Brad A. Bessinger, PhD, PG, RG

Principal Geochemist

EDUCATION

PhD, Geochemistry, University of California at Berkeley, 2000

MS, Rock Mechanics, University of California at Berkeley, 1997

BS, Engineering Geology, Stanford University, 1993

PROFESSIONAL REGISTRATIONS

Registered Geologist, Oregon, No. G2117

Licensed Geologist, Washington, No. 2847

Professional Geologist, California, No. 10296

PROFESSIONAL AFFILIATIONS

National Ground Water Association

Groundwater Resources Association of California

Dr. Bessinger specializes in environmental chemistry and the analysis of fate and transport of arsenic, metals, radionuclides, and organic contaminants in the environment. His expertise includes designing and conducting contaminant fate and transport studies, environmental forensics investigations, and water quality assessments. His consulting services include obtaining and interpreting geochemical and isotopic data, developing reactive transport models for sediment and groundwater evaluations, preparing site treatability studies, and investigating the sources of contaminants for litigation, insurance claims, and Natural Resource Damage Assessments (NRDA). Dr. Bessinger's expertise in geochemistry and reactive transport modeling is routinely used in monitored natural attenuation (MNA) investigations and geochemical compatibility evaluations for managed aquifer recharge (MAR) projects.

CONTAMINANT FATE AND TRANSPORT

Arsenic Fate and Transport Study, Former Mill Site, Washington
Managed a geochemical fate and transport investigation to determine the source and fate of arsenic in groundwater adjacent to the Snohomish River. Developed sampling and testing plans for groundwater and soil and conducted geochemical modeling to assess relative contributions of natural versus wood treatment sources of arsenic. Updated a surface complexation modeling thermodynamic database for simulating arsenic adsorption. Used a reactive transport model that was calibrated to site geochemical data to predict arsenic fate and transport and the potential for offsite migration to sediments. Results were used in a Supplemental Remedial Investigation.

Radionuclide Fate and Transport Modeling, Former Landfill, Missouri
Predicted the mobility of radionuclides in uranium processing wastes in a solid waste landfill. Conducted a laboratory evaluation of source mineralogy, speciation, and leaching potential. Developed a humic acid complexation thermodynamic database and used it to calibrate a reactive transport model. Evaluated the effectiveness of monitored natural attenuation in preventing groundwater radionuclide migration to a nearby river. Identified significant factors affecting radium generation in leachate. Concluded significant attenuation would occur in the landfill vadose zone and underlying aquifer. Prepared a summary report for submission to the U.S. Environmental Protection Agency (EPA).

Radium Monitored Natural Attenuation Evaluation, Manufacturing Facility, Oregon
Served as technical lead for a monitored natural attenuation (MNA) investigation at an industrial site to understand effectiveness of MNA as a remedy. Managed the collection and analysis of groundwater and soil geochemical data and developed reactive transport models to long term fate and transport of radium in groundwater.

Radium Monitored Natural Attenuation Evaluation, Former Smelter, Texas
Supervised a monitored natural attenuation (MNA) investigation at a former smelter to understand factors affecting radium migration in groundwater. Managed the collection and analysis of groundwater geochemical data and the statistical evaluation of plume stability. Designed work plans to collect and analyze groundwater and soils to identify radium attenuation processes, aquifer attenuation capacity, and the long-term fate and transport of radium. Developed reactive transport model to predict MNA effectiveness as a remedy component.

Arsenic, Selenium, and Metals Natural Attenuation Evaluation, Former Coal Power Plant, Nevada
Directed a natural attenuation investigation of arsenic and metals in groundwater underlying a series of flue-gas desulfurization evaporation ponds. Evaluated historical data, directed field and laboratory investigations to characterize site geochemistry, and developed a reactive transport model to evaluate the effectiveness of natural attenuation to prevent migration of constituents in groundwater. Prepared reports, presentations, and represented the client to lead regulatory agency.

Geochemical Modeling Peer Review, Former Mining Site, New Mexico
Provided peer review of a geochemical model designed to predict the leaching potential of uranium in historical tailings and the potential for migration in an alluvial aquifer. Evaluated tailings geochemical data that included mineralogy, sequential extractions, and humidity cell tests. Tested model assumptions concerning attenuation mechanisms and rates. Confirmed model was properly calibrated and results accurate.

Hexavalent Chromium Leaching Investigation, Hanford Site, Washington
Evaluated the potential for hexavalent chromium to be leached into groundwater at the Hanford Site 100-D groundwater operable unit (OU). Developed a kinetic-based, solid-solution reactive transport model that simulated soil column leaching tests. Geochemical formulation was incorporated into MT3D to evaluate field-based remedies.

Arsenic Fate and Transport Study, Port of Tacoma, Washington
Conducted a geochemical investigation as part of a Remedial Investigation to determine arsenic mobility in groundwater affected by slag. Designed a geochemical study to assess arsenic speciation and mobility, which included sequential extractions procedures, batch leaching tests, and adsorption experiments. Project included evaluating the effectiveness of monitored natural attenuation.

Arsenic Monitored Natural Attenuation Study, Former Phosphate Mine and Manufacturing Facility, Florida
Conducted a geochemical investigation to determine arsenic and boron mobility at a former industrial facility. Metals speciation and mobility were determined using electron microprobe analysis, sequential extraction test results, and batch leaching and adsorption tests. Developed a reactive transport model to predict long-term impacts on drinking water aquifers. Submitted report to regulatory agency. Monitored natural attenuation was approved as the site remedy for arsenic.

Copper and Zinc Remedial Alternatives Evaluation, Ore Processing Site, British Columbia
Served as the lead geochemist on an interdisciplinary expert panel to assess the effectiveness of proposed remediation at an industrial site used for the loading and unloading of bulk mineral ore concentrates (copper, lead, zinc, and nickel sulfides). Evaluated site data and previously unidentified remedial alternatives. Developed a conceptual site model of copper and zinc fate and transport to support the alternatives evaluation. Submitted a report to Environment Canada.

Monitored Natural Attenuation Evaluation of Zinc, Former Galvanizing Plants, Oregon
Developed reactive transport groundwater models to evaluate the fate and transport of zinc in groundwater at two former zinc galvanizing sites. Calibrated the models to existing site data and forecasted the downgradient extent of zinc migration. Identified significant attenuation of zinc in the aquifer that would prevent impacts to a nearby river. Prepared reports for clients for submission to lead regulatory agency as part of No Further Action Determination Requests.

Polychlorinated Biphenyls Fate and Transport Study, Federal Facility, Missouri
Evaluated the potential for offsite, colloidal transport of Polychlorinated Biphenyls (PCBs) via the groundwater pathway. Developed low-flow sampling and testing procedures and evaluated the effects of sample filtration by interpreting congener distributions in unfiltered groundwater, filtered samples, and filters. Also provided technical review of a PCB surface water fate and transport/bioaccumulation model to determine the effectiveness of site remediation.

Resource Conservation and Recovery Act Facility Investigation, Former Lead Smelter, Montana
As Senior Geochemist, identified geochemical and isotopic source signatures in groundwater to establish nature and extent of contamination. Consulting also included site geochemical investigations for development of a groundwater model and selection of remedial alternatives for arsenic and selenium contamination.

Arsenic Monitored Natural Attenuation Performance Assessment, Pipeline Compressor Station, Texas
Evaluated Monitored Natural Attenuation (MNA) as a remedy for arsenic in groundwater. Designed a field, laboratory and modeling study following U.S. Environmental Protection Agency (EPA) guidance on the use of MNA to achieve appropriate cleanup levels in groundwater within a reasonable timeframe. Identified attenuation mechanisms and rates, sequestration stability, and aquifer capacity. Developed a reactive transport model to demonstrate that MNA is an effective remedy for achieving appropriate cleanup levels in groundwater.

Hexavalent Chromium Fate and Transport Evaluation, Industrial Facility, California
Designed a geochemical study of hexavalent chromium in groundwater. Conducted geochemical characterization of vadose zone soils to quantify adsorptive and reductive capacity. Incorporated laboratory results into a geochemical reactive transport model to assess fate and transport of historical releases. Prepared an expert report for litigation.

Volatile Organic Compound Remediation Oversight, Industrial Site, Illinois
Provided third-party review for U.S. Environmental Protection Agency (EPA) Region 5 at an industrial site contaminated by trichloroethylene (TCE) and carbon tetrachloride (CT) in groundwater. Reviewed and provided comments on technical reports describing remediation performance monitoring results and in-situ treatability studies involving zero-valent iron (ZVI) and organic substrate amendments. Assessment included evaluating geochemical evidence for reductive dechlorination of solvents and potential field-scale implementation issues.

Volatile Organic Compound Remedial Alternatives Evaluation, Industrial Facility, Illinois
Reviewed the technical basis for selecting appropriate remediation of a trichloroethylene (TCE) groundwater plume. For the U.S. Environmental Protection Agency (EPA), assessed the accuracy of conceptual and groundwater flow models being used to forecast contaminant fate and transport under several remediation scenarios. Evaluated spatial distribution of TCE in groundwater and conducted particle-tracking and statistical-trend analyses. Concluded that model calibration was poor and estimates of clean-up times were highly uncertain. Provided recommendations on improving model predictions.

Volatile Organic Compound Degradation Modeling, Confidential Client, New York
Conducted a technical review of tetrachloroethylene (PCE), trichloroethylene (TCE), and dichloroethene (DCE) degradation rates in sand and gravel aquifers. Identified probable degradation pathways based on site hydrogeology and geochemistry. Provided scientifically defensible degradation rate constants and retardation factors for modeling fate and transport of volatile organic compound (VOCs) in groundwater.

Facilitated Dioxin Groundwater Transport Assessment, Confidential Client, Rhode Island
Evaluated the potential for 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) to be mobilized by volatile organic compounds (VOCs) cosolvents and/or natural dissolved organic matter in groundwater. Reviewed the scientific literature and developed a cosolvent solute-specific log-linear model to describe portioning between mobile and immobile phases. Established that site conditions are not conducive to facilitated groundwater transport; however, dissolved humic and fulvic acids could mobilize TCDD and generate concentrations in groundwater within the range of observations.

National Institute of Health Research Grant on Remediation of Recalcitrant Hazardous Substances in Sediment
Conducted basic research into the use of reactive amendments as an alternative remediation technology for hazardous metal and metalloid contaminants (As, Hg, Se, Pb, Cu) of high priority in sediments at Superfund and other contaminated sites. Developed a biogeochemical reactive transport model to evaluate the effectiveness of various chemical amendments in reducing arsenic and mercury mobility in sediment caps. Model results were also investigated in laboratory experiments to identify reaction products and measure dissolution rates. The refined model and laboratory experiments were designed to assist in the selection of suitable sites for sediment capping.

Onondaga Lake Sediment Remedial Design, Superfund Site, New York
Predicted the long-term effectiveness of chemical amendments for neutralizing hyperalkaline pH and mercury in a proposed sediment cap. Conducted batch tests to assess the effectiveness of different chemical amendments in treating hyperalkaline pore water. Also developed geochemical models to simulate observed chemical changes and to predict long-term effectiveness under field conditions. Results were used as part of site feasibility studies, guiding the eventual remedy.

Groundwater Denitrification and Perchlorate Reduction Modeling, Confidential Client, California
Parameterized a Monod kinetic MT3DMS model for simulating denitrification and perchlorate reduction in a sand and gravel aquifer. Evaluated aquifer geochemistry and assigned rates for fate-and-transport calculations based on observed contaminant concentrations, inferred microbial activity, and inhibiting processes.

Acid Mine Drainage Remediation Performance Assessment, Confidential Client, California
Apportioned sources of arsenic and metals in a mine waste-contaminated stream using diagnostic ratios, mass balance, and chemical mixing/reaction models. Assessed changes in bioavailability due to site remediation by predicting the aqueous speciation of contaminants. Study results were used to determine remediation effectiveness for litigation.

Manganese Groundwater Plume Evaluation, Sawmill Facility, Oregon
Conducted a geochemical investigation to determine impacts of a dissolved manganese plume on ecological receptors in riverine sediment downgradient of an industrial site. Evaluated groundwater, sediment, and pore water biogeochemistry and concluded manganese attenuation was occurring. Manganese concentrations in sediment pore water were demonstrated to be within the natural range, resulting in the suspension of site regulatory activities.

Hanford Groundwater Geochemistry and Chromium Modeling, Hanford Site, Washington
Project work included technical review of documents providing the basis for modeling chromium using MT3DMS. Also developed environmental calculation briefs for evaluating and interpreting groundwater geochemistry.

Adaptation of Hydrocarbon Model for Multicomponent Simulations, U.S. Environmental Protection Agency
Determined biodegradation rate parameters for modeling surrogate petroleum hydrocarbon compounds using the U.S. Environmental Protection Agency's (EPA) Hydrocarbon Spill Screening Model (HSSM). Evaluated the scientific literature and developed reaction stoichiometries and appropriate rate constants. Also provided technical guidance on code modification.

Volatile Organic Compound Exposure Assessment, Industrial Facility, Illinois
Assessed the potential for historical atmospheric emissions of vinyl chloride and 1,1-dichloroethene (1,1-DCE) from an industrial facility. Developed a kinetic model describing volatilization and polymerization within the plant's reactors. Also modeled potential releases from an industrial lagoon receiving plant effluent. Results were used in developing expert opinions on alleged exposure as part of a toxic tort case.

Volatile Organic Compound Remediation Performance Assessment, Industrial Facility, Oregon
Evaluated the effectiveness of groundwater remediation efforts on reducing concentrations of volatile organic compound (VOCs) in groundwater. Work was completed as part of a site remediation performance assessment.

Slag Impact Evaluation, Former Steel Mill, Oregon
Evaluated groundwater quality data to determine the potential impact of slag materials on metals concentrations in downgradient monitoring wells. Used geochemical modeling to demonstrate offsite migration of dissolved metals was being mitigated by natural attenuation.

Raritan River Remedial Investigation/Feasibility Study Investigation, Former Manufacturing Plant, New Jersey
Developed a geochemical reactive transport model to predict the potential for recontamination of clean cover materials placed over arsenic-contaminated sediments in a tidal wetland affected by industrial discharges and dumping. Used the model to evaluate the long-term effectiveness of a proposed cap.

Arsenic Remedial Alternatives Evaluation, Former Pesticides Manufacturer, Minnesota
Designed and executed a geochemical study of arsenic fate and transport in groundwater at a former pesticide manufacturing facility. Developed field sampling plans, laboratory studies, and an integrated PHREEQC/MT3DMS model to predict the extent of arsenic migration to a potential water-supply aquifer. Evaluated the effectiveness of engineered remedial alternatives using model output for a site feasibility study.

Natural Resource Damage Assessment, Lake Tenkiller, Oklahoma
Provided litigation support as part of a Natural Resource Damage Assessment (NRDA) lawsuit. Investigated the fate and transport of arsenic, nutrients, pathogens, and metals in poultry litter applied within an agricultural watershed. Examined geochemical evidence for transport from litter-applied fields to rivers, streams, and lacustrine sediment, and compared to background and other anthropogenic sources. Also assessed biodegradation pathways and rates of organo-arsenical compounds and potential of these additives to be preserved in poultry litter and therefore susceptible to aerial dispersion and deposition as house dust.

Contamination Assessment and Reduction Project Model Review, Confidential Client, New Jersey
Provided technical review of the Contamination Assessment and Reduction Project (CARP) model for metals and organic contaminants in the Passaic River and Newark Bay. Evaluated adequacy of modeled geochemical processes and uncertainty associated with model-predicted source contributions and remediation effectiveness.

Mercury Fate and Transport Evaluation, Confidential Client, New Jersey
Summarized the scientific understanding of mercury transport, fate, and bioaccumulation for a client affected by regulatory actions concerning mercury methylation. Client used results to ensure cost effectiveness and success of proposed remedial actions.

Barium Bioavailability Investigation, Red Dog Mine, Alaska
Calculated the bioavailability of barium in soil affected by fugitive dust from mining operations. Evaluated field and laboratory methods for determining barium concentrations in soils and developed geochemical models to interpret in vitro test results. Results were used in ecological risk assessment and were published as a peer-reviewed journal article.

Chromated Copper Arsenate Geochemical Evaluation, Confidential Client, Florida
Evaluated the fate and transport of arsenic in Chromated Copper Arsenate (CCA)-treated wood being disposed in construction and debris landfills. Examined lysimeter experiments, speciation results, and groundwater monitoring data. Provided comments on the scientific validity of published conclusions regarding these data.

Chromium Geochemical Modeling, Confidential Client, New Jersey
Evaluated the natural attenuation of hexavalent chromium in a tidal marsh. Identified the major geochemical factors restricting migration under variable environmental conditions. Incorporated field and laboratory data into a kinetic-based, reactive transport model. Predicted potential migration of hexavalent chromium to soil and groundwater.

Arsenic and Lead Bioavailability Investigations, Confidential Client, Missouri and New York
Identified the sources and relative bioavailability of arsenic and lead in soil in smelter communities. Compared mineralogy to ore concentrate material, smelter emissions, soil alteration products, and other anthropogenic sources. Developed reports to supplement human health-risk assessments.

Groundwater Transport of Polychlorinated Biphenyls, Confidential Client, Washington
Evaluated the fate and transport of polychlorinated biphenyls (PCBs) in groundwater at a site upgradient of an impaired surface water body. Analyzed historical hydrology and chemistry data to identify source areas. Calculated solubility and identified transport mechanisms for specific congeners in groundwater. Used fate and transport modeling to demonstrate that groundwater contamination is unlikely to contribute to the observed impairment.

San Francisco Bay Model, San Francisco International Airport and FAA, California
Managed geochemical modeling activities for a study of the effects of dredging and disposal in San Francisco Bay. Calibrated and verified numerical biogeochemical reactive transport models for copper, mercury, nickel, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs) in San Francisco Bay. Presented and defended findings to panel of government and academic experts assembled by the National Oceanic and Atmospheric Administration (NOAA). Authored technical reports in support of anticipated National Environmental Policy Act/California Environmental Quality Act (NEPA/CEQA) requirements and published results.

San Luis Drain Alternatives Evaluation Project, Bureau of Reclamation, California
Managed MIKE 21 modeling tasks for this project. Developed reactive transport models to predict changes in salinity at water treatment plant intakes and selenium bioaccumulation in ecological receptors. Work was performed for National Environmental Policy Act/California Environmental Quality Act (NEPA/CEQA) certification.

Contaminated Upland Marsh Mercury Study, University of California at Berkeley, California
Managed mercury bench-scale treatability study for remediation of a contaminated upland marsh. Evaluated in situ treatment alternatives for remediating mercury-contaminated groundwater using site geochemistry, laboratory treatability tests, and reactive transport model predictions. Final remediation based on study results. Results published in peer-reviewed scientific literature.

Hydrocarbons, Metals, and Arsenic Natural Attenuation Study, Bulk Fuel Terminal, Oregon
Supervised this natural attenuation study. Developed site sampling and analysis plans to assess the geochemistry and the nature and extent of contamination. Developed a reactive transport model that included hydrocarbon degradation, redox reactions, and arsenic transport. Used model predictions to support results and recommendations for the site remedial investigation/feasibility study (RI/FS).

San Francisco Bay Metals Contamination Evaluation, Industrial Client, California
Modeled potential groundwater and surface water contamination resulting from exposed cinder piles in a marsh. Assessed the effectiveness of engineered and natural barriers to protect surface water and groundwater from discharges of copper, zinc, and acid. Used results of groundwater/surface water reactive transport models to justify appropriate cleanup levels and remedial design to the lead regulatory agency.

Sediment Remediation Evaluation, Confidential Client, California
Performed water quality modeling of inorganic and organic contaminants associated with dredging and disposal of contaminated sediments in San Francisco Bay. Developed custom chemical software and compared predictions to water quality objectives as part of a sediment remediation effort.

Nitrate Impacts in Groundwater Evaluation, Meat Processing Facility, Washington
Performed a groundwater quality evaluation as part of a waste discharge permit renewal application. Assessed potential impacts associated with the use of treated wastewater for irrigation.

Groundwater Quality Evaluation, Landfill Site, Oregon
Performed groundwater monitoring and statistical analysis of water-quality data for landfill permitting.

Water Quality Evaluation, Sand and Gravel Quarry, California
Evaluated water quality data to determine potential impacts of quarry operations on surface water.
University of California at Berkeley, California.

Metal/Metalloid Transport in Groundwater, Lawrence Berkeley National Laboratory, California
Conducted scientific research on the geochemistry of arsenic, antimony, mercury, gold, and silver. Evaluated laboratory experiments, compiled thermodynamic databases, and developed software for statistically evaluating speciation and mobility at ambient and elevated temperatures and pressures. Results published in reports prepared for Lawrence Berkeley National Laboratory.

Radionuclide Geochemistry Evaluation, Yucca Mountain Nuclear Waste Repository, Nevada
Served as a geologic consultant to the Mineral and Nuclear Engineering Department faculty at the University of California at Berkeley. Assessed potential migration of radionuclides in the proposed nuclear waste repository. Analysis published in a peer-reviewed scientific journal.

ENVIRONMENTAL FORENSICS

Groundwater Salinity Source Investigation, Former Coal Power Plant, Nevada
Served as principal geochemist to identify the nature and extent of Total Dissolved Solids (TDS) in naturally-saline groundwater. Work included the development of field and laboratory monitoring programs. Also identified source signatures using statistical methods, elemental ratios, and stable isotopes (δD, δO, δ^{18}O-SO_4, δ^{34}S-SO_4). Assessed potential impacts from natural brines, desulfurization pond releases, agricultural infiltration, and petroleum hydrocarbon releases. Determined sources using isotopic mixing and geochemical inverse models.

Radiological Activity Source Investigation, Natural Gas Producer, North Dakota
Conducted an evaluation of the sources of elevated gross alpha and beta activities in groundwater/perched water samples that were collected in response to a produced water incident. Reviewed laboratory procedures used, uncertainties in the procedures, and sample-specific biases. Documented the geochemistry of uranium and thorium in produced waters and compared their known fate and transport to distribution in site soil and groundwater. Determined that measured gross alpha and beta activities were unrelated to the incident. Prepared a report and defended findings to U.S. Environmental Protection Agency (EPA) and tribal agencies.

Groundwater Arsenic Source Evaluation, Manufacturing Plant, Oregon
Served as principal geochemist to identify potential sources of arsenic at an upland facility constructed using natural channel sediments from the adjacent Willamette River. Evaluated historical data, including arsenic and iron concentrations in fill, sediments, groundwater, and porewater. Arsenic concentrations were found to be consistent with naturally-elevated levels and/or sampling artifacts. Conducted a subsequent geochemical investigation to establish redox conditions and confirm the hypothesis that elevated levels are related to naturally-reducing conditions and not site activities. Results used as part of an effort to achieve a source control decision/closure.

Total Dissolved Solids and Metals Source Evaluation, Former Mining Site, California
Retained as an expert by a mining company to investigate the geology and geochemistry of acid mine drainage and the relative importance of potential sources of Total Dissolved Solids (TDS) and metals to an alpine stream. Evaluated historical water quality data and used geochemical modeling to simulate the effect of waste dump releases, tunnel discharges, groundwater underflow, and overall mixing on the water quality of the stream. Due to complex site geochemistry, modeling required the incorporation of iron oxidation, metals adsorption, and equilibrium mineral precipitation. By evaluating pre- and post-remediation water quality, previous geochemical modeling was determined to be oversimplified and that the effectiveness of site remediation was overstated by previous consultants.

Tetrachloroethylene and Trichloroethylene Degradation Evaluation, Confidential Client, California
Assessed the potential for migration of tetrachloroethylene (PCE) and trichloroethylene (TCE) in a groundwater aquifer having multiple sources. Examined evidence for attenuation along a flow path due to reductive dechlorination, abiotic degradation, and/or adsorption. Evaluated groundwater geochemistry to identify conditions conducive to attenuation and used compound ratio analysis and reactive transport modeling to test

hypotheses. Work was performed as part of litigation to apportion relative contributions to a chlorinated solvent groundwater plume.

Groundwater Contaminant Source Evaluation, Landfill Site, Wyoming
Served as technical expert in litigation over sources of arsenic and organic contaminants in groundwater near a solid waste landfill. Performed statistical evaluations to determine background concentrations. Also determined sources of major ions in groundwater using geochemical mixing calculations. Prepared quarterly monitoring reports in compliance with State regulations. Prepared an expert report and provided a deposition.

Groundwater Arsenic Source Study, Former Smelter Site, Montana
Conducted an evaluation of potential sources of arsenic in groundwater in a smelter community. Compared reported dissolved concentrations to background levels, performed reactive transport modeling to assess migration from surface contamination, and utilized ion and isotopic ratios to distinguish water sources. Results were summarized in an expert report prepared for a toxic tort case.

Chlorinated Solvent Plume Evaluation, Confidential Client, California
Critically evaluated methods used by plaintiffs' technical expert for determining sources of volatile organic compound (VOCs) (tetrachloroethylene [PCE], trichloroethylene [TCE], trichloroacetic acid (TCA), and 1,1-DCE) in groundwater. Identified and quantified uncertainty in source assessment using diagnostic ratios to age-date solvent plumes and determine source proximity. Also reviewed and summarized scientific literature on abiotic and biotic degradation and effects on data interpretation.

Post-Construction Mercury Source Study, SEATAC Airport, Washington
Identified sources of mercury in groundwater in a series of monitoring wells having concentrations above site action levels. Conducted statistical analysis and developed a geochemical model that simulated interaction between soil organics and mercury. Concluded (presented in the site remediation performance assessment) that measured concentrations were related to the natural biogeochemical cycling of peat.

Sediment Environmental Forensics Investigation, San Diego Harbor, California
Investigated sources of polychlorinated biphenyls (PCBs) in harbor sediment. Evaluated historical sources, Aroclor and homolog concentrations, and the distribution of PCB congener fingerprints. Prepared a report used in mediation between potentially responsible parties.

Contaminated Sediment Investigation, Port of Los Angeles, California
Investigated the sources of metals in contaminated sediment. Performed statistical and spatial analyses of sediment chemistry and prepared a report allocating client contribution to observed contaminant levels.

City Well Contamination Study, Confidential Client, Idaho
Evaluated potential sources of petroleum hydrocarbons, BTEX compounds, and polycyclic aromatic hydrocarbons (PAHs) to groundwater in this city's municipal wells and sediment. Study included review of historical site operations, comparison of data to site background, and spatial distributions. Results were used to assist client in resolving potential environmental site liabilities.

Volatile Organic Compound Source Assessment, Confidential Client, California
Conducted an apportionment evaluation to determine the relative contribution of volatile organic compounds (VOCs) (tetrachloroethylene [PCE], trichloroethylene [TCE], TCA, 1,1-DCE, 1,2-DCE, and 1,1-dichloroethane (1,1-DCA) in groundwater and indoor air. Utilized chemical ratios to determine sources and degradation rates of compounds. Reactive transport modeling was used to support apportionment.

Metals and Arsenic in Soil, Former Smelter Site, West Virginia
Managed an investigation of the contribution of a former smelter to concentrations of arsenic, cadmium, lead, and zinc in residential soil and house dust. Identified natural and anthropogenic sources of metals in the affected communities and statistically assessed background. Used spatial distribution and metal ratios to ascertain source. Prepared an expert report to contest claims filed in a class-action lawsuit.

Polycyclic Aromatic Hydrocarbons Source Assessment, Manufactured Gas Plant, Washington
Managed an environmental forensics investigation of the sources of polycyclic aromatic hydrocarbons (PAHs) in sediment near a former manufactured gas plant (MGP) and tar refinery. Analyzed historical documents pertaining to site operations and developed sampling and analysis plans to obtain source materials. Utilized chemical fingerprinting techniques to apportion sources as part of a cost allocation case.

Polycyclic Aromatic Hydrocarbons Source Assessment, Bulk Fuel Terminal Plant, Oregon
Managed an investigation of the sources of polycyclic aromatic hydrocarbons (PAHs) in sediment in an industrial waterway near a bulk fuel terminal. Developed site sampling and analysis plans to obtain source and sediment samples for chemical fingerprinting.

Phosphorus Source Assessment, Confidential Client, Washington
Managed a study to assess sources of elevated groundwater phosphorus concentrations suspected of contributing to lake eutrophication. Analyzed groundwater data and developed a geochemical reactive transport model to demonstrate the relative importance of natural versus anthropogenic sources. Report provided to lead agency in consideration of possible remedies.

Metals and Hydrocarbons in Waterway Sediment, Confidential Client, Washington
Assessed the contributions of industrial sources on PAHs and metals concentrations in an industrial waterway. Utilized site histories, industrial practices, and site discharge data to reconstruct historical releases and calculate mass loadings. Prepared a report for a cost recovery lawsuit.

Oil Refinery Source Assessment, Confidential Client, New Jersey
Investigated sources of petroleum hydrocarbons and other organic and inorganic compounds at petroleum refineries and petrochemical facilities. Reconstructed site operations, materials handled, waste disposal practices, and process chemicals used. Related chemicals to those identified as exceeding soil quality criteria. Considered natural and urban background. Developed a report for a Natural Resource Damage Assessment (NRDA) lawsuit.

Residential Soil Arsenic Contamination Evaluation, Confidential Client, Minnesota
Evaluated sources of arsenic in soils potentially affected by historical manufacturing of arsenical pesticides. Utilized electron microprobe speciation and metal ratio techniques to identify chemical fingerprints.

Mercury in Indoor Air Evaluation, Confidential Client, Pennsylvania
Evaluated claims of mercury exposure caused by removal of natural gas pressure regulators. Critiqued removal procedures and calculated evaporation rate of elemental mercury. Documented sources/evidence of variability in exposure caused by removal. Prepared an expert report to contest claims filed in a class-action lawsuit.

Dioxin in Lake Sediment Expert Testimony Support, Confidential Client, Texas
Provided expert testimony support for a study evaluating the transport and fate of dioxin in lacustrine environments. Reviewed site-specific loads, hydrology, and chemical data. Compared likely sediment transport

processes to potential air deposition pathways. Used scientific results, site history, and sworn depositions to apportion dioxin contributions to sediment.

WATER QUALITY ASSESSMENTS

ASR Geochemical Compatibility Evaluations, Water Districts, Oregon and Washington
Conducted geochemical compatibility evaluations for aquifer storage and recovery (ASR) systems in Oregon and Washington (City of Beaverton, City of Cornelius, City of Dufur, City of Fossil, City of Prineville, City of Stayton, City of Tigard, Tualatin Valley Water District, City of Walla Walla, and the City of West Richland). Work included the evaluation of mineralogical and groundwater sampling data and the development of geochemical mixing and kinetic-based reactive transport models to predict water quality and clogging potential during ASR operations. Provided summary reports identifying potential compatibility issues and effective mitigation measures.

Aquifer Sustainability Evaluation, Mound Basin Groundwater Sustainability Agency, California
Performed water quality and isotope evaluations for the Mound Basin Groundwater Sustainability Agency (MBGSA). The primary objective was to better understand the groundwater flow system of the basin, which has multiple aquifers. Specific issues addressed included (1) the sources and mechanisms of groundwater recharge, (2) groundwater age and dynamics, (3) interconnections between aquifers, (4) interaction between surface water and groundwater, and (5) potential salinization. A sampling and analysis program was designed, and geochemical and isotopic groundwater sampling results evaluated, to identify recharge sources and assess sustainability.

Aquifer Storage and Recovery Arsenic Evaluation, City of Davis, California
Conducted a geochemical evaluation to determine the potential for arsenic mobilization caused by the injection and recovery of treated potable water. Geochemical characterization consisted of analyzing recharge water and groundwater chemistry, identifying the minerals naturally sequestering arsenic, and predicting mineral dissolution and arsenic desorption rates. Geochemical reactive transport modeling of pilot test results was performed to understand arsenic mobilization and attenuation mechanisms, predicting future arsenic concentrations in recharge water, and evaluating mitigation measures. Prepared a report that concluded aquifer conditioning and/or modifications to recharge water chemistry can prevent impacts from occurring.

Indirect Potable Reuse Geochemical Compatibility Evaluation, City of Morro Bay, California
Evaluated the geochemical compatibility of highly treated recycled water with the City of Morro Bay's water-supply aquifer. Conducted geochemical mixing modeling and reactive transport modeling to predict water quality and clogging potential. Provided a summary report to the Regional Water Quality Control Board as part of a Groundwater Replenishment Reuse Project (GRRP) permit application.

Aquifer Storage and Recovery Compatibility Evaluation, City of Bowling Green, Ohio
Designed a geochemical investigation to evaluate the compatibility of injecting treated surface water into a carbonate aquifer affected by anoxic conditions. Used PHREEQC geochemical model to determine the effects of groundwater mixing on constituent concentrations and potential mineral precipitates. Also developed a reactive transport model to predict effects of aquifer mineral dissolution on the fate and transport of constituents such as arsenic and sulfate that could potentially be mobilized during system cycling. Evaluated operational measures that could be employed to mitigate possible water quality impacts.

Aquifer Storage and Recovery Source Water Treatability Study, City of Salem, Oregon
Performed an evaluation to identify pre-injection treatment alternatives to reduce residual chlorine in Aquifer Storage and Recovery (ASR) source water, with the goal of lowering the disinfection byproduct (DBP) formation potential during storage in the City of Salem's host aquifer. A geochemical reactive transport model was developed to predict the effects of different treatment alternatives and doses on water quality and potential adverse reactions with the ASR aquifer.

Aquifer Storage and Recovery Performance Assessment, Joint Water Commission, Oregon
Evaluated the effects of elevated iron and manganese in injected water on the performance of an existing Aquifer Storage and Recovery (ASR) system. Reviewed site data and natural redox conditions in the aquifer. Concluded that the primary injectate was particulate iron and manganese oxides and that storage in the ASR aquifer could result in manganese re-dissolution. Evaluated mixing conditions and natural pore throat sizes to assess vulnerability of the ASR system due to episodic introduction of the metal oxides.

Water Supply Well Iron and Manganese Investigation, City of Redmond, Washington
Investigated changes in iron and manganese concentrations in water-supply wells. Reviewed geological logs and historical water quality monitoring data. Reported that the aquifer was naturally-reducing due to the presence of peat in the aquifer. Biodegradation of this material naturally contributes to the release of iron and manganese from aquifer minerals to groundwater. Changes in groundwater flow over time due to groundwater usage in the basin may have contributed to migration of locally-reducing conditions to the impacted wells.

Aquifer Storage and Recovery Arsenic Evaluation, Water Replenishment District, California
Performed a geochemical assessment for the Water Replenishment District (WRD) of Southern California to evaluate potential effects of the aquifer storage and recovery (ASR) system on liberation of arsenic from aquifer minerals. Designed a laboratory study of aquifer sediments, including arsenic speciation and sequential extraction analysis. Project included technical oversight and geochemical modeling using the U.S. Geological Survey (USGS)-supported geochemical model PHREEQC.

Aquifer Storage and Recovery Mineralogy Evaluation, City of Woodland, California
Conducted an evaluation of the effects of aquifer geochemistry on the quality of recovered water from the proposed City of Woodland's aquifer storage and recovery (ASR) system. Reviewed mineralogical and chemistry data and used the USGS-supported geochemical model PHREEQC to assess potential impacts associated with arsenic, selenium, and hexavalent chromium in aquifer minerals. Also determined effects associated with residual ozone. Provided model predictions and recommendations on system operation to reduce potential impacts.

Groundwater Quality Impact Assessment, Confidential Client, Oregon
Predicted the effects of a proposed aggregate mining and processing operation to cause adverse impacts to groundwater quality and quantity in downgradient irrigation supply wells. Reviewed water quality analyses from irrigation wells and conducted geochemical modelling to predict changes in groundwater pH. Model simulated oxidation-reduction reactions related to carbon and nitrate cycling, groundwater degassing, mineral dissolution, and cation exchange.

Aquifer Storage and Recovery Geochemical Compatibility Evaluation, Water Replenishment District, California
Evaluated water chemistry data in support of the Water Replenishment District of Southern California's Indirect Potable Reuse (IPR) Injection Well Feasibility Study. Work included using PHREEQC to assess the likelihood of mineral precipitation reactions to cause clogging, and the identification of processes that could generate

elevated concentrations of arsenic in recovered water. Concluded no impacts were likely. Provided recommendations to mitigate any observed effects in the future.

Aquifer Storage and Recovery Well Performance Assessment, Calleguas Water District, California
Evaluated sources of poor aquifer storage and recovery (ASR) system well performance in selected wells for the Calleguas Water District. Reviewed water-chemistry data and identified potential clogging issues associated with degassing and strong redox-fronts near affected wells. Provided recommendations on changes in injection well chemistry and pumping rates to improve performance.

Aquifer Storage and Recovery Efficiency Evaluation, City of Kennewick, Washington
Evaluated chemistry of recovered water to quantify the relative proportion of injected water recovered during system operation. Reviewed general chemistry of injected water and groundwater and developed mixing curves for indicator constituents to assess relative proportions in recovered water. Also identified water-aquifer reactions deduced from the mixing curves and the potential long-term effects of these reactions on water quality. Developed a two-dimensional (2D) reactive transport model to confirm hypotheses.

Aquifer Storage and Recovery Aquifer Conditioning Study, City of Meridian, Idaho
Determined the feasibility of conditioning an aquifer to create an oxidized treatment zone to remove dissolved manganese from public supply groundwater for the City of Meridian. Designed sampling and analysis plans to characterize the geochemical conditions in the aquifer. Also developed a reactive transport model to simulate pilot-scale conditioning experiments, thereby identifying the factors that control oxygen demand and manganese concentrations. The model was used to identify the number of cycles needed to achieve conditioning and to evaluate the performance of chemical oxidants to achieve more rapid aquifer oxidation.

Marcellus Shale Baseline Water Quality Evaluation, Natural Gas Producer, West Virginia
Conducted a baseline water quality assessment in an area undergoing natural gas exploration and production. Compared constituent concentrations in groundwater to standards protective of drinking water resources. Also determined potential sources of dissolved ions using ion ratio plots and compared these results to previous investigations in the region. Evaluated composition of hydrocarbon gases in shallow groundwater to establish baseline sources and ambient concentrations. A monitoring report was developed that identified water-quality impairments pre-dating Marcellus gas production.

Pavillion Hydraulic Fracturing Study Technical Review, U.S. Environmental Protection Agency, Wyoming
Reviewed the technical basis for the U.S. Environmental Protection Agency's (EPA) conclusion that hydraulic fracturing fluids were contaminating groundwater in a shallow aquifer in Pavillion, Wyoming. Evaluated site hydrology, well construction, laboratory reports, and reported concentrations of inorganic ions and petroleum hydrocarbons. Concluded that poor well construction was impacting groundwater chemistry. Also found that the EPA based its conclusions on questionable laboratory data and did not adequately consider natural background conditions.

Mamm Creek Natural Gas Development Water Quality Study, Natural Gas Producer, Colorado
Evaluated groundwater quality in a natural gas-producing area to assess potential impacts associated with hydraulic fracturing and extraction. Analysis included an evaluation of spatial and temporal trends in chloride concentrations and an evaluation of methane sources as inferred from stable carbon isotopes. Provided baseline and impact reports.

Pipeline System Clogging and Remediation, Industrial Facility, New Mexico
Conducted a geochemical study to identify the cause of pipeline scale and to determine if there was an alternative to periodic cleaning and rehabilitation. Work involved laboratory characterization of scale and geochemical modeling to identify factors responsible for its formation. Results were used to guide decisions on pipeline operation and maintenance.

Columbia Basin Groundwater Ages Study, Ground Water Management Area, Washington
Participated in a study assessing groundwater sources and ages in the Columbia Basin Ground Water Management Area. Work utilized stable isotopes (δD, δO), chemical and isotopic age tracers (CFCs, SF_6, ^{3}H [tritium], and ^{14}C), and predictive numerical models to assess effects of agricultural withdrawals on the long-term supply of irrigation water.

Groundwater Acid Neutralization Study, Confidential Client, Oregon
Conducted a geochemical evaluation of a shallow aquifer that was contaminated by historical releases of acidic process water to identify in-situ remedies for neutralization. Identified mechanisms and rates of pH neutralization from bench-scale tests and evaluated potential field-scale performance for a focused feasibility study. Field application of the groundwater amendment successfully neutralized acidity.

Columbia Basin Gas Characterization, Natural Gas Producer, Oregon
Performed a genetic characterization of gases in groundwater wells to assess potential natural gas resources. Distinguished methane sources by using dissolved and free gas compositions, stable carbon and hydrogen isotopes, and groundwater ages.

Groundwater Treatment System Optimal Operation Evaluation, Industrial Facility, California
Identified optimal operating conditions for groundwater treatment systems based on water chemistry. Evaluation included systems to remove arsenic from groundwater by using ferric chloride and systems to prevent scale formation by using dissolved carbon dioxide.

Stream Impact Assessment, Industrial Facility, Michigan
Modeled the effects of reduced outflow from a surface impoundment on downstream water temperature.

Guadalupe River Mercury Total Maximum Daily Load Assessment, Confidential Client, California
Reviewed technical basis for establishing numeric targets for a proposed total maximum daily load (TMDL) for the Guadalupe River in California. Evaluated site data and provided guidance on effectiveness of various source control measures and methyl mercury reduction plans. Prioritized measures based on effectiveness and the potential for successful implementation.

San Francisco Bay Mercury Total Maximum Daily Load Assessment, Confidential Client, California
Analyzed effectiveness of total maximum daily load (TMDL) for mercury in San Francisco Bay. Evaluated assumptions inherent in the scientific approach within the context of source assessment and numeric targets, mercury methylation, and food web pathways. Demonstrated that proposed numerical targets for mercury inadequately consider mercury speciation. Assessment report was used in contention of source allocations.

Semi-Permeable Membrane Devices Technical Review, Confidential Client, Alaska
Provided senior review of the ability of Semi-Permeable Membrane Devices (to predict time-weighted average hydrocarbon concentrations in water and receptor tissues. Evaluated existing field and laboratory studies. Provided a summary report on method effectiveness and limitations.

Groundwater Use Investigation, Confidential Client, California
Evaluated clogging issues associated with groundwater extraction and irrigation. Results of this project were used in insurance claim.

Groundwater Remediation Performance Assessment, Confidential Client, California
Assessed the performance of groundwater remediation activities at a petroleum-impacted site as part of a cost recovery lawsuit.

Publications and Presentations

Bessinger, B. and J. Melady, 2024. Geochemical Modeling of PFAS Fate and Transport During Aquifer Storage and Recovery in the Pacific Northwest. Presentation at 14th Washington Hydrogeology Symposium. Auburn, WA, April 22-25, 2024.

Bessinger, B. and T. Thompson, 2023. Geochemical Characterization and Reactive Transport Modeling to Evaluate Arsenic in MAR. Presentation at the 2023 National Groundwater Association (NGWA) Managed Aquifer Recharge (MAR) Conference. San Antonio, TX, April 24-25, 2023.

Bessinger, B. and T. Thompson, 2023. Geochemical Modeling for Evaluating Compatibility in Managed Aquifer Recharge Projects. Presentation at the 2023 California Water and Environmental Modeling Forum (CWEMF). Folsom, CA, April 17-19, 2023.

Bessinger, B. and B. Bondy, 2022. The Use of Stable and Radiogenic Isotopes to Understand Groundwater Recharge in the Mound Basin, California. Presentation at 12th Washington Hydrogeology Symposium. Tacoma, WA, May 10-11, 2022.

Bessinger, B., E. Hughes, D. Vlassopoulos, J. Goin, R. Pratt, and R. Healy, 2022. The Fate and Transport of Arsenic in Groundwater Impacted by Slag, Tacoma, WA. Presentation at 12th Washington Hydrogeology Symposium. Tacoma, WA, May 10-11, 2022.

Bessinger, B., T. Thompson, J. Barry, B. Franz, and D. O'Rourke, 2022. Geochemical Compatibility Considerations in Managed Aquifer Recharge in California. Presentation at Fifth Annual Western Groundwater Congress. Sacramento, CA, September 19-21, 2022.

Bessinger, B., and R. Hennet, 2019. Effectiveness of Monitored Natural Attenuation (MNA) as a Groundwater Remedy for Arsenic in Phosphatic Wastes. Groundwater Monitoring & Remediation, v. 39, pp. 52-68.

Bessinger, B., 2019. Geochemical Modeling for Project Managers. Presentation of Short Course to Electric Power Research Institute (EPRI), Columbus, OH, August 22, 2019.

Bessinger, B., V. Bedekar, M. Tonkin, J. Szecsody, N. Qafoku, and M. Truex, 2015. Simulation of Co-Precipitated Chromate-Calcite at a Waste Site. Presentation at MODFLOW and More 2015: Modeling a Complex World, Golden, CO, May 31-June 3, 2015.

Bessinger, B., and C. Neville, 2015. Solute Transport Modeling: Ideal and Otherwise. Presentation of Short Course at the 10th Washington Hydrogeology Symposium, Tacoma, WA, April 14-16, 2015.

Bessinger, B.A., 2014. The Use of Stable Isotopes to Identify Sources of Mercury in Sediment: A Review and Uncertainty Analysis. Environmental Forensics, v. 15, pp. 265-280.

Bessinger, B.A., D. Vlassopoulos, S. Serrano, and P.A. O'Day, 2012. Reactive Transport Modeling of Subaqueous Sediment Caps and Implications for the Long-Term Fate of Arsenic, Mercury, and Methylmercury. Aquatic Geochemistry, v. 18, pp. 297-326.

Bessinger, B.A., 2012. Application of Stable Isotopes to Identify Sources of Mercury in the Environment. Presentation at the 52nd Annual PNWIS/A&WMA Conference, Portland, OR, November 7-9, 2012.

Bessinger, B., and R. Hennet, 2012. The Effect of Mineralogical Speciation on Arsenic and Boron Mobility in Phosphatic Wastes. Presentation at 22nd Annual International Conference on Soil, Water, Energy, and Air. San Diego, CA, March 19-22, 2012.

Serrano, S., D. Vlassopoulos, B. Bessinger, and P.A. O'Day, 2012. Immobilization of Hg(II) by Co-precipitation in Sulfate-Cement Systems. Environmental Science and Technology, v. 46, pp. 6767-6775.

Bessinger, B., and D. Vlassopoulos, 2011. A Reactive Transport Model of Mercury Fate in Sediment. Presentation at the 8th Washington Hydrogeology Symposium, Tacoma, WA, April 26-28, 2011.

Vlassopoulos, D., J. Goin, B. Bessinger, C. Kiehl-Simpson, and E. Glaza, 2011. Evaluation of pH-Buffering Amendments for In Situ Capping of Hyperalkaline Contaminated Sediments. Presentation at 6th International Conference on Remediation of Contaminated Sediments. New Orleans, LA, February 7-10, 2011.

Bessinger, B., and C. Marks, 2010. Treatment of Mercury-Contaminated Soils with Activated Carbon: A Laboratory, Field, and Modeling Study. Remediation Journal, v. 21, no. 1, pp. 115-135.

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O'Day, P., S. Serrano, B. Bessinger, V. Illera, and D. Vlassopoulos, 2009. Sediment Remediation of Metal and Metalloid Contaminants with Reactive Amendments. Presentation at Goldschmidt 2009, Davos, Switzerland, June 21-26, 2009.

Serrano, S., P. O'Day, B. Bessinger, and D. Vlassopoulos, 2009. Immobilization of Mercury (II) by Ettringite-Type Phases: Modeling and Experiments. Presentation at the Geological Society of America Annual Meeting, Portland, OR, October 18-21, 2009.

Bessinger, B., and F. Mohsen, 2008. Simulation of Tidal Effects on Contaminant Fate and Transport near the Sediment-Water Interface. Presentation at Pacific Northwest Society of Environmental Toxicology and Chemistry (PNW-SETAC) Annual Meeting, Corvallis, OR, March 27-29, 2008.

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DEPOSITION AND TESTIMONY EXPERIENCE

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