ERIC G. LAPPALA, P.E., P.H., CRSM

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QUALIFICATIONS AND EXPERIENCE

Mr. Lappala has over 45 years of professional consulting in the Environmental, Water Resources Development, Hazardous Waste, and Radioactive Waste fields. As a professional consultant, Mr. Lappala has led and managed teams to successfully integrate technical, regulatory and economic factors into clients' management strategies. He has provided these services to the U...S. Departments of Interior, Defense, and Energy; state and local agencies, and over 60 Fortune® 500 companies representing the following industry groups: Aerospace, Chemicals, Electronics, Food & Beverage Processing, Forest & Paper Products, Manufacturing, Metal Products, Oil and Gas, Pharmaceuticals, Telecommunications, Transportation, Utilities, and Waste Management These services include:

- Assessment, development and management of ground water and surface-water supply systems for agricultural, municipal, and industrial users;
- Peer review, litigation support and expert witness services in the areas of hydrogeology, contaminant transport, and waste site development;
- Permitting and compliance assistance for land application systems for treated wastewater and biosolids;
- Development Engineer and Manager for entitlement of major subdivision projects;
- Investigation, permitting, and licensing of hazardous and low-level radioactive waste disposal facilities;
- Investigation and remediation of contaminated sites regulated under CERCLA, RCRA, and numerous State Voluntary Cleanup Programs;
- Development and implementation of multi-site, multi-company environmental liability management programs; and
- Development of Environmental Management Systems and Environmental Information Management Systems to enhance regulatory compliance at operating plants and facilities.

Mr. Lappala has represented hundreds of clients in public hearings, regulatory agency meetings, court proceedings, and legislative committees. He is a licensed Professional Engineer and a Certified Remedial Site Manger in North Carolina, and a Certified Professional Hydrologist with the American Institute of Hydrology.

Representative Projects

Reclaimed Water and Non-discharge Permitting

Vadose zone monitoring and modeling of potential nitrate migration from biosolids application
Developed and implemented a system of vadose zone monitoring approved by the NC Division of Water Quality to evaluate the potential migration of nitrate below the root zone following the permitted resumption of biosolids to agricultural fields after a 12 year non-application period. Instrumented three representative fields using Decagon G3 Drain Gages™ to collect deep percolation for NO3 analyses at depths of approximately 2 feet and 8 feet, supplemented by matric potential and moisture content monitoring to detect downward moisture movement. In the interval between the Drain Gages. Water collected in the drain gages, matric potential and moisture content are recorded on an hourly basis using field data loggers. Client: City of Raleigh Public Utilities Department.

Monitoring of Groundwater and Surface Water Quality to Assess Impacts of Residential Development
Ten-year ongoing program of installation and sampling of surface water stations and monitoring wells to provide background water quality and potential impacts from construction activities of a large mixed use development in Chatham County, NC. Monitoring program was developed and is being implemented in conformance with requirements of both Chatham County and the NC Division of Water Quality. Installation of monitoring stations and sampling are periodically adjusted in accordance with past results and build-out of the development. Client: Newland Communities Briar Chapel.

Nitrate transport modeling to obtain variance from wet weather storage liner requirements
A site-wide model was constructed and calibrated of the surficial aquifer and used as the boundary conditions for a local-scale model that included the as-built topography and bathymetry of the wet weather storage reservoir for the Surf City wastewater treatment system. The local scale model was used to assess the likely maximum lateral and vertical extent of NO3 that exceeds the NC 2L groundwater standard of 10 mg/l after 30 years. The report based on the model was used as the approval of the wastewater permit for the reservoir even though the permeability of its clay liner was greater than that specified in the NC 2T Non-Discharge Rule. Client: Town of Surf City, Onslow County, NC

Assessment of conjunctive use of reclaimed water on residential Lots, Chatham County, NC
Evaluation of changes to permitted disposal of reclaimed water from dedicated sprayfields and common area irrigation to include conjunctive use for irrigation on residential lots. Responsibilities include hydrologic and hydrogeologic and water balance evaluation of areas to be used conjunctively, modification of an existing on-going groundwater and surface water monitoring program, and preparation of required water balance for modification of the non-discharge permit. Client: Newland Communities

Hydrogeologic and water balance studies in support of non-discharge permit application for irrigation of individual lots with reclaimed water, residential subdivision, Union County, North Carolina
Principal investigator for hydrogeologic site investigation, modeling, and water balance analyses to in support of design and non-discharge permitting of the disposal of highly treated reclaimed wastewater on individual lots for a 200-home up-scale development outside of Charlotte, NC. Client: Infinity Partners.

Reclaimed water application system, Bald Head Island, NC
Developed a unique approach for expanding the disposal for reuse quality wastewater from 400,000 gallons per day (gpd) to 650,000 gpd that is conformant with the current North Carolina subchapter 2T non-discharge rules using hydrogeologic and water balance modeling. Currently completing the necessary hydrogeologic, soils, and water balance studies in support of the application for modification of the existing non-discharge permit. Client: Village of Bald Head Island and The Bald Head Island Club.

Hydrogeologic, supplemental water supply, and water balance studies, residential subdivision, Union County, North Carolina
Principal investigator for hydrogeologic site investigation, location and testing of supplemental water supply wells, and water balance analyses to aid developer in assessing water and wastewater options for a 450-home residential development south of Matthews, NC. Client: Newland Communities.

Design of a large amenity lake, residential subdivision, New Hanover County, North Carolina
Hydrogeologic and engineering evaluation to develop the design parameters for a large lake to serve as the central amenity for a large subdivision adjacent to the Cape Fear River south of Wilmington, NC. Field assessment and modeling analyses used to develop alternatives and design data to maintain acceptable water levels and quality. Client: Newland Communities.

Hydrogeologic analysis and modeling to provide deign parameters and report in support of a non-discharge permit for a subdivision in Currituck County, NC.
Groundwater flow modeling to develop the design parameters and report in support of the non-discharge permit application for the discharge of treated wastewater using a high-rate infiltration basin to serve a development adjacent to Currituck Sound. Client: Confidential

Hydrogeologic and water balance studies in support of non-discharge permit applications, two mixed use developments, Brunswick County, North Carolina
Principal investigator for hydrogeologic site investigation, modeling, and water balance analyses to in support of design and non-discharge permitting of combined sprayfields and infiltration basins for the disposal of reclaimed wastewater from two large mixed- use developments in Southport, NC. Client: Cape Fear Development LLC.

Hydrogeologic analysis and modeling to provide design parameters and report in support of a non-discharge permit, condominium development in Atlantic Beach, NC.
Groundwater flow and transport modeling and analysis in support of a non-discharge permit for reclaimed water from a multi-story condominium development that required assessment of the combined effects of the wastewater irrigation system from an adjacent development, infiltration from stormwater control basins, tidal effects and pumping from adjacent water supply wells. Client: Confidential

Hydrogeologic services in support of onsite high-rate infiltration basin and drain system for treated wastewater, Onslow County, NC.
Hydrogeologic site investigation, groundwater flow modeling, and water balance analyses to design a system of high-rate infiltration basins and drains to enhance basin infiltration in support of a large subdivision bordering the Atlantic Intra-Coastal Waterway west of Topsail Island, NC. Client: Wakefield Development

Hydrogeologic, supplemental water supply and water balance studies, very large residential subdivision, Chatham County, North Carolina
Hydrogeologic site investigation and water balance analyses to aid developer in assessing water and wastewater options for a proposed 7,500-acre development adjacent to Pittsboro, NC. Client: Confidential.

Hydrogeologic modeling in support of non-discharge permit application, commercial development, Hatteras, North Carolina
Construction and application of a three-dimensional groundwater flow model to assess the acceptable degree of mounding from infiltration of treated wastewater from a commercial development. Model required inclusion of the effects of the fresh-saltwater interface on both the ocean and sound sides of Hatteras Island. Client: Confidential

Permitting application of sprayfield irrigation of treated wastewater effluent from a commercial development, Rowan County, North Carolina
Hydrogeologic site investigation, modeling, and water balance analyses to in support of design and permitting of sprayfields for the disposal of reclaimed wastewater from a residential subdivision development in the piedmont of

North Carolina as a non-discharge facility. Work products were used in support of a successful agency express review of the non-discharge permit application and the permit has been issued. Client: High Rock Development

Review and Critical Analysis for the Modification of Irrigation Operating Rules, Large Golf Course Development, North Carolina
Independent analysis of sprayfield application of reclaimed water to golf course and other sprayfields following several years of operation. The study resulted in recommendations for changes in sprayfield operation to maximize application of reclaimed water while minimizing the use of certain fields that had developed low permeability horizons as the result of the parent soils and golf course construction. Client: Governors Club.

Permitting application of sprayfield irrigation of treated wastewater effluent from a commercial development, Guilford County, North Carolina
Hydrogeologic site investigation, modeling, and water balance analyses in support of design and permitting of sprayfields for the disposal of reclaimed wastewater from a commercial development in the piedmont of North Carolina as a non-discharge facility. Work products were used in support of a successful agency express review of the non-discharge permit application and the permit has been issued. Client: Oak Ridge Commons

Hydrogeologic and Wet Weather Storage Analysis, Large Compact Community Development, Chatham County North Carolina
Hydrogeologic site investigation and modeling to in support of design and permitting of sprayfields for the disposal of reclaimed wastewater from a 1,600 acre development in the piedmont of North Carolina as a non-discharge facility. Project included gathering site-specific data to support a conceptual model of groundwater-surface water and to constrain the construction and calibration of a three-dimensional groundwater flow model. Model was used to eliminate areas having the potential for development of a shallow permanent watertable under conditions of maximum irrigation application. Work products were used in support of a successful agency express review of the non-discharge permit application and the permit has been issued. Client: Newland
Communities

Hydrogeologic assessment and flow and transport modeling for sprayfield expansion for wastewater from a vegetable processing plant, Sampson County NC.
Hydrogeologic assessment and flow and transport modeling to permit additional acreage to dispose of treated wastewater effluent from a very large vegetable processing plant. Included optimization analysis using the groundwater flow model to maximize permitted wastewater application rates so as to maintain acceptable separation of the Seasonal High Water Table and the land surface. Responsible for managing the preparation and submittal of the modification to client's existing non-discharge permit, including coordination of all soils, agronomy, and engineering components of the application. Client: Allens, Inc.

Permitting for new spray irrigation facility, pork processing plant, Duplin County, North Carolina
Modeling and water balance for existing and new sprayfields used to dispose of treated wastewater from a pork processing Performed field investigation to install monitoring wells and conduct pumping tests. Constructed and applied three dimensional groundwater flow model to assess the appropriate hydraulic loading rates and to define local low areas needing fill to avoid areas where the water table would likely be less than three feet. Report included in non-discharge permit submittal for Express Review, and permit has been granted. Client: The Pork Company.

Permitting application of spray irrigation of combined industrial and municipal wastewater effluent, North Carolina
Site characterization, modeling, and monitoring in support of a permit for the disposal of treated effluent from combined municipal and industrial waste water plants. Disposal fields comprise shallow soils overlying fractured rocks of the Carolina Slate Belt. Client: Sheaffer International.

Permitting for new spray irrigation facility, food processing plant, North Carolina

Modeling of the hydrologic fate and transport of constituents in effluent from food processing plants that is applied using spray irrigation. Constructed and applied models of vadose zone and saturated zone groundwater flow and transport Made extensive use of sensitivity analyses to successfully demonstrate to the permitting agency that the site would conform to regulatory requirements, eliminating the need for additional extensive and exhaustive site investigation. Client: Bruce Foods.

Permitting of the resumption of biosolids application to agricultural fields, Wake County NC.
Developed and applied an approach that integrated watershed response models, variably saturated flow and transport models, and three-dimensional groundwater flow and transport models to demonstrate the likely timing and magnitude of any impacts to compliance with groundwater standards from the resumption of application of Class A and Class B biosolids to selected fields at the Neuse River Wastewater Treatment Plant. The models were constrained by extensive data collected since 2000 on groundwater and surface water nitrate concentrations, water levels, surface water flow rates, laboratory measurements of unsaturated flow properties, and vertical profiles of residual nitrate above the watertable. The analyses resulted in a recommendation that biosolids application could be resumed on over 350 acres of the fields with no exceedences of the NC 2L NO_3 standard at the compliance boundary. The North Carolina Division of Water Quality is in the process of approving a modification to Raleigh's Residuals Management Permit based upon this analysis. Client: City of Raleigh Public Utilities Department.

Water Supply and Hydrogeologic Investigations

Well design and modeling of system impacts to county water supply wells, active groundwater heat pump system, Manteo, NC
Designed extraction and injection well screens and sustained pumping and injection rates for an active groundwater withdrawal-heat exchanger- groundwater injection system for the University of North Carolina System Coastal Studies Institute. Conducted and analyzed pumping tests of extraction wells, constructed and applied a three-dimensional groundwater flow model to demonstrate the lack of significant impacts to nearby Dare County water supply wells, and to compare the effects of pumping and injection from the upper Yorktown aquifer and pumping from the Upper and injection into the Lower Yorktown Aquifer. Client: Soil & Environmental Consultants and Eastern Carolina University.

Assessment of the effects of regional water importation to Falls-of-the-Neuse Reservoir, Wake County, North Carolina
Mr. Lappala conducted analyses of alternatives to meet future water demands for the City of Raleigh and Wake County using the OASIS network model of the Neuse River Basin developed by the North Carolina Division of Water Resources. These analyses included the construction of additional reservoirs in the basin and importation of as much as 58 million gallons per day via construction of a 132 mile long pipeline from a well field in eastern North Carolina. The analyses demonstrated that such a major importation project was the only viable way to meet projected water demands past 2040. Client: Eagle Water Company.

Determination of safe yield of Manatee Reservoir, Manatee County Florida
Mr. Lappala performed extensive watershed, streamflow and reservoir analysis calculate the safe yield to be supplied to Manatee County as a water supply. These analyses included the construction and application of a SWAT model of the Manatee Reservoir watershed to generate estimates of return flow of excess irrigation water, analysis of streamflow records to extrapolate missing data in space and time, and construction and application of a daily reservoir operations model to compute safe yield under scenarios that included reservoir releases stipulated by the Southwest Florida Water Management District necessary to maintain ecologic conditions in the river and estuary below the reservoir. Client: Manatee County

Artificial recharge projects, Nebraska
Co-investigator on several Nebraska projects involving recharge through wells and spreading including: field, laboratory, and model studies of flow and transport in unsaturated zones; design and installation of recharge wells; and injection tests performed for periods up to 2 years. Recharge was successful. Client: Central Platte Natural Resources District.

Central Coastal Plain Supplemental Water Supply, North Carolina
As president of Eagle Water Company, Mr., Lappala manages all aspects of a proposed water development project that is designed to use under-utilized groundwater from the Castle-Hayne Formation to provide supplemental water supplies to municipalities and public utilities in the Central Coastal Plain Capacity Use Area as designated by the North Carolina Environmental Management Commission. Key Project components include: Assurance of water supplies that are of adequate quality and sustainable for greater than 50 years; Contracting with an adequate customer base to make the project economically viable; Design, Engineering, and Construction of a pumping and transmission system of as much as 75 miles in length to multiple customers; and obtaining Project Financing. Client: Eagle Water Company.

Supplemental Water Supply Evaluation, Union County, NC
Field investigation, location of test wells, and supervision of test well installation and testing to provide supplemental water supply for a large subdivision. Required the use of regional and local geophysical surveys field mapping, and lineament analyses to locate test wells in complex bedrock of the Charlotte Belt. Client: Newland Communities.

Water balance modeling to develop irrigation scheduling design parameters City of Raleigh Biosolids Phase III Fields, Wake County, North Carolina
Developed and applied a 100-year daily water balance model for a corn-wheat-soybean rotation to demonstrate the likely irrigation volumes and rates to maintain optimal crop growth and nutrient uptake while minimizing groundwater recharge in support of permitting the irrigation of seven new fields with reclaimed wastewater. The model demonstrated that using demand irrigation of these fields will result in low recharge rates and nitrate (NO_3) concentrations in recharge that are less than the state 10 mg/l 2L groundwater standard.

Hydrogeologic, and fate and transport modeling in support of permitting of a construction and demolition landfill, Hyde County, North Carolina
Principal investigator for the construction, calibration and application of a three-dimensional model of groundwater and surface water movement and discharge to assess the potential impacts of arsenic and other metals that may be present in leachate from a proposed regional construction and demolition landfill adjacent to the Atlantic Intracoastal Waterway. Client: Confidential.

Modeling of Nitrate Loading to Neuse River from Past Biosolids Application, North Carolina
Principal investigator for modeling of nitrate loading to the Neuse River via groundwater and surface water discharge from biosolids application to fields near the City of Raleigh's Neuse River Waste Water Treatment Plant. Loading from groundwater discharge was assessed using a three-dimensional flow and transport model integrated with ArcGIS™. Loading from surface water was assessed using the USDA Surface Water Assessment Tool (SWAT) integrated with ArcView™. Model has been used in support of remedial action design. Client: City of Raleigh Public Utilities Department.

Response to Notice of Violation, Municipal Spray Irrigation Facility, North Carolina
Principal investigator for responding to NOV from the North Carolina Division of Water Quality for alleged impacts to groundwater at the Elm City Wastewater Spray Irrigation Facility. Used existing data, new field tests and measurements, and modeling to demonstrate that spray field operations were not the source of levels of nitrates in monitoring wells in excess of NC groundwater standards. The most likely source was shown to be previous agricultural operations on the property and adjacent properties. Client: Town of Elm City.

Peer Review, Litigation Consulting, and Testimony

Analysis of Claimed Impacts to Residential Lots from Raising Water Levels in Boating Access Waterways, Bladen County, NC
Prepared analyses with three-dimensional groundwater flow and surface water flow models to demonstrate that site development and drainage conditions on the lots in question were the most likely cause of claims of groundwater rising beneath structures on the subject lots. Client Baytree Lakes Development Co.

Litigation Consulting, Claims of Impacts to Residential Development Water Supply from Biosolids Application Fields, Wake County, NC

Developed analyses with three-dimensional groundwater flow and transport models of a fractured rock aquifer to demonstrate that under past, current and reasonably expected climatic conditions (including global climate change) that there was no possibility that such impacts would occur. Included developing analyses based upon suppositions of opposing counsel and expert witnesses. Included preparation of deposition questions for counsel and reviow and comment on opposing expert witnesses, and preparation of expert testimony. review of opposing Case has been resolved in favor of my client without going to trial. Client: Kilpatrick-Townsend ,LLP and City of Raleigh Public Utilities Department.

Peer Review of Multi-year Groundwater-Surface Water Modeling Project for 29,000 sq. mi area of Nebraska, Wyoming, Colorado, and Kansas

Peer review team leader and principal reviewer of detailed groundwater-surface water models for the Cooperative Hydrologic Study (COHYST). The models were prepared by a team comprising the U.S. Geological Survey, the State of Nebraska, local Natural Resource Districts, and the Central Platte Power and Irrigation District. The models were constructed and calibrated to support compliance by Nebraska with a three-state agreement to manage groundwater and surface water conjunctively to preserve and enhance migratory waterfowl habitat along the Platte River, and as tools for local resource management agencies to assess a wide range of groundwater and surface water management strategies. Principal review criteria included adequacy of conceptual and numerical models, calibration, sensitivity, and verification analyses, uncertainty in model analyses to meet project objectives, and alternative modeling approaches. Client: Cooperative Hydrology Study Steering Committee

Ward Valley California National Academy of Science Peer Review Hearings

Prepared and presented testimony on four of the seven issues evaluated by the NAS panel: Potential transfer of contaminants through the unsaturated zone and potential for contamination of groundwater; Potential infiltration from the repository trenches by shallow subsurface flow; Potential for hydrologic connection between the site and the Colorado River; and The need for monitoring plans for groundwater and the unsaturated zone downgradient of the site. Client: US Ecology.

Denial of License for the Central Interstate Compact Proposed Low Level Radioactive Waste Disposal Facility, Boyd County, Nebraska

Principal hydrogeologic consultant and expert witness for the State of Nebraska in litigation regarding the denial of the license application. Responsible for: Developing independent conceptual and simulation models of the occurrence and movement of groundwater in the vadose and saturated zones; Documenting and demonstrating the presence and frequency of occurrence of the watertable relative to disposal facility components. Documenting and demonstrating the occurrence of groundwater discharge from shallow groundwater systems within the disposal facility boundary; Assessing the adequacy with which the applicant integrated site characterization and performance assessment modeling; Assessing the adequacy with which the applicant considered reasonable hydrologic and hydrogeologic bounding case scenarios for performance assessment'; Developed and presented time-lapse visualizations of groundwater discharge; prepared expert reports; and presented testimony in open court regarding these issues.

Cost Allocation Testimony, Clare, Michigan

Provided expert testimony in case involving multiple potential sources of groundwater contamination of a municipal well field. Preparation for testimony included extensive review of existing data collected by multiple consultants to the parties, integration of that in formation using a Geographic Information System, and three-dimensional groundwater flow and flowpath modeling. The GIS was successfully used in live testimony to respond to answers from the judge and from counsel representing all parties to the action. Client: Illinois Tool Works.

Waste Disposal Facility Siting License, Louisiana

Testified as a qualified expert witness on issues of groundwater flow and chemical transport. Successfully demonstrated that the site as designed would not result in any adverse impacts on groundwater or surface water. Site is located behind levees in the floodplain of the Mississippi River at an elevation lower than the mean river stage. Site operating license was issued as a result of this testimony. Client: Genstar-Briscoe-Maphis.

Contract Project Management

Brownfields development, former aircraft manufacturing facility, Southington, Connecticut
Responsible for recruiting and managing environmental engineering firms to implement compliance with the CT Transfer Act requirements for the former Pratt & Whitney manufacturing plant. Responsible for overseeing and approving project budgets, work plans, schedules, and work products. Serve as the client representative at meetings with regulatory agencies and AIG, the issuer of the cost-cap insurance policy for the site. Client: Cherokee Investment Partners.

Entitlement of three residential and mixed use developments, Southport, North Carolina
Responsible for managing and coordinating work by engineers, landscape architects, and surveyors for the final plat approval for three developments in Brunswick County, NC. Required significant coordination and negotiation with officials of the City of Southport to conform to requirements driven by the coastal location of the projects as well as city development ordinances. Included management of required coastal storm surge flooding studies to demonstrate effects of site development. Final plat approval has been obtained for all three subdivisions subject to owners posting infrastructure construction bonds. Client: Confidential

Radioactive Waste

Modeling and Quantitative Analysis in Support of Westinghouse Electric Application to dispose waste from Hematite, MO facility at US Ecology Idaho
Prepared and applied a three-dimensional groundwater flow model centered on the US Ecology Idaho site and used to demonstrate that the ultimate impact of rising water levels beneath the site that have been observed over the last 10 years will not reduce the protectiveness of the site. Included assessment of potential causes of rising water levels including changes in regional recharge over geologic time and consolidation of clays by surface loading of waste in disposal cells. Client: US Ecology Idaho.

Fate and Transport Modeling to Support US Ecology Application for Waste Acceptance Criteria Modification, Grand View, Idaho
Prepared Waste Acceptance Criteria modification application sections regarding the likely fate, transport, and water-pathway dose resulting from a combination of the existing waste stream and proposed additional waste streams that may include power plant decommissioning and demolition wastes. Used RESRAD and VS2DT in combination with site-specific transport parameters to successfully demonstrate that the water pathway dose was less than acceptable criteria set by the State of Idaho. The WAC modification was approved by the State of Idaho with only minor comments and questions regarding the fate and transport modeling. Client: US Ecology Idaho.

Central Interstate Compact Proposed Low Level Radioactive Waste Disposal Facility, Boyd County, Nebraska
Principal hydrogeologic consultant and expert witness for the State of Nebraska in litigation regarding the denial of the license application. Responsible for: Developing independent conceptual and simulation models of the occurrence and movement of groundwater in the vadose and saturated zones; Documenting and simulation of recharge at the site using fine-time-scale modeling of the vadose zone; Documenting and demonstrating the presence and frequency of occurrence of the watertable relative to disposal facility components. Documenting and demonstrating the occurrence of groundwater discharge from shallow groundwater systems within the disposal facility boundary; Assessing the adequacy with which the applicant integrated site characterization and performance assessment modeling; Assessing the adequacy with which the applicant considered reasonable hydrologic and hydrogeologic bounding case scenarios for performance assessment'; Developed and presented time-lapse visualizations of groundwater discharge; prepared expert reports; and presented testimony in open court regarding these issues. Client: State of Nebraska

North Carolina Low-Level Radioactive Waste Disposal Facility, Wake County, North Carolina

Principal technical consultant responsible for assessing past unsuccessful technical and regulatory negotiation approaches to licensing a disposal site for low-level radioactive waste in North Carolina under their obligation to the Southeast Compact Commission. Assigned to lead a multi-consultant team responsible for implementing these recommendations and negotiating a consensus work plan with the regulatory body charged with licensing the disposal facility. Successfully negotiated the consensus work plan and developed a revised project management approach (and management team) to implement the plan. All parties acknowledge this approach to be the best, most cost-effective method ever developed to prepare this complex License Application. Client: North Carolina Low-Level Radioactive Waste Management Authority.

Ward Valley Site License, California
Principal technical consultant for the site selection, characterization and preparation of license application for the California Low Level Radioactive Waste Disposal Facility. One of the principal architects of the approach assisted with site selection, characterization, and the required monitoring vadose zone monitoring plan. Prepared numerous technical position papers during the project, and provided testimony to technical panels and the California Legislature. Designed and supervised tasks including detailed characterization and modeling of the potential transport of radionuclide species in the vadose and saturated zones, gas phase transport, and field demonstrations of transport processes. Client: U.S. Ecology

Invited Participant in Symposium: Recent developments in modeling unsaturated flow and transport
Battelle Northwest Laboratories conference, Battelle Conference Center, Seattle, Washington. Presented review paper on the state of the practice of modeling unsaturated flow and transport and recommendations for future research needs. Client: U.S. Geological Survey.

Nation-wide Low-Level Radioactive Waste Disposal Facilities.
Provided consultation and review of experiments, and reports, on low-level radioactive waste disposal sites including Beatty, Nevada; Sheffield, Illinois; Maxey Flats, Kentucky; West Valley, New York; and Barnwell, South Carolina. Client: U.S. Geological Survey.

Civilian High Level Nuclear Waste Disposal Program
Responsible for review of all hydrological studies and reports for evaluation of suitability of area for high-level radioactive waste disposal at Gulf Coast Salt Domes and Atlantic Coast Piedmont granitic plutons locations. Evaluated and redirected computer modeling studies of regional, near-field, and repository-scale hydrological transport systems. Client: U...S. Department of Energy.

Fate and Transport Research.
As research hydrologist, performed basic and applied research relating to occurrence and movement of water, solutes, and heat in unsaturated zone. Activities included: (l) computer modeling of multidimensional systems to describe simultaneous movement of water, heat, and solutes in variably saturated systems; (2) design and execution of laboratory and field experiments for heat and moisture movement relating to problems of radioactive waste disposal and groundwater recharge in arid and semiarid areas; (3) writing and documenting computer program for automatic identification of aquifer contaminant transport parameters from single-well tracer tests; (4) computer modeling and field measurements of evapotranspiration from shallow water tables; and (5) direct measurement and modeling of recharge under different vegetation types. Client: U.S. Geological Survey

Natural Attenuation Projects

Natural Attenuation Decision, Industrial Site, North Carolina.
Served as the principal technical reviewer for project that was successful in obtaining Monitored Natural Attenuation as the approved remedy at a complex site in Research Triangle Park. Site strategy included demonstrating through extensive data analysis and visualization methods that attenuation was being accomplished as a result of the combination of restricted flow paths in fractured, Triassic rocks and a series of reductive de-halogenation processes. Client: Bristol Meyers-Squibb.

Major Contaminated Site Investigations

Hydrogeologic and Geochemical Modeling of Cobalt Migration from Industrial Site, North Carolina
Assessment of the potential for migration of cobalt in groundwater to compliance boundary from a formerly used metals processing facility in Scotland County, NC. Project scope includes construction and calibration of a three dimensional flow and transport model using an extensive database of characterization and monitoring data provided by another consultant and use of the models to evaluate transport with and without reactive barriers to cobalt migration. Client: Umicore and Dunklee and Dunham.

Remediation of contamination by heavy metals, golf course maintenance facility North Carolina.
Completed site investigation, modeling, and remedial design and implementation for groundwater contamination by arsenic, lead, and chromium from a turf-maintenance washing facility. Remedial design included use of a Permeable Reactive Barrier, source removal by groundwater extraction and disposal to a public wastewater treatment facility, and natural attenuation. Project required extensive interaction and negotiation with owners of properties overlying the contamination plume. Approval to remove the remedial system has been obtained from the NC Division of Water Quality as the result of the successful remediation of the contaminated groundwater. Client: Bluegreen Golf Clubs, Inc.

Semiconductor manufacturer, Mountain View, California
Project manager for remedial investigation at a semiconductor-manufacturing site in Mountain View, California. The project included a soil gas investigation; underground tank, sump, and pipeline evaluations; installation of multiple-level monitoring wells; borings; chemical analysis; and contaminant hydrogeologic analysis. Client: Confidential

RI/FS, Santa Clara, California
Project manager for remedial investigation/feasibility study in Santa Clara County, California. Project included a soil gas investigation, the installation of monitoring wells, an aquifer simulation, a contaminant hydrogeologic analysis, and design of groundwater control and treatment systems. Client: Confidential

Landfill Investigations, Pima County Arizona
At two landfills in Pima County, Arizona, managed groundwater study to determine relative contributions of three sources of pollution and to recommend cleanup procedures. Client: Pima County, Arizona

Cost Allocation Modeling, California
Provided guidance using a quasi-three-dimensional finite element flow and transport model to design most economically efficient aquifer restoration programs for an industrial site in Santa Clara County, California. Performed analytical and numerical modeling to demonstrate relative contribution from multiple parties contributing to a complex, multi-aquifer groundwater contamination site. Client: Raytheon Semiconductor

Multi-site, Multi-Company Regulatory Compliance

Enterprise-Wide Compliance Management Program, Nationwide
As client manager to a large industrial client, responsible for providing appropriate company resources to manage and implement a system that encompassed environmental matters resulting from regulatory actions at the state and federal level, from property transactions, and from other corporate-wide environmental management programs. Implemented a system of management controls, information management, and communications that has provided the client with consistent technical, cost, and regulatory strategy approaches. This system is used on over 20 sites across the U.S., and is served by project managers and resources drawn from company offices nationwide. Client: Allegheny-Teledyne, Inc.

Development of corporate-wide Environmental Management System

Principal consultant for a large, multi-company, multi-site manufacturing client. Developed the initial planning tools and approaches used with the client to create an Environmental Management approach tailored to meet the needs and requirements of the corporation, division, company, and plant. Working with the client, Mr. Lappala developed an approach and systems to capture the following information: baseline waste generation, waste characterization, waste emission, and regulatory compliance requirements. This system serves is now being used across all business lines and corporate levels to minimize environmental costs and manage change in products, processes, and regulatory requirements. Client: Confidential.

Environmental Liability Management Program.
Principal consultant for the evaluation of the presence of and consequences of multi-media contamination for over 400 industrial and other facilities throughout North America and Europe. Designed the approach used to minimize financial and regulatory exposure impacts on company operations. Client: Confidential.

Regulatory Strategy and Response Program
In support of programs involving divestiture and regulatory compliance at multiple facilities across the U.S., Mr. Lappala served as principal consultant for the management of environmental evaluations and investigations. responsible for the approaches and consulting services for projects ranging from short notice due diligence evaluations to those implemented under CERCLA and RCRA. Client: Confidential.

Federal Superfund Sites

Mr. Lappala has worked at more than 25 Superfund sites including: Woodlands; Tucson International Airport Area; Advanced Micro Devices; Fairchild; GATX Annex Terminal; IBM; Intel; Moffett Naval Air Station; McKesson Chemical; Purity Oil Sales; Raytheon; Signetics; Stringfellow; Teledyne Semiconductor; TRW Microwave, Inc.; United Heckathorn Co.; Lowry Landfill; Marshall Landfill; Rocky Mountain Arsenal; Woodbury Chemical; Acme Solvents; Kane and Lombard Street; Times Beach; Chemsol; South Valley; and Wasatch Chemical (Lot 6). The following project descriptions provide examples of Mr. Lappala's Superfund site experience:

Rocky Mountain Arsenal, Denver, Colorado
Co-investigator for construction, calibration, and use of finite element groundwater flow and contaminant transport models. Project manager for design and implementation of groundwater sampling protocol and monitoring programs. As the principal investigator, assisted in developing model of groundwater system. Consultant on problems related to offsite migration of pesticides and products related to chemical weapons manufacture. Managed 3-year project defining contaminant sources in support of litigation and remedial action planning. Client: U.S. Army.

Semiconductor facility, Mountain View, California
Project manager for remedial investigation and operable unit feasibility studies at 100-acre site with multiple contamination sources, plumes, and aquifers. Client: The MEW RI/FS Group.

Boulder-Marshal Landfill, Colorado
Project manager for development of work plan and review and oversight of EPA contractors for remedial investigation/feasibility study. Client: Confidential.

Times Beach, Missouri
Project manager for hydrogeologic and geotechnical investigation of dioxin contamination. Client: CH2M Hill.

Tacoma Tar Pits, Commencement Bay, Tacoma, Washington
Project manager for investigation of former Manufactured Gas Plant site, including sampling waste, groundwater, and surface water. Client: CH2M Hill.

Petroleum facility, Fresno, California
Project manager for remedial investigation at Purity Oil Sales, Inc., site. Client: California Department of Health Services.

South Valley, Albuquerque, New Mexico
Consultant for hydrogeology and modeling for solvent-contaminated groundwater to assess impacts on Municipal well fields. Client: van Waters & Rogers.

Acme Solvents, Rockford, Illinois
Consultant for initial hydrogeology, field investigations and evaluation of interim remedial measures. Client: Acme Solvents Steering Committee.

Lowry Landfill, Colorado
Technical consultant for a remedial investigation/endangerment assessment/feasibility study at the Lowry Landfill. Responsibilities included design and consulting on groundwater and contaminant transport modeling. Client: The Lowry Coalition.

RCRA

RCRA Facility Investigation, Calvert City Kentucky
Provided site investigation and remediation strategy for one of the largest RCRA RFI sites in the county at a chemical manufacturing facility in Kentucky. Responsibilities included formulating site conceptual models and designing data collection programs to confirm these models. RFI activities were designed to consolidate as many RCRA SWMUs as possible under the CAMU concept to minimize site investigation and remedial costs. Client: Elf Atochem.

RFI, Electrical Equipment Manufacturer Raleigh, North Carolina
Provided technical strategy and implementation planning for a site with multiple SWMUs involving soil and groundwater contamination. Client: Square D Company.

Nationwide TSD Facility Audit Program
Technical consultant and investigator for a nationwide program of periodic audits of RCRA-permitted TSD Facilities to assure industrial clients that these facilities were operating and had operated in a manner that did not result in risk to generators from disposal of their regulated wastes. Clients: Confidential.

Regulatory Program Assistance, Nationwide
Provided technical consulting and review to EPA for implementation of Resource Conservation and Recovery Act (RCRA). Work involved review of applications for variances to requirements for groundwater monitoring and technical changes to regulations. Client: A.T. Kearney.

No-Migration Petition, Waste Isolation Pilot Plant in Carlsbad, New Mexico
Technical reviewer to assess the adequacy of the petition in addressing groundwater transport pathways as well as gas generation from mixed radioactive and hazardous waste proposed for disposal at the facility. Client: A.T. Kearney.

State-Lead Regulatory Programs

Negotiation of Favorable Administrative Order on Consent, Pennsylvania
Project manager and client advocate for the successful negotiation of an AOC that codified the results of a successful limited-scope investigation for a site contaminated with chlorinated solvents in fractured bedrock to depths of 400 feet, the presence of NAPLs, and contamination of an adjacent steam. Site investigation and negotiation successfully integrated the requirement to coordinate and manage stream channel improvements performed by a contractor to the local municipality because the stream sediments were impacted by groundwater discharge from the site. Client: Allegheny Teledyne Inc.

Major Utility Compliance Project, California

Technical consultant for project planning and review to help major California utility achieve regulatory compliance. Work included vadose zone and groundwater investigations to evaluate integrity of ponds. Client: Southern California Edison

Major Petroleum Refinery, California
Provided technical consulting services to bring major southern California petroleum refinery into compliance with regulations. Project involved evaluation of leakage from raw crude and refined product storage tanks and distribution systems. Client: Mobil Oil Company.

Underground Tank Regulation Consulting, California
Prepared alternative regulations for vadose zone and groundwater monitoring for Assembly Bill 1362 (Sher Bill) and presented them to California Regional Water Quality Control Board. Project involved evaluation of technical feasibility of proposed regulations, and produced more economical monitoring methods for vadose and saturated zones. Client: Western Oil and Gas Association

Information Technology and Geographic Information Management Systems

Development of Data Management Hydraulic Modeling and Geographic Information Management Systems for a Phosphate mining and manufacturing complex, North Carolina
Developed a system for the integrated management of mining, surveying, utility, process water flow, and environmental compliance information for the largest phosphate fertilizer mining and manufacturing complex in North America. Integrated legacy databases and flat files into a SQL server environment. Integrated SQL database with ArcView™ and prepared over 100 interactive gridded datasets for mine development and management. Developed custom GIS query and reporting tools using MapObjects™ and Visual Basic™ for real time monitoring of the flow and chemical content for the no-discharge recycling process water system. Developed and demonstrated a prototype for deployment over client's intranet using Microsoft .NET™ technologies. Client: PCS Phosphate

Development of a compliance management plan for groundwater contamination at a major pharmaceutical manufacturing facility, North Carolina
Developed a database-GIS system by integrated large volumes of legacy data from a variety of formats. Completed system is a tool for client to use in demonstrating compliance with environmental regulations, for demonstrating the basis for locations where monitoring is no longer needed, and as a tool for guiding additional site investigations. Client: Confidential

PROFESSIONAL EXPERIENCE

EAGLE RESOURCES, P.A.

1999 - Present
Southport, NC
President and Principal Engineer
Independent consultant providing professional hydrologic, hydrogeologic, and engineering services to public and private clients in the areas of Water Resources Development, Siting and Permitting Waste disposal and Management Facilities, Water and Wastewater Permitting and Compliance, Environmental Liability Management, , Environmental Litigation Support, and Environmental Due Diligence.

HARDING LAWSON ASSOCIATES

1983 - 1999
Senior Vice President
1996 - 1999 Raleigh, NC
1989 - 1996 Princeton, NJ
1983 - 1989 Novato, CA

- Managed and developed the company's largest three private sector accounts for a consecutive 4- year period. Assisted clients with regulatory strategy and planning, technical advice, oversight of other consultants, and regulatory negotiation.
- Managed all company-wide private sector business development.
- Managed all company-wide federal sector business development, contract compliance, and project implementation
- Responsible for starting offices in Tucson, Denver, Princeton, and Raleigh.
- Standing member of senior management team reporting to the CEO and President.
- Actively participated in the team that launched a successful IPO in 1987.

THE EARTH TECHNOLOGY COMPANY

1981 – 1983 Long Beach, CA
Associate Hydrogeologist and Group Manager

U.S. GEOLOGICAL SURVEY

1968 – 1981
Research Hydrologist Denver, CO
Hydrologist Lincoln, NE, Albuquerque, NM

EDUCATION

BS in Watershed Management, Colorado State University, 1968

MS in Civil Engineering, Water Resources Development, University of Nebraska, 1977

Over 100 quarter-hours of continuing professional education in engineering, geology, information management, business management, and environmental sciences

REGISTRATIONS AND CERTIFICATIONS

- Licensed Professional Engineer North Carolina, No. 026990
- Certified Professional Hydrogeologist, No. 319, American Institute of Hydrology
- Registered Site Manager, NC Inactive Hazardous Sites Cleanup Program.

PROFESSIONAL MEMBERSHIPS AND POSITIONS

- American Society of Civil Engineers
- American Institute of Hydrology
- National Association of Groundwater Scientists and Engineers
- American Water Resources Association
- American Chemical Society
- American Water Works Association (Member of North Carolina Water Reuse Committee)
- American Consulting Engineers Council: National Chairman of Environmental Committee, 1991-1993
- Soil Science Society of America

REFERENCES

Please feel free to contact the following individuals as current references for Mr. Lappala:

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PUBLICATIONS and PROFESSIONAL CONSULTING REPORTS

Mr. Lappala is the author of over 40 publications, and over one hundred consulting reports and presentations. He was the principal author of the computer program VS2D, which is widely used in the environmental industry to analyze problems of water and contaminant transport in the vadose zone.

Representative publications include the following.

2013. Permit WQ0003832, Limited Corrective Action Plan, Bruce Foods' Wilson NC Processing Facility, Wastewater Surface Irrigation, Wilson, NC. January 19.

2012. Method and Results Demonstrating the Acceptability of Resuming Biosolids Application to Selected Areas of the City of Raleigh Neuse River Waste Water Treatment Plant Fields, Wake County, NC. July 19.

2012. Supplemental Hydrogeologic Report The Pork Company New Sprayfield, Duplin County, North Carolina, July 12.

2011. Summary of Pumping Test on Coastal Studies Institute (CSI) Well PW-1, Recommended Extraction and Injection Well Locations, and Summary of Modeling Hydraulic Impact on Dare County Skyco Well 9 by CSI Pumping Wells, Dare County, NC, August 19.

2011. Summary of Groundwater Flow and Transport Analysis to Evaluate Remedial Alternatives for High Chloride Concentrations in Proctor Brothers Nursery Irrigation Wells, Cumberland County, NC, May 17.

2011, Professional Opinion Regarding Groundwater and Drainage Conditions 1355 Bay Tree Drive, Bladen county, NC, February 9.

2010. Evaluation of Safe Yield of Manatee Reservoir to Provide Water Supply for Manatee County Public Utilities, Manatee County, Florida, October 29.

2010. Groundwater Mounding Analysis And Groundwater Quality Assessment, Wrenn Road Wastewater Treatment Plant Spray Irrigation System, Garner, Wake County, North Carolina, May 21.

2010. Review of Infiltration Basin Performance River Dunes Basin 3, Bay River Metropolitan Sewer Authority Pamlico County, North Carolina, May 7.

2009. Numerical Simulation of Extraction Well Capture, Progress Energy Brunswick Nuclear Plant Groundwater Remediation, December 30.

2009. Comprehensive Site Assessment and Corrective Action Plan Report, Carolina National Golf Course Maintenance Facility, Brunswick County, NC, October 27.

2009. Loading Capacity Assessment Permit WQ0003823, Bruce Foods Irrigation Fields B and C, Wilson, NC, May 19.

2009. Hydrogeologic Assessment High-Rate Infiltration Basin, Trinity Bay Development, Currituck County, NC, May 5.

2009. Hydrogeologic and Geochemical Assessment, Permit WQ0003823, Bruce Foods Irrigation Field A, Wilson, NC, January 17.

2008. Hydrogeologic and Water Balance and Wet-Weather Storage Analyses, Allens, Inc. Plant # 7 Permit WQ0004268 Rowan Road Irrigation Fields. Sampson County, North Carolina, December16.

2008. Hydrogeologic Assessment, River Road Development, New Hanover, county, NC, December 1.

2008. Hydrogeologic Report Ocean King Development, Atlantic Beach, North Carolina, July 11.

2008. Hydrogeologic Report, The Woods Development, Union County, NC, April 3.

2008. Hydrogeologic Report, Town of Elm City Sprayfield Expansion, Wilson and Nash Counties, NC, March 30.

2007. Assessment of Irrigation Requirements City of Raleigh Neuse River Wastewater Treatment Plant, Phase III Sprayfields, Wake County, November 11.

2007. Evaluation of Alternative Cap Design Horry County, South Carolina Landfill, March 11.

2006. Hydrogeologic Model and Water Balance Analysis, Sewanee Utility District, St. Mary's Land Application Unit, Franklin County, TN, September 28.

2006. Hydrogeologic and Fate and Transport Analysis, Proposed Construction and Demolition Landfill, Hyde County, NC, August 12.

2006. Hydrogeologic Study, Southport Crossing Wastewater Treatment Facilities, Southport, NC, July 10.

2006. Hydrogeologic Study, Williams corner Development, Chatham County, NC, June 4.

2006. Analysis of Groundwater Discharge to Stonyton Creek, Cherokee Investment Partners LLC, Former Borden/Smith-Douglass Facility, Kinston, North Carolina, March 5.

2006 Groundwater Mounding Analysis Sea Castle Development Dare County, North Carolina March 4.

2006. Water Balance and Wet Weather Storage Analysis, Governor's Club, Chatham county, NC, January 31.

2005. Hydrogeologic Study, Water Balance, and Wet Weather Storage Determination, Sunset Pointe Development, Rowan County, North Carolina December 14

2005. Site-Specific RESRAD Water Pathway Parameters for the Contaminated Soil, Vadose Zone, and Saturated Zone, US Ecology, Grand View, Idaho, April 7.

2005. Hydrogeologic Study, Water Balance, and Wet Weather Storage Determination, JPC Utilities Sprayfield Expansion Guilford County, North Carolina May 15.

2005. Analysis of Groundwater Discharge to Stonyton Creek. Cherokee Investment Partners LLC Former Borden/Smith-Douglass Facility Kinston, North Carolina. August 1.

2005. Hydrogeologic Study, Water Balance, and Wet Weather Storage Determination, Briar Chapel Development Chatham County, NC February 5.

2004. Hydrogeologic Study, Water Balance, and Wet Weather Storage Determination, Rockbridge Subdivision Knightdale, N.C. August 15.

2004. Hydrogeologic Report, The Pork Company New Sprayfield, Duplin County, NC, February 17.

2004. Hydrogeologic Study, Ridgley Hills Development, Wake County, NC, February 3.

2003. Simulation of Nitrate Transport in Groundwater City of Raleigh Biosolids Application Fields, September 10.

2003. UST Closure Report, Waste Motor Oil Tank 004, Hooker Oil Company Brantley Service Station, Highway 33, Aurora, NC, June 25.

2003. Limited Site Assessment Report, Hooker Oil Company Brantley Service Station, Highway 33, Aurora, NC, May 31.

2003. Free Product Recovery Report, Hooker Oil Company Brantley Service Station, Highway 33, Aurora, NC, May 9.

2002. Hydrogeologic Study, Water Balance, and Wet Weather Storage Determination, Sheaffer International – Marshville Facilities and Proposed Irrigation Application Areas Union County, NC, November 6.

2002. Introduction to Modeling of Hydrologic Systems: Internet interactive learning course: American Water Resources Association.

1992. Computer Models for Subsurface Water. *in* Handbook of Hydrology (with M.P. Anderson, D.S. Ward, and T.A. Pricket). *Ed.* David R. Maidment. McGraw-Hill, Inc.

1991. Field measurements and modeling as applied to estimating recharge rates and potential radionuclide migration, California Low Level Radioactive Waste Disposal Facility, Ward Valley, California, Symposium-Recharge in Arid and Semi-Arid Regions, 83rd Annual Meeting, Soil Science Society of America, October.

1989. Status of performance assessment, California low-level radioactive waste disposal facility. Paper presented at Focus 89 - Nuclear Waste Isolation in the Unsaturated Zone; Las Vegas, Nevada, September 18-21 (with J.L. Grant and S.A. Romano). In *Proceedings* from symposium. 1988. Soil Venting of Volatile Organic Compounds from Low Permeability Soil at a site in Santa Clara County, California. Paper presented at the American Institute of Chemical Engineers Conference, Denver, Colorado, and August 21-24.

1984. Detection of soil and groundwater contamination by shallow soil gas sampling. Paper presented at Hazardous Materials Control Research Institute's Fifth National Conference on Management of Uncontrolled Hazardous Waste Sites, November, Washington, D.C. (with G. M. Thompson).

1983. Evaluation of *in-situ* natural clay layer for the containment of coal fired power plant wastes at the Intermountain Power Project, Lynndyl, Utah. Consulting report.

1983. Two-dimensional fluid flow in variably saturated porous media with nonlinear source terms and boundary conditions, computer program documentation. U.S. Geological Survey, Open-File Report, Menlo Park, California.

1982. Simulating the effects of organic leachates on clay liners. In Proceedings, Symposium on the Role of Unsaturated Zones in Hazardous and Radioactive Waste Disposal, Spring Annual Meeting, Philadelphia, Pennsylvania, American Geophysical Union, Washington, D.C.

1982. Recent developments in modeling unsaturated flow and transport. In *Proceedings*, jointly sponsored NCS/Battelle Northwest Laboratories conference, Battelle Conference Center, Seattle, Washington.

1982. Evaluation of the exploratory stage of the U.S. Army Toxic and Hazardous Materials Agency contamination survey at Tooele Army Depot, Tooele, Utah. Consulting report prepared under U.S. Army contract DAAG49-8l-C-0l92.

1981. Experimental determination of coupled heat and moisture movement in unsaturated sand. Abstract of paper presented at John Ferris Symposium on Groundwater Hydraulics, Spring Annual Meeting, Baltimore, Maryland, American Geophysical Union, Washington, D.C. (with D. I. Stannard).

1980. Documentation of programs for the solution of the dispersion-convection equation with linear adsorption and kinetics in radial coordinates with automatic parameter identification. Water Resources Investigations, U.S. Geological Survey, Menlo Park, California.

1980. Modeling of water and solute transport under variably saturated conditions: state-of-the-art. In *Proceedings*, Interagency Workshop on Modeling and Low Level Radioactive Waste Management, Denver, Colorado.

1979. Factors involved in movement of water through the unsaturated zone. In *Proceedings*, meeting of the Groundwater Management Districts Association, Colorado Springs, Colorado.

1979. Simulated changes in groundwater levels and streamflow resulting from future development (1970-2020) in the Platte River Basin, Nebraska. Open File Report 79-26, Water Resources Investigations, U.S. Geological Survey, Menlo Park, California (with P. A. Emery and F. J. Otradovsky).

1979. The simulation of solute and heat transport to evaluate aquifer parameters. In *Proceedings*, Symposium on Trace Element Migration by Fluid Flow, Fall Annual Meeting, San Francisco, American Geophysical Union, Washington, D.C.

1978. Predictive analyses of groundwater discharges in the Willow Creek Watershed, Northeast Nebraska. Water Resources Investigations 78-67, U.S. Geological Survey, Menlo Park, California (with J. T. Dugan).

1978. Groundwater availability in the Hitchcock-Red Willow, Frenchman Valley and Meeker Driftwood Irrigation Districts, Southwest Nebraska. Open File Report 76-461, U.S. Geological Survey, Menlo Park, California (with P. F. Hemphill and R. E. Booker).

1977. Coupled models at the soil and saturated zones for use as a water management tool. In *Proceedings*, Symposium on Unified Studies of the Saturated-Unsaturated Zones, American Geophysical Union, Spring Annual Meeting, Washington, D.C.

1977. Quantitative hydrogeology of the Upper Republican Natural Resources District, Southwest Nebraska. Water Resources Investigations 78-38, U.S. Geological Survey, Menlo Park, California.

1976. Changes in the water supply in the Upper Republican Natural Resources District, Southwest Nebraska, from 1952-75. Open File Report 76-498, U.S. Geological Survey, Menlo Park, California.

1975. Review of hydrologic data and interpretations, Nebraska Mid-state Diversion, Pick-Sloan Missouri Basin program. Administrative report prepared for the U.S. Department of the Interior, U.S. Geological Survey, Menlo Park, California (with E. P. Weeks and V. B. Sauer).

1975. Stream-aquifer hydrology. Technical report, Missouri River Basin Commission, State of Missouri.

1974. Calibration of regional groundwater flow models in the absence of time-dependent system response. In *Proceedings*, Symposium on the Groundwater/Surface-Water Interface, Fall Annual Meeting, San Francisco, California, American Geophysical Union, Washington, D.C.

1974. Groundwater hydrology of the northern high plains of New Mexico. New Mexico State Engineer Technical Report.

1972. Groundwater resources of Mora River drainage basin, western Mora County, New Mexico. New Mexico State Engineer, Technical Report 37 (with J. W. Mercer).

1972. Erwin-1 Production Well, City of Gallup, McKinley County, New Mexico. Open File Report, U.S. Geological Survey, Menlo Park, California (with J. W. Mercer).

1971. Drilling and testing of Well 69, Fort Wingate Army Depot, McKinley County, New Mexico. Open File Report, U.S. Geological Survey, Menlo Park, California (with J. W. Mercer).

1970. A geophysical study of alluvial valleys in western Mora County, New Mexico. Open File Report, U.S. Geological Survey, Menlo Park, California (with J. W. Mercer).

1970. Investigation of a water supply near Encino, New Mexico, in relation to nearby high-energy detonations. Open File Report, U.S. Geological Survey, Menlo Park, California (with F. C. Koopman and J. A. Basler).