Exponent®
Engineering & Scientific Consulting

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Professional Profile

At Exponent, Dr. Duncan specializes in environmental compliance and cost allocation and assessment. She has over a decade of experience in environmental health and safety, exposure assessment, chemical fate and transport, and solid waste and wastewater permitting.

Dr. Duncan has evaluated remediation and compliance efforts under federal (e.g., CERCLA, RCRA, CWA, SDWA) and state regulatory programs for sites with soil, sediment, groundwater, and surface water contamination. Projects have included organic contaminants (e.g., polychlorinated biphenyls [PCBs], dioxins/furans, polycyclic aromatic hydrocarbons [PAHs], DDx, per- and polyfluoroalkyl substances [PFAS]) and inorganic contaminants (e.g., boron, cadmium, cobalt, lead, lithium, zinc).

Dr. Duncan has conducted gap assessments for international environmental regulations and standards. This work resulted in proposing new regulatory frameworks and designing/conducting training modules for government agency personnel. She has evaluated international environmental regulations and standards for countries on six continents.

Dr. Duncan has conducted over one hundred assessments to evaluate exposure to asbestos, assessed hazards for dozens of chemicals in personal care products, and refined methods utilizing laser ablation in biomonitoring of metal isotopes in humans. She has also supported clients in evaluating hazardous and non-hazardous waste management practices, complex multi-party site assessments, modifications to general National Pollutant Discharge Elimination System (NPDES) permits, environmental stewardship, and standard of care activities.

Academic Credentials & Professional Honors

Ph.D., Environmental and Occupational Hygiene, University of Washington, 2019

M.S., Environmental Heath, University of Washington, 2016

B.S., Biology, Seattle University, 2007

Licenses and Certifications

40-Hour Hazardous Waste Operation and Emergency Response Certification (HAZWOPER)

8-Hour HAZWOPER Managers and Supervisor Training

Certified Industrial Hygienist (CIH)

Academic Appointments

University of Washington, Department of Environmental and Occupational Health Sciences, Lecturer

Professional Affiliations

Air & Waste Management Association

American Academy of Environmental Engineers and Scientists

American Bar Association (associate member)

American Society of Civil Engineers (affiliate member, Environmental Health and Water Quality Committee member)

National Association of Environmental Professionals

Publications

Duncan, B.R., M. Hasegawa, D.A. Marshall, L.F. Gonzalez-Cuyar, M. Paulsen, M. Kobayashi, K.R. Maravilla, and C.D. Simpson. 2021. Variability in hair gadolinium concentrations among decedents who received gadolinium-based contrast agents. An Bioanal Chem 413(6):1571–1582.

Hasegawa, M., B.R. Duncan, D.A. Marshall, L.F. Gonzalez-Cuyar, M. Paulsen, M. Kobayashi, C. Simpson, and K.R. Maravilla. 2020. Human hair as a possible surrogate marker of retained tissue gadolinium: a pilot autopsy study correlating gadolinium concentrations in hair with brain and other tissues among decedents who received gadolinium-based contrast agents. Invest Radiol 55(10):636–642.

Cooper, E., M. Blanco, B. Duncan, R. Shaffer, J. Kissel. 2019. Potential contribution of dermal pathways to nicotine exposure in children residing in smoking households (TU-PO-47). International Society of Exposure Science and International Society of Indoor Air Quality and Climate, August 18–22, 2019, Kaunas, Lithuania.

EPRI. 2019. Chemical constituents in coal combustion products: cobalt. 3002016497. Electric Power Research Institute, Palo Alto, CA.

Duncan, B, G.D. Onstad, S.J. Trufan, P.M. Rabinowitz. 2019. Comparison of water quality indicators and the density of unconventional gas wells in Southwestern Pennsylvania. World Environmental and Water Resources Congress: Groundwater, Sustainability, Hydro-Climate/Climate Change, and Environmental Engineering, May 19–23, 2019, Pittsburgh, PA.

EPRI. 2018. Chemical constituents in coal combustion products: lithium. 3002012311. Electric Power Research Institute, Palo Alto, CA.

Duncan B., G. Onstad, P. Rabinowitz. 2016. Temporal and spatial analysis of groundwater quality and unconventional gas well density in Washington County, Pennsylvania (Preliminary Analysis). Semiahmoo Annual Occupational, Environmental and Public Health Conference, January 7–8, 2016, Blaine, WA.

Duncan B, M. Belisle. 2014. Big picture strategies for big data analysis. SETAC North America 35th Annual Meeting, November 9–13, 2014, Vancouver, BC, Canada.

Johns, M.W., M.E. Edwards, B.R. Duncan, J. Harney, T. Thompson, R.M. Atlas. 2011. Evaluation of relationships among fluorescence, dissolved oxygen, and analytical chemistry measurements of the water column as indicators of MC252 oil in the Gulf of Mexico. SETAC North America 33rd Annual Meeting, November 13–17, 2011, Boston, MA.

Project Experience

Oil and Gas

Conducted preliminary cost assessment for response costs related to investigating contamination that may have resulted from a sinkhole in an area with natural gas drilling. Reviewed appropriateness of costs incurred to comply with requirements as directed by the Louisiana Department of Natural Resources, Office of Conservation.

Developed comprehensive strategy to perform cost assessment for remediation efforts at a petroleum refinery in Illinois. Evaluated appropriateness of remedial costs incurred over 30 years and analyzed cost allocation methodology development amongst several potentially responsible parties (PRPs).

Evaluated numerous insurance policies, costs incurred, and well completion activities at the Eisenbarth well pad in the Marcellus Shale region of Pennsylvania, where a fire and several explosions on a multi-well natural gas well pad resulted in a fish kill, environmental contamination and subsequent remediation. Assessed reasonableness of costs incurred and differential insurance coverage based upon remediation activities and invoicing records.

Reconstructed historic discharges, spills, waste disposal areas/landfills/dumps, and other sources of environmental contamination from a manufactured gas plant (MGP) in Michigan. Contaminants of interest included non-aqueous phase liquid (NAPL), volatile organic compounds (VOCs), and polycyclic aromatic hydrocarbons (PAHs).

Compiled information on historic spills and environmental impacts from an oil field in California over a five-year period. Assessed ponds, pipelines, tanks, generators, berms, and impoundments. Evaluated potential transport to surface and groundwater resources.

Assessed relationship between groundwater quality and unconventional gas well density at households in Washington County, Pennsylvania. Performed statistical analysis of the data using multiple linear regression with Box-Cox transformations, correlation matrices, and principal component analysis (PCA) in R and spatial analysis in ArcGIS. Included adjustment for geological, hydrological, hydrogeological, climatological, soil composition, well characteristics.

Analyzed water column, chemistry, and biodegradation data for the MC252 Deepwater Horizon oil spill. Temporal and spatial analyses included overlaying conductivity, temperature, depth (CTD), fluorescence, and dissolved oxygen sensor array data with laboratory chemical analyses and biodegradation calculations. Assembled multi-million row database with environmental chemistry, ecological, acoustic monitoring, telemetry, and transmissometer data for use in the multi-jurisdictional, multi-billion dollar natural resource damage assessment (NRDA) claim.

Manufacturing

Steel

Performed cost assessment of remediation activities at a large steel mill in Indiana. Remediation activities, including dredging of the adjacent river, were undertaken over several decades and in response to numerous Clean Water Act (CWA) and natural resource damages (NRD) consent decrees as well as a Resource Conservation and Recovery Act (RCRA) corrective action order. The site covered thousands of acres and included numerous waste management units. Evaluated remediation costs against individual requirements of the consent decrees and corrective action order.

Chemical Products

Conducted hazard assessments for over one hundred chemical components in personal care products.

Focused on toxicological endpoints such as carcinogenicity, mutagenicity, allergenicity, and reproductive/developmental. Integrated information from international classifications (e.g., Europe, Australia, Japan, U.S.) and individual studies from regulatory agencies and private institutions. Evaluated lines of evidence for compounds of interest and appropriate read-across compounds. Assessments considered study quality, comprehensive reporting, test species, and interpretation of results.

Supported historical reconstruction of facility operations and sewer/discharge practices at a resin manufacturing facility and a fertilizer blending facility. Analysis focused on transport pathways from the facilities to the nearby harbor and contributions of cleanup drivers (PCBs, PAHs, DDT and metabolites [DDx], and dioxins/furans) in large harbor-wide remediation. Assessed regulatory compliance with state and federal agencies over the course of operations.

Reviewed potential transport pathways from a DDT production facility to a down gradient property. Performed historic reconstruction of the pathway (i.e., property development and filling activities) with aerial photographs, drain construction records, soil borings, soil chemistry data streams. Assessed precipitation data in relation to high water events that may have influenced chemical transport.

Reviewed regulatory compliance with federal (RCRA) and state (NPDES) requirements and environmental stewardship history at a PFAS chemicals manufacturing site with an onsite wastewater treatment plant. Integrated investigation and remediation activities that occurred in the course of 23 years in response to numerous consent decrees, agreements, and voluntary assessments. Assessed wastewater discharges in compliance with NPDES permitting requirements and sludge/biosolids disposal practices.

Compiled and assessed state and federal regulatory requirements for environmental approvals at a polystyrene plant in Asia.

Reconstructed historic disposal activities at the Oakdale, Woodbury, and Cottage Grove landfills in Minnesota. The Cottage Grove facility, in addition to being a disposal site, manufactured and researched PFAS. Reviewed soil and groundwater remediation activities, including installation of a full scale granular activated carbon (GAC) system at Oakdale, undertaken in accordance with state requirements. Evaluated permitting activity and compliance with historic regulations and management practices during the operational period for the landfills.

Evaluated more than 1,000 journal articles, poster presentations, government publications, and reports related to PFAS, as part of a review effort and database creation on the state of knowledge regarding this class of compounds.

Assessed compliance of architectural coatings with federal, state, and regional VOC regulations. Applied calculations to architectural coating formulations to verify compliance with EPA Title 40 Code of Federal Regulations (CFR) Part 51 requirements, California Air Resources Board (CARB), South Coast Air Quality Management District (SCAQMD), and Ozone Transport Commission VOC calculation methods. Developed data management tool to automate the calculation process and prevent user errors during data entry.

Paper

Conducted historical site reconstruction for industrial activities in and around a harbor site. Focused largely on activities related to paper mills and wood product management. Assessed compliance with Washington State (Model Toxics Control Act [MTCA]) and federal (CERCLA, RCRA, NPDES) requirements over time. Compared operations between several owners/operators. Conducted allocation among potentially liable parties for investigation and remediation costs related to contamination from PCBs, metals, dioxins/furans, carcinogenic PAHs (cPAHs), and woody debris in harbor sediments.

Leather

Assessed operation and disposal practices at a tannery in Michigan for potential PFAS groundwater contamination. Compared tannery practices to state (primarily Part 201) and federal (RCRA, Comprehensive Environmental Response, Compensation and Liability Act of 1980 [CERCLA], CWA) requirements. Evaluated state of the knowledge for overall disposal practices and PFAS-related waste disposal at various times throughout the approximate 100-year history of the facility.

Concrete

Evaluated costs incurred during participation in the Washington State Voluntary Cleanup Program (VCP). Costs were related to remedy selection, remediation, and post-remedy monitoring. Contaminants of concern were formaldehyde and petroleum hydrocarbons in soil and formaldehyde and arsenic in groundwater. Assessed compliance with MTCA and permitting requirements.

Power and Water

Evaluated changes in onsite equipment, processes, production capacities, and waste materials onsite at several manufactured gas plants (MGPs) in New York. Reviewed historic publications, regulatory documents, and environmental investigations to compile details in support of insurance litigation matters.

Assessed wastewater effluent limits in numerous countries throughout the world including Australia, Canada, Chile, France, Germany, Hungary, Kuwait, Mexico, Peru, Romania, Saudi Arabia, and the United States. Industrial, municipal/domestic, and commercial dischargers were reviewed to evaluate potential application of membrane filtration technologies. Conducted in-depth review of the discharge regulations to identify enforcement drivers for agency action when violations occur.

Reviewed water reservoir and distribution system constructed in Washington in the early 1900s. Summarized previous repairs to the tunnels and floodgates and cost of the repairs.

Prepared technical reports on coal combustion product (CCP) constituents including lithium, cobalt, and boron. Structured literature review methodologies and conducted quality assurance/quality control (QA/QC) for sections on occurrences, uses, and sources; geochemistry and fate and transport; human health toxicology; and ecological toxicology. Prepared summary of drinking water limits and health advisories lithium, cobalt, boron, arsenic, chromium, selenium, thallium, molybdenum, and radium. Conducted regulatory document and literature review for recent human health and toxicology publications. Incorporated findings into an interactive tool to support remediation site managers.

Compiled violation and exceedance data for a wastewater treatment plant in Massachusetts. Compared National Pollutant Discharge Elimination System (NPDES) permit requirements to discharge monitoring report (DMR) data extracted from EPA's Enforcement and Compliance History Online (ECHO) and Integrated Compliance Information System (ICIS) databases.

Developed sampling and analysis plan (SAP), quality assurance project plan (QAPP), and health and safety plan (HASP) for investigation and characterization of a fly ash site in British Columbia.

Performed data extraction, mapping, and general characterization of soil, sediment, and groundwater chemistry data for nuclear power site, using data from a multi-billion row database maintained by the U.S. Department of Energy. Compared chemistry (metals, radionuclides, PCBs, VOCs, trichloroethene [TCE], perchloroethylene [PCE]) to benchmark criteria.

Mines, Smelters, and Refineries

Performed numerous tasks related to the remedial investigation/feasibility study (RI/FS) and NRD efforts at the Upper Columbia River site in British Columbia and Washington State. Compiled soil and sediment chemistry database from the Washington State Department of Ecology Environmental Information Management System (EIMS) and individual research studies in northeastern Washington to estimate soil background levels for target analyte list (TAL) metals, and supported development of data quality

objectives (DQOs). Summarized mercury isotope data in sediment samples at numerous target and reference sites along the river. Assessed metals contributions to river sediments from natural (e.g., landslides) and anthropogenic (e.g., mining and smelting) sources.

Coordinated historic document management efforts for litigation involving cost allocation at a mine in New Mexico between governmental and private PRPs. Managed chemistry and ecological data collected over multiple decades at the mine and surrounding area.

Managed and analyzed soil data from a large residential area surrounding an historic copper smelter in New Jersey. Estimated impacts on a distance-weighted basis from the smelter stacks for lead and arsenic.

Performed data analysis on smelter residue material for lead in samples collected throughout a large residential area in Kansas. Compared concentrations among visual classification groupings and location around the residence (e.g., alley, walkway, driplines, etc.). Analysis was included in design of the remediation strategy.

Evaluated remediation costs for a mine site in Nevada under federal (CERCLA) and state (Nevada Division of Environmental Protection [NDEP]) programs. Analysis included determination of cost drivers under the different programs.

Conducted historic evaluation of the Big River Mine Tailings site in Missouri, which included seven different mining sites. Compared site timeline to other comparable National Priorities List (NPL) mine sites for regulatory agency involvement and major milestones.

Construction

Analyzed PCB concentrations in urban runoff in support of probabilistic analysis to assess potential PCB concentrations in effluent after treatment through best management practices (BMPs) at construction sites. Considered partitioning relationship between suspended sediment and water and suspended solid removal efficiencies for selected BMPs.

Determined reasonableness of costs incurred in response to unexpected interim remedial actions undertaken per Washington State MTCA to mitigate contaminated groundwater (TCE and daughter products). Impacts were from previous industrial dry cleaning operations located hydraulically upgradient and contaminated groundwater was withdrawn during construction dewatering in Seattle, WA. Reviewed chlorinated VOC (CVOC) movement in groundwater and efficacy of GAC and aeration treatment prior to discharge. Evaluated communications between operator and Washington State Department of Ecology in regard to construction stormwater general permit discharge compliance.

Analyzed groundwater levels and flows at a city well field in Oregon to assess whether withdrawal events coincided with settling events that resulted in damage to building foundations. Utilized time series analysis for data collected over 16 years and automated data output for real-time interpretation.

Recycling

Conducted sampling at a steel recycling facility for a case involving potential exposure to airborne lime (dust). Developed site sampling plan and health and safety plan and collected samples from piles of stocked lime, the rail line where the lime was delivered, and area soils. Worked with onsite HSE and company personnel to document circumstances around the date of claimed exposure.

Solid Waste Treatment, Storage, Disposal

Reconstructed historic disposal operations at an Ohio landfill that received domestic, commercial, and industrial waste streams for over 50 years. Identified hazardous waste streams and waste streams burned via open burning or an air curtain destructor (ACD) that operated onsite. Compared soil chemistry

data for contaminants of concern, primarily TCE and its daughter products, to benchmark values. Assessed the potential for burned wood pallets to contribute manganese and zinc to soil concentrations.

Reviewed permit requirements for solid waste disposal and waste to energy facilities in Oregon and Washington. Conducted permit searches on EPA's Facility Registry Service (FRS) website.

Agriculture

Reviewed regulations in the EU, United Kingdom (UK), Canada, U.S., and Mexico to determine whether dimethylaminoethanol was currently regulated for use as a component of fruit coatings on apples and citrus. Evaluated requirements for food additives, coatings, processing aids, and food contact materials.

Reviewed fruit packing facilities' general NPDES permit in Washington State for new chemical use requirements and modification options. Assessed permit implications for the use of a new biopesticide and reporting requirements for facilities.

Printing

Supported evaluation of waste ink composition to advise client whether waste may meet criteria of hazardous waste. Reviewed federal and state (California) regulations related to hazardous waste designation.

Airports, Air Bases, and Marinas

Managed team to review over 100,000 documents to assess multiple airport sites in England that used PFAS-containing aqueous film-forming foams (AFFF). AFFF was used to extinguish training and real fires and was spilled during various times throughout the airport operations.

Conducted data mining and analysis for 1,2,3-trichloropropane (1,2,3-TCP) in groundwater adjacent to an historic air force base in California. Utilized the California Groundwater Ambient Monitoring and Assessment Program (GAMA) and EPA Unregulated Contaminant Monitoring Rule (UCMR) databases and evaluated historic releases of 1,2,3-TCP.

Evaluated adequacy of sediment samples previously collected from a marina in Washington to determine source(s) of contamination. Compared sediment concentrations and profiles to upland soil and groundwater sources to sources from marina operations including sandblasting and painting. Contaminants of concern included PAHs and metals.

Vehicle Maintenance

Developed sampling and analysis plan (SAP), quality assurance project plan (QAPP), and health and safety plan (HASP) for an RI work plan at a vehicle maintenance facility operated by the Washington State Department of Transportation. Contaminants of concern at the site included metals, VOCs, SVOCs, PAHs, total petroleum hydrocarbons (TPH; including diesel and gasoline range organics), herbicides, and dioxins/furans. Conducted soil sampling at the site, including screening with a photoionization detector, in accordance with the RI work plan.

Reconstructed historic operation and spill information from a light and heavy-duty vehicle washing location in Oregon. Evaluated fate and transport of chlorinated (e.g., TCE and PCE) and non-chlorinated (e.g., toluene, ethylbenzene, xylene, and hexane) solvents using soil and groundwater chemistry data.

Government

Managed complex multi-year project with the Kuwait Environmental Protection Agency to analyze the country's water and waste management standards and laws and propose an updated government framework. Compared regulations to programs in the United States (CERCLA, RCRA, CWA), the

European Union (EU Water/Waste Framework Directives, Globally Harmonized System [GHS], Registration, Evaluation, Authorization and Restriction of Chemicals [REACH]), Canada (Canadian Environmental Protection Act [CEPA], Canada Water Act), and the Gulf Cooperation Council (GCC) countries. Performed a gap analysis of Kuwait's environmental laws and reviewed interactions between regulatory agencies and the regulated community. Identified governmental framework support systems and environmental data collection, management, and reporting strategies. Worked with Ministry members to develop an integrated solid waste and wastewater effluent permitting system and permit documentation. Presented results to multi-agency project participants in Kuwait and developed training modules for current government employees involved in permitting, compliance, enforcement, and standard development. Coordinated meetings for project team members in four countries and five time zones.

Multi-Industry

Developed database to organize and track historic operations, entity lineage, chemical compounds, transport pathways, and compliance violations to allocate costs among hundreds of PRPs at a large and complex site including soil, surface water, and sediment contamination. The site of interest was a highly industrialized area in New Jersey that included pre-1900 operations and a variety of industry types including: chemical production, automotive repair, smelting and refining, electro-plating, pharmaceuticals, paint manufacturing, gas stations, wastewater treatment plants, paper manufacturing, transit centers, electric and gas utilities, metal fabrication, asphalt manufacturing, drum cleaning and reclamation, and solid waste treatment/storage/disposal facilities. Additionally, assessed numerous municipalities and associated public services (e.g., state-owned facilities and combined sewer overflows) for contributions. Utilized EPA and state regulatory databases for permitted facilities (e.g., RCRA and NPDES permits) to extract information on compliance violations.

Performed temporal trend analysis of proposed, final, constructed, and deleted sites on the EPA NPL.

Performed database QA/QC and management for the sediment chemistry database for the Western Port Angeles Harbor RI/FS work to fill in data gaps. Updated toxicity equivalence (TEQ) calculated values for dioxins and PCBs in sediment chemistry samples.

Natural Disaster

Conducted literature review to identify publications with environmental chemistry data on debris and ash from wildland, urban, and suburban fires. Contaminants included organics (PCBs, PAHs, benzene, dioxins/furans), inorganics (arsenic, cadmium, copper, lead, manganese, nickel, zinc), and asbestos. Characterized source materials for contaminants. Focused on evaluating potential exposures for workers (first responders and cleanup crews) and private citizens.

Analyzed data describing precipitation and piezometer levels from monitoring wells located on the Whitman Bench above the Oso Landslide. Assessed relationship between rainfall events and groundwater levels and automated data processing and output.

Exposure Assessment

Assessed exposure for over a hundred individuals to asbestos through workplace, military, personal hobby, consumer product, and domestic sources. Reviewed depositions, Social Security records, military records, medical records, and answers to interrogatories, to provide resulting summary reports to experts.