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Engineering & Scientific Consulting

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Professional Profile

Mr. Gary Bigham is a Principal in Exponent's Environmental and Earth Sciences practice who specializes in the evaluation of water quality and the transport, fate, and effects of contaminants in the environment. He has managed and been the principal investigator of field, laboratory, and theoretical assessments of a wide variety of contaminants in lakes, rivers, estuarine waters, ocean waters, groundwater, and air.

Mr. Bigham has been designated an expert in litigation involving the effects of phosphorus runoff and mercury bioaccumulation in the Florida Everglades. He has also served as a consulting expert on a major litigation involving impacts of phosphorus, nitrogen, and other compounds from confined animal feeding operations (CAFOs) in Oklahoma and Arkansas. He has completed numerous assessments of eutrophication and contaminant transport employing a variety of numerical water quality models. He has recently applied EPA's state-of-the-art Environmental Fluid Dynamics Model to 39 miles of the Lower Fox River, Wisconsin to simulate sediment transport and deposition of PCBs historically discharged from multiple paper mills.

Mr. Bigham's international experience includes leading the technical development of a natural resource damage claim for the Kingdom of Jordan to the United Nations Compensation Commission for damages arising from the first Gulf War. He evaluated potential human exposure to spilled oil and produced-water discharges in the Amazon basin of Ecuador and completed an assessment of potential human exposure to mercury vapor from a spill in the Peruvian highlands. He also applied water quality models to predict conditions in and downstream of a proposed reservoir in Bolivia and to assess water quality and greenhouse gas emissions for a proposed reservoir in Guyana. He evaluated the potential impacts of dredging and related modifications to a container port facility in Buenos Aires, Argentina. In Brazil, he evaluated water quality monitoring during construction of the Santo Antônio Dam Project on the Madera River for mercury-related impacts.

Academic Credentials & Professional Honors

M.S., Geophysical Science, Georgia Institute of Technology, 1972

B.S., Geology, Oregon State University, 1968

Prior Experience

Vice President, PTI Environmental Services, 1987-1997

Senior Scientist, Tetra Tech, Inc., 1974-1987

Environmental Scientist, U.S. Army Corps of Engineers, 1972-1974

Professional Affiliations

American Chemical Society

Geological Society of America

Publications

Bigham G, Masue-Slowey Y, Murray K, Henry E. Critical Review - Biogeochemical controls on methylmercury in soils and sediments: Implications for site management. Integrated Environmental Assessment and Management. V 13, No. 2, pp 249-263, 2017.

Bigham G, Liang, L, Balouet, JC, Chalot, M. Phytoscreening-based assessment of mercury in soil. Environ Sci Pollut Res. V 22, pp 19285-19291, 2015.

Bigham G. Mercury in tree rings as a tool for environmental forensics investigations. Abstracts, 12th International Conference on Mercury as a Global Pollutant, Jeju, Korea, June 15-19, 2015.

Berger C, Bigham G, Wells S. Prediction of GHG emissions from a new reservoir. ASCE EWRI World Environment & Water Resources Congress, 2014.

Morse T, Ponchaut N, Bigham G. Gas extractions from Lake Kivu, Rwanda: The dynamics of the degassed water plume. ASCE EWRI World Environment & Water Resources Congress, Portland, OR, June1-5, 2014.

Bigham G, Balouet J-C, Chalot M, Liang L. Dendrochemistry and phytoscreening of mercury in trees. Abstracts - SETAC North America annual meeting, Nashville TN, November 18-21, 2013.

Bigham G, Pozzi C, Monti C. Using mercury stable isotope ratios to trace steel plant atmospheric emissions in southern Italy. Abstracts - 11th International Conference on Mercury as a Global Pollutant, Edinburgh, Scotland, July 28-August 2, 2013.

Bigham G, Liang L. Preservation of urine samples for biomonitoring of mercury exposure. Abstracts - 11th International Conference on Mercury as a Global Pollutant, Edinburgh, Scotland, July 28-August 2, 2013.

Bigham G, Gard N, Monti C, Pozzi C. The remediation regimes. In: The EU Environmental Liability Directive: A Commentary. Bergkamp L, Goldsmith B (eds), Oxford University Press, 371 pp, 2013.

Bigham G, Feng X (guest editors). Mercury biogeochemical cycling in mercury contaminated environments. Applied Geochemistry 2011; 26(2).

Bigham G, Law S. Agriculture meets Natural Resource Damage claims. Agricultural Management Committee Newsletter, American Bar Association, August 2009.

Bigham G, Chan W, Dekermenjian M, Reza A. Indoor concentrations of mercury vapor following various spill scenarios. Environmental Forensics 2008; 9(2):187-196.

Chan W, Bigham G, Dekermenjian M. Exposure to elemental mercury from a spill. In: Abstracts—11th International Conference on Indoor Air Quality and Climate, Copenhagen, Denmark, August 17-22, 2008.

Henry B, Bigham G. Measurement of mercury concentrations in marsh drainages over a tidal cycle. American Geophysical Union Fall Meeting, San Francisco, CA, 2007, abstract #B11B-0401.

Bigham G, Gard N, Drury D. Assessment of natural resource damages at the New Almaden mercury mining district, California. In: Abstracts—8th International Conference on Mercury as a Global Pollutant, Madison, WI, August 6-11, 2006.

Bigham GN, Henry B, Bessinger B. Mercury. In: Environmental Forensics, Contaminant Specific Guide. Morrison RD and Murphy BL (eds), Academic Press, 2006.

Shrestha P, Bigham G, Hamilton D, Doroudian M. A three-dimensional model for Lake Sam Rayburn, Texas. Proceedings, ASCE International Perspective on Environmental and Water Resources, New Delhi, India, December 18-20, 2006.

Bigham G, Henry B, Bessinger B. Mercury—A tale of two toxins. Natural Resources & Environment, American Bar Association 2005; 19(4).

Bigham G. Assessment of exposure to mercury vapor in indoor air from spilled elemental mercury. Presented at the 7th International Conference on Mercury as a Global Pollutant, Lubljana, Slovenia, 2004. Extended abstract in: RMZ Materials and Geoenvironment, 2004; 51(1):587-598.

Bigham GN, Mackay C. The role of nutrients, organic carbon, and sulfur species in mercury methylation and bioaccumulation. In abstracts-SETAC Europe, 13th annual meeting, Hamburg, Germany; April 27-May 1, 2003.

Mackay CE, Colton JE, Bigham G. Structuring population-based ecological risk assessments in a dynamic landscape. In: Coastal and Estuarine Risk Assessment. Newman MC, Roberts Jr. MH, and Hale RC (eds), Lewis Publishers, Boca Raton, FL, 2002.

Bigham GN, Vandal GM. A drainage basin perspective of mercury transport and bioaccumulation: Onondaga Lake, New York. Neurotoxicology 1996; 17(1):279-290.

Becker DS, Bigham GN. Distribution of mercury in the aquatic food web of Onondaga Lake. Water Air and Soil Pollution 1995; 80:563-571.

Becker DS, Rose CD, Bigham GN. Comparison of the 10-day freshwater sediment toxicity tests using Hyalella azteca and Chironomus tentans. Environmental Toxicology and Chemistry 1995; 4(12):2089-2094.

Henry EA, Dodge-Murphy LJ, Bigham GN, Klein SM. Modeling the transport and fate of mercury in an urban lake (Onondaga Lake, NY). Water Air and Soil Pollution 1995; 80:489-498.

Henry EA, Dodge-Murphy LJ, Bigham GN, Klein SM, Gilmour CC. Total mercury and methylmercury mass balance in an alkaline, hypereutrophic urban lake (Onondaga Lake, NY). Water Air and Soil Pollution 1995; 80:509-518.

Bigham GN. Oceanic disposal of waste from manganese nodule processing. In: Oceanic Processes in Marine Pollution, Volume 3, Marine Waste Management—Science and Policy. Champ MA and Park DK (eds), Robert E. Krieger Publishing Company, Malabar, FL, 1989.

Bigham GN. Zone of influence, inner continental shelf of Georgia. Journal of Sediment Petrol 1973; 31(1):207-21.

Project Experience

Contaminant Transport and Fate Technical lead on behalf of the U.S. Department of State (DOS) for evaluation of the potential transport and fate of crude oil (diluted bitumen or dilbit) in the event of a spill from the Keystone XL pipeline project. The project included review of information in the DOS final environmental impact statement and supplementary analysis of the impacts of dilbit on groundwater from a very small spill and a large spill, as well as impacts of a spill to surface waters. Evaluated the transport

and fate of spilled oil and produced water alleged in a toxic tort claim related to oil exploration and production from the Sacha field in the Amazon basin region of Ecuador and provided an expert report for ChevronTexaco. Prepared an expert report in a property damage case in Brunswick, Georgia, regarding deposition of mercury and PCBs on intertidal and riparian properties. Managed an ecological risk assessment and potential natural resource assessment for Honeywell at a tidal marsh in Georgia contaminated by mercury, PCBs, and other substances. The project included a detailed evaluation of mercury species and PCB congeners in sediment, water, and biota, as well as food-web modeling of ecological effects. Assisted in the design and implementation of field data collection and field experimentation to predict water quality for an open-pit mine in Indonesia.

Cost Allocation Prepared an expert report and testimony for an arbitration panel on the allocation of costs for remediation of elemental mercury spilled at a municipal sewage treatment plant in Dubuque, Iowa. Evaluated, for remediation cost allocation, the chemical and physical characteristics of contaminated sediments requiring remediation at a shipyard in San Diego Bay. The allocation estimated the fraction of the contamination that historically originated within the shipyard site and the fraction that originated from the discharge of stormwater runoff from a creek adjacent to the shipyard. Prepared a historical sedimentation and fate analysis in allocation mediation among three companies for remediation costs of PAH-contaminated sediments at a site in Boston Harbor. Conducted an environmental forensics investigation of the timing and nature of transport and deposition of wastes from coke, coal tar, and manufactured gas plants. Prepared an expert report for arbitration on a risk-based approach for allocation of remediation costs at a commercial landfill site in the New Jersey Pine Barrens. Also conducted an environmental forensics investigation to determine the sources of onsite contaminants. ***Mercury*** Prepared an expert report on the sources and fate of mercury contamination to the Penobscot River estuary in Maine. The report considered historical mercury discharges and utilized data from dated (Cs-137 and Pb-210) sediment cores. Mercury concentrations and stable isotope ratio data demonstrated the presence of multiple sources, in addition to atmospheric deposition. Evaluated human health and ecological risks of predicted mercury emissions from an LNG liquefaction facility on the coast of the state of Western Australia. A key part of the assessment was the evaluation of the fate of mercury once deposited by wet and dry deposition. Primary issues were the potential of mercury methylation in soil and in littoral environments receiving infrequent stormwater runoff. Evaluated the environmental impact of mercury and sulfate deposition (acid rain) related to emissions from a coal-burning industrial boiler in Maryland on federal lands in northern Virginia and West Virginia. Provided deposition and trial testimony. Used stable mercury isotope ratio data from flue dust, soil, and vegetation to evaluate deposition of particulate matter from stack emissions at a large integrated steel mill in southern Italy. Prepared an evaluation of stable mercury isotope ratios in surface water, groundwater, and plant effluent for a mercury-cell chlor alkali plant in northern Italy. Developed estimates of mercury vapor emission rate associated with the ordered removal of brine mud landfills at a former mercury-cell chlor-alkali plant on the Penobscot River in Maine. The emission rates were back-calculated, using AERMOD, from measured vapor emissions from similar material during remediation at another chlor-alkali plant. Provided regulatory hearing testimony. Evaluated a wetland that formed next to a highway and downstream of the former Abbot – Turkey Run mercury mine in northern California to determine the nature and timing of its formation. The work also included development of a technical approach to determine if the wetland is a significant source of inorganic mercury and methylmercury to Harley Gulch and Cache Creek located downstream. Performed a survey of mercury concentrations in indoor air and soil vapor at a chemical facility in Canton, Ohio. Evaluated potential exposure to mercury vapor related to a spill of elemental mercury over 40 km of highway in the Peruvian highlands. Exposure occurred when residents took the mercury home. The project included construction of a room similar to a rural Peruvian home and measuring mercury vapor concentrations in the room following a controlled mercury release. The results were used to verify a mathematical mercury evaporation and exposure model. Also evaluated mercury in urine data to corroborate model results. Performed a reconnaissance of the Almaden Quicksilver County Park on behalf of the Santa Clara County Parks and Recreation Department to identify sites of soil erosion. The areas were prioritized according to their potential contribution of sediment and mercury to the Guadalupe River system. Prepared comments on behalf of the Santa Clara Parks and Recreation Department on the Guadalupe River Mercury TMDL report. Prepared an expert report in defense of a class action claim against a natural gas utility for mercury exposure related to removal of gas pressure regulators. The work included evaluation of regulator removal procedures and estimation of the potential

short- and long-term mercury exposure in indoor air. Prepared and submitted comments on the TMDL report for mercury in San Francisco Bay on behalf of the Santa Clara Valley Water District. Provided review and comment of a TMDL for mercury in the Guadalupe River prepared by a contractor for the Santa Clara Valley Water District. Project manager for a cooperative Natural Resource Damage Assessment for the Guadalupe River Basin that drains the former Almaden Mercury Mining District near San Jose, California. Work also included additional sampling, analyses, and interpretation of mercury data for various media. Project manager for evaluation of factors that influence bioaccumulation of mercury and other contaminants in fishes for the Michigan DEQ. Also recommended parameters to include in fish monitoring programs. The objective was to ensure that all appropriate parameters needed to identify the cause of long-term trends are measured. Provided comments for Westinghouse Savannah River Laboratory on the draft TMDL for mercury in the Savannah River developed by U.S. EPA Region 4. Designated as an expert witness in standard-of-care litigation involving a consulting engineering firm's clean up of a mercury-contaminated building. Member of a panel of mercury experts to evaluate mercury behavior, bioaccumulation, and remedies at South River, a tributary of the Shenandoah River, Virginia, for DuPont and the VADEQ. Project manager for evaluation of the behavior, effects, and remediation of elemental mercury spilled in homes from gas pressure regulators in Detroit, Michigan. Project manager for evaluation of mercury toxicity and treatability in petroleum industry effluents for the American Petroleum Institute. Project also included a separate evaluation of reported mercury concentration data in crude oil. Managed a project designed to evaluate mercury cycling and bioaccumulation in fresh and estuarine waters to help guide future investigations for the Aluminum Company of America. Expert witness on the issue of the relationship between mercury bioaccumulation in aquatic food webs and the degree of eutrophication in the south Florida Water Conservation Areas and the Everglades. ***Natural Resource Damage Assessment*** Assisted the US Department of Justice and US Department of Energy in defense of natural resource damage claim at the Oak Ridge National Laboratory site in Tennessee. The claim included injuries to terrestrial, aquatic, groundwater, and surface water resources. Provided technical support to an analysis of damages to groundwater from a bauxite processing facility and oil refinery complex on St. Croix, U.S. Virgin Islands. Served as a consulting expert for a first-of-its-kind NRD claim involving confined animal feeding operations (CAFOs) in Oklahoma and Arkansas. Evaluated animal waste and soil chemical data along with information in nutrient management plans. Evaluated transport of contaminants by stormwater runoff and potential water quality effects on downstream surface waters and a reservoir. Developed a comprehensive web-based compilation of reports and data linked to a GIS map of relevant locations. Prepared a preliminary estimate of potential natural resources damage liability for a chemical facility in Delaware. Potential damages were related to solvents in groundwater, surface water, and tidal wetlands. Prepared an expert report and provided deposition testimony regarding delineation of a PCE groundwater plume and associated natural resource damages at a former manufacturing facility in North Brunswick, New Jersey. Project manager for a cooperative Natural Resource Damage Assessment for the Guadalupe River Basin that drains the former Almaden Mercury Mining District near San Jose, California. Project included development of a Habitat Equivalency Analysis and negotiation of restoration with resource trustees. Performed a preliminary Habitat Equivalency Analysis of natural resource damages related to mercury contamination of Onondaga Lake, New York. Project manager to provide an evaluation of a Natural Resource Damage Assessment prepared by the State of New Jersey for a landfill site. Evaluated injuries to fisheries, groundwater, and wetlands and prepared alternative assessment. Project also included development of restoration alternatives. Developed the technical claim to the United Nations Compensation Commission on behalf of the Kingdom of Jordan for environmental damages to water resources incurred during the Gulf War. Also developed a claim and work plan for monitoring and assessment to further quantify damages. Directed a preliminary natural resource damage evaluation for a complex aquatic system in Montana affected by mining wastes. ***NPDES Permitting*** Evaluated the source of metals in water discharged from the NASSCO graving dock in San Diego Harbor. Performed field leach testing of likely sources of copper, nickel, and zinc and prepared a model to predict concentrations in water from initial flooding through ship launching. Also performed field sampling of flood waters over several launch cycles to verify the model. Prepared an expert report regarding compliance of the City and County of Honolulu's Sand Island and Honouliuli municipal sewage treatment plants with terms of their NPDES discharge permits and Section 301(h) waivers from the requirements of secondary treatment. Also addressed the appropriateness of the City and County's applications for NPDES permit and Section 301(h) waiver renewals. Served as resident manager for a numerical water quality modeling study of the effects of municipal wastewater discharges

to all the bays around Long Island, New York. The purpose of the study was to develop a regional plan for sewage disposal to minimize water quality impacts. Served as project manager and technical director to evaluate the fate and effects of submarine tailings disposal to a fjord in southeastern Alaska, for EPA's evaluation of an NPDES discharge permit. Managed and performed an EPA field evaluation of the effects of fish processing waste disposal on marine waters and sediment at a site in the Aleutian Islands, Alaska. Managed an investigation for two fish processing companies to support a request to EPA and the State of Alaska for continued discharge of fish processing waste at a site in the Aleutian Islands, Alaska. ***Water Quality Modeling*** Performed a technical evaluation of a WASP-based water and sediment quality model for the US Department of Justice. The model was developed to simulate a plume created by a spill of acid mine drainage into a river in the southwest US. Applied EPA's state-of-the-art Environmental Fluid Dynamics Model to 39-miles of the Lower Fox River, Wisconsin to simulate sediment transport and deposition of PCBs historically discharged, from 1954 to 2007, from 11 paper mills. The hindcast model was thoroughly calibrated, validated, and key model inputs tested for sensitivity. Results were utilized to determine the mass of PCBs accumulated in each of ~3,000 model grid cells from each of the historical dischargers. Applied US EPA's Merc-4 water quality model to simulate mercury cycling and bioaccumulation in Onondaga Lake, NY. The WASP-based model simulated the fate of mercury inputs from tributaries, sewer outfalls, sediment flux, and atmospheric deposition. The model simulated mercury methylation in surface sediments and the water column. The model was also linked to fish bioenergetics model for simulation of mercury bioaccumulation. An extensive data collection program was also conducted for use in model calibration and verification. Prepared a water quality evaluation of the proposed Amaila Falls Reservoir in Guyana on behalf of the project developer. Utilized the water quality model CE Qual W2 to simulate water quality in the reservoir and downstream. A particular focus of the study was evaluation of greenhouse gases emitted by the pre-reservoir tropical river compared to emission from the reservoir. Performed a modeling study to evaluate the behavior of discharge plumes from a methane extraction facility on the stability of Lake Kivu, Rwanda. Utilized the Computational Fluid Dynamics (CFD) code to determine the depth of plume stratification. Also evaluated water quality impacts of the wash water discharge on near surface waters. Prepared a water quality evaluation for the proposed Misicuni Reservoir in Bolivia on behalf of the Inter-American Development Bank. Applied the coupled DYRESM-CAEDYM hydrodynamic and water quality models to predict water quality in the reservoir. Also applied the biogeochemical model PHREEQC to evaluate the release of contaminants from sediments under anaerobic conditions. Prepared a risk evaluation of mineral oil spilled from a transformer at a hydroelectric dam in western Montana for submittal to EPA Region 8. The evaluation included estimation of the spill rate and transport and dilution, which were compared to anecdotal observations of oil sheen. Special attention was given to the fate of the PCBs contained in the mineral oil. Managed an evaluation for NCR of sediment transport, water quality, and food-web models applied to PCB-contaminated sediments in the Fox River and Green Bay, Wisconsin, for a potential natural resource damage claim. Also participated on a state-industry work group to evaluate and modify applicable models. Served as project manager and technical director for portions of EPA's evaluation of the fate and effects of drilling muds and cuttings in Alaska's marine waters. Applied the Offshore Operators Committee model to simulate dispersion of the plume. Served as project manager for an analysis of the fate of drilling mud and cuttings discharges to the Beaufort Sea for two oil companies. Applied the Offshore Operators Committee model to simulate dispersion of the plume. Served as project manager and technical director for portions of EPA's evaluation of the fate and effects of drilling muds and cuttings in Alaska's marine waters. Performed analyses of the fate and effects on water quality of municipal sewage discharge plumes to marine waters of the U.S. West Coast and Puerto Rico and evaluated compliance with water quality criteria as part of EPA's evaluation of applications, nationwide, for Section 30l(h) waivers from the requirement of secondary treatment. Managed a numerical water quality evaluation and field verification study for a harbor development project in Saudi Arabia. Performed bathymetric surveys, dye dispersion tests and measured tides, currents, and alongshore sediment transport. Served a resident manager of water quality modeling studies of all of the bays around Long Island, New York. The purpose of the studies was to determine the optimum location for municipal sewage outfalls as part of a long-term regional (Section 208) planning program.

Additional Education & Training

Post-graduate course work in Environmental Engineering, University of Southern California, 1975–1976

Deposition & Trial Testimony

NCR Corporation, et al. v. George A. Whiting Paper Co., et al. 08-ev-00016-WCG (E.D. Wis.) and United States of America and the State of Wisconsin v. NCR Corporation, et al. 10-cv-00910-WCG (E.D. Wis.), November 18, 2016. Deposition testimony.

United States v. Westvaco Corporation, et al., U.S. District Court of Maryland, Case No. MGJ 00-cv-2602, December 10, 2015. Deposition testimony.

State of California v. Continental Insurance Company, et al. Superior Court of the State of California, County of Riverside Case No. CIV 239784, December 2, 2014. Deposition testimony.

Natural Resources Defense Council. Inc. et al. v. HoltraChem Manufacturing Company, LLC et al. U.S. District Court for Maine, Civil No. 1:00-cv-00069-JAW, March, 13, 2014. Deposition testimony.

Miron Construction Co., Inc, v. City of Dubuque et al., American Arbitration Association Case NO. 58 192 Y 00169 11, April 12, 2013. Arbitration and deposition testimony.

United States v. Westvaco Corporation, et al., U.S. District Court of Maryland, Case No. MGJ 00-cv-2602, January 16, 2013. Trial and deposition testimony.

Maine Department of Environmental Protection v Mallinckrodt, Maine Board of Environmental Protection, Penobscot County, Maine, January 25-February 4, 2010. Hearing testimony.

Middlesex Corporation v Phelps, Superior Court of Washington, Pierce County, Case No. 08-2-05524-3, September 9, 2009. Deposition testimony.

Huddleston et al., v. Union Pacific Railroad et al., Superior Court of the State of California, Contra Costa County, Case NO. C 05 - 02394, March 19, 2009. Deposition testimony.

New Jersey Department of Environmental Protection (NJDEP) and the Administrator of the New Jersey spill compensation Fund v Parker-Hannifin Corporation, State Court of New Jersey Docket No.: MID-L-286-06, March 13, 2008. Deposition testimony.

City of Pomona v ARCO et al., U.S. District Court Central District of California, Case No. CV 05 2353 RGK (JTLx), March 27, 2006. Deposition testimony.

Donald Brophy v Philadelphia Gas Works, Court of Common Pleas of Philadelphia County, First Judicial District of Pennsylvania, Civil Trial Division, Case No. 07MR05J1, March 7, 2005. Class certification hearing testimony.

Anderson v. Donahue Industries, Inc., et al., 1st Judicial District Court, Jasper County, Texas, Case No. 24516, April 13, 2004, Deposition testimony.

Richard L. Muller Jr. v. General Electric Company, U.S. District Court Northern District of Georgia, Rome Division, Case No. No. 4:99-CV-294-HLM, May 2002 and March 2004. Affidavit testimony.

Edwin Watters et al. v. General Electric Company, U.S. District Court Northern District of Georgia, Rome Division, Case No. 4:98-CV-0195-HLM, July 8, 1999. Class certification hearing testimony.

Mercer et al. v. Rockwell International, U.S. District Court, Western District of Kentucky at Bowling Green, Case No. 1:87CV-106-H, September 1997. Jury trial testimony.

Sugar Cane Growers v. South Florida Water Management District, U.S. District Court, Southern District of Florida, Case No. 88-1886-CIV-Hoeveler, November 1995. Deposition and Trial testimony.