullerene and their Impact on C60 Transport, Bioavailability and Toxicity” ($400,000), 12/01/08-08/30/11 (PI: Qilin Li)

U.S. EPA, “Quantum Dot Weathering and its Effects on Microbial Communities” ($400,000) 9/01/08-8/31/11 (Co-PI: Vicki Colvin)

U.S. EPA, “Interactions of Natural Organic Matter with C60 Fullerene and their Impact on C_{60} Transport, Bioavailability and Toxicity” ($400,000) 9/01/08-8/31/11 (PI: Qilin Li)

BP America, “1,4-Dioxane Biodegradation in the Arctic” ($125,000) 9/01/08-9/01/12

BP America, “Modeling the effect of fuel alcohol on BTEX plume dynamics” ($50,000) 9/01/08-9/01/10

National Science Foundation, “C_{60} Biotransformation and Bioaccumulation: Environmental Impact Implications” ($240,000) 8/01/08-8/31/10 (Co-PI: Vicki Colvin)

National Science Foundation, “Correlation between Biomarker Concentrations and Hydrocarbon Biodegradation Rates to Enhance the Selection and Performance Assessment of Bioremediation and Natural Attenuation” ($128,531) 9/01/07-8/31/09

Chevron, “The Water Footprint of Biofuels” ($100,000) 9/01/07-8/31/09 (Co-PI: Amy Jaffe).

API, “The Impact of E85 on BTEX and other Hydrocarbons in Ground Water” (300,000) 7/1/07-6/30/09, (Co-PI: Bill Rixey)

API, “The Impact of E95 and E10 on BTEX and other Hydrocarbons in Ground Water” (270,000) 7/1/05-6/30/07, (Co-PI: Bill Rixey)

U.S. EPA, “Collaborative effect of surface coatings on the environmental and microbial fate of nano-iron and Fe-oxide nanoparticles” ($75,000 subcontract to CMU) 9/01/07-8/31/10 (Co-PI Greg Lowry)

U.S. EPA, “Microbial Impacts of Engineered Nanoparticles” ($375,000) 9/1/05-8/31/08 (Co-PI Mark Wiesner)

National Science Foundation, “Civil and Environmental Engineering Program Update to the 21st Century” ($100,000) 9/01/05-8/31/06 (Co-PI Phil Bedient)

National Science Foundation, “Fullerene-Microbial Interactions: Implications for disinfection and risk assessment” ($150,000) 9/1/05-8/31/06 (Co-PI with Mark Wiesner and Jiasong Fang)

National Science Foundation, “NSF CAREER Award Proposal Writing Workshop” ($16,000) 6/15/05-12/31/05

EPA/GCHSRC, “Development of an RTQ-PCR protocol for the detection and quantification of anaerobic benzene degraders” (100,000) 9/04-8/06.

ESTCP, “Reductions in DNAPL longevity through biological flux enhancement” ($200,000) 6/1/2004-5/31/2006 (Co-PI Herb Ward).

National Science Foundation, “Workshop on U.S.-Latin American Caribbean environmental problems and sustainable solutions“ ($28,000) 5/15/04-12/31/04.

U.S. Army Corps of Engineers, CECER Lab “Evaluation of Rotating Biofilter Reactor at the Iowa Army Ammunitions Plant ($160,000) 05/01/03-12/31/04

National Science Foundation, “PAH biodegradation in the rhizosphere of tropical plants” ($100,000) 9/15/02-8/14/04.

ISWRRI, “Fate and transfer of antibiotic resistance genes” ($132,430), 5/02-4/04.

National Science Foundation, “Environmental Impacts of Ethanol in Gasoline: A Planning Trip to Brazil” ($12,915) 8/15/01-8/14/02.

American Petroleum Institute, “Effect of Ethanol on BTEX Plume Length” ($38,994) 8/01/01 - 7/31/02.

SERDP, “Fe(0)-Based Bioremediation of RDX Contaminated Groundwater” ($500,000) 8/01/01 - 12/31/03

EPA/OER, “Effect of the gasoline oxygenate ethanol on the migration and natural attenuation of BTEX” ($194,878) 1/1/00 -8/31/04.

SERDP, “Fe(0)-Based Bioremediation of RDX Contaminated Aquifers” ($99,997) 1/01/00 - 12/31/00.

American Petroleum Institute, “Effect of Ethanol on BTEX and MTBE Natural Attenuation” ($85,000) 7/01/99 - 6/30/01.

EPA/HSRC, “Iron-Enhanced Bioremediation of Aquifers Contaminated with Chlorinated Solvents, Heavy Metal, and Agrochemical Mixtures”, ($150,000), 10/01/99-5/31/01 01 (Co-PI with G.F. Parkin and M. Scherer).

Lawrence Livermore National Lab, “The Use of Ethanol as a Transportation Fuel Oxygenate” ($98,055), 8/1/99 - 6/30/01.

Iowa Comprehensive Petroleum Underground Storage Tank Fund Board "Tier 3 model evaluation of groundwater contaminant models" ($43,255 direct costs) 1/01/99 - 5/31/00.

U.S. Geological Survey.ISWRRI, “Treatment of Nitrate-Contaminated Groundwater with Fe(0) and Autotrophic Denitrifiers” ($180,086) 9/01/98-8/31/00.

Department of Energy, “Biogeochemical Interactions in Zero-Valent Iron Walls” ($491,985), 9/01/98 - 8/31/01 (Co-PI with G.F. Parkin and J.L. Schnoor)

National Science Foundation, "Research Training Grant: Gene expression in bioremediation" ($1,600,000)

9/01/96 - 8/31/00 (PI is E.P. Greenberg).

Iowa Comprehensive Petroleum Underground Storage Tank Fund Board "Evaluation of Tier-3 Groundwater Models" ($92,836direct costs) 1/1/99-12/31/01.

Iowa Comprehensive Petroleum Underground Storage Tank Fund Board "Evaluation of Tier-2 Groundwater Modeling Program" ($17,079 direct costs) 5/01/98 - 12/31/98.

Hoescht Celanese, Inc., "Phytoremediation of 1,4-dioxane and bioaugmentation of the poplar rhizosphere" ($88,317) 9/01/98 - 8/31/99 (Co-PI with Jerry L. Schnoor).

Hoescht Celanese, Inc., "Phytoremediation of sites contaminated with dioxane" ($93,000) 9/01/96 - 8/31/97 (Co-PI with Jerry L. Schnoor).

National Science Foundation, "Career Award" ($275,000) 7/01/95 - 6/30/99.

EPA/OER, "Biostimulation of BTX degradation with environmentally benign aromatic substrates" ($246,342) 10/1/95 - 9/30/98.

Center for Health Effects of Environmental Contamination, “Bioaugmentation of the poplar rhizosphere with GEMs " ($15,000) 2/1/97-8/31/97.

Center for Health Effects of Environmental Contamination, "Expression of toluene dioxygenase under various redox and substrate conditions" ($15,000) 1/01/95 - 12/31/95.

Center for Health Effects of Environmental Contamination, "Effect of poplar trees on microbial populations important to hazardous waste bioremediation" ($15,000) 1/01/95 - 12/31/95.

EPA/HSRC, "The role of elemental iron in biotransformations of halogenated xenobiotics" ($554,591) 5/1/95 - 4/30/98. (Co-PI with Gene F. Parkin and Jerry L. Schnoor).

Montgomery Watson, Inc. (funded by DoD), "TCE uptake by common garden vegetables" ($154,500) 9/01/94 - 8/31/95.

NIEHS Environmental Health Sciences Core Center at Iowa, "Enhanced degradation of trace levels of benzene" ($9,000) 7/01/94 - 3/31/95.

Center for Global and Regional Environmental Research, "Reductive dechlorination of chlorinated methanes with iron metal" ($15,000) 9/01/94 - 8/31/95.

Iowa State Water Resources Research Institute, "The effect of structural analogues on monoaromatic hydrocarbon biodegradation" ($59,020 plus $45,000 in equipment match-up from U. of Iowa) 7/01/93 - 6/30/96.

National Science Foundation, "The effect of sustained nitrate exposure on monoaromatic hydrocarbon biodegradation" ($11,952) 1/01/94 - 12/31/94.

Microbiotics Corp., "The use of Microtox as a screening tool to evaluate bioremediation techniques" (Equipment grant for $ 10,000) 7/1/94.