

BRUCE K. DARLING

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Dr. Bruce K. Darling's background encompasses the fields of hydrogeology, groundwater exploration and development, geochemistry, statistical analysis of geological data, and water planning and economics. He has consulted for many clients on matters related to the chemistry of water resources and the origin, transport, and fate of contaminants in groundwater and surface water systems. Bruce has substantial experience with problems related to the occurrence of arsenic, heavy metals, naturally occurring radionuclides, groundwater age-dating, and identification of sources of natural gas contamination in groundwater. He is proficient in the use of PHREEQCI, Geochemist's Workbench, and Visual MINTEQ, and the statistical analysis program Minitab. Through his affiliation with Hydrogeologists Without Borders, he is technical director on a project to develop spring water resources for villages in the eastern Marakwet District of The Great Rift Valley of Kenya, and he also serves as technical adviser to Well Aware, a nonprofit organization involved in the development of water resources in Kenya. He is a licensed professional geologist (P.G. #57) in Texas.

EDUCATION

Ph.D., Geological Sciences (Hydrogeology and Geochemistry), 1997, The University of Texas at Austin

M.A., Energy & Mineral Resources (Mineral Economics), 1989, The University of Texas at Austin

M.S., Geology, 1984, The University of Louisiana at Lafayette

B.A., Philosophy, 1975, The University of Louisiana at Lafayette

Ph.D. Program, Mineral Economics Department (1989), Colorado School of Mines, Golden, Colorado

EXPERIENCE

Hydrogeologists Without Borders, Marakwet Water & Sanitation Project, Technical Director

Well Aware, Technical Adviser for Projects in Kenya

Austin Community College, January 2008 – Present, Adjunct Lecturer in Geology

Southwest Groundwater Consulting, LLC, Established October 2007, Principal

Geology Department, University of Louisiana at Lafayette, 2004 to December 2006, Adjunct Lecturer

LBG-Guyton Associates, Austin, TX, 1996 to 2007, Geochemist/Hydrogeologist

Law Environmental, Inc., Kennesaw, GA, 1994 to 1996, Geochemist/Hydrogeologist

Bureau of Economic Geology, Austin, TX, 1990 to 1994, Graduate Research Assistant/Hydrogeologist

Austin Community College, Austin, TX, 1990 to 1991, Adjunct Faculty Member, Geology

U.S. Bureau of Mines, Denver CO, 1989, Minerals Economist (Summer Appointment)

Pennzoil Exploration & Production Company, Midland, TX, 1981 to 1986, Exploration Geologist

REPRESENTATIVE EXPERIENCE

Geochemistry

Saint Johns Water Management District, Florida – Compiled, reduced, analyzed, and interpreted data on the flux of nutrients to bodies of surface water. Analysis evaluated effects on chemistry of runoff from different land-use areas, along with the effects of septic tanks, sewer lines, spray fields, reuse water and confined animal operations. Investigation was basis for recommending permitting of land-use in the district.

Culberson and Hudspeth Counties, Texas - Directed investigation of groundwater and surface water systems between the towns of Sierra Blanca and Van Horn, Texas to assess potential impact of application of treated sewage sludge (biosolids) on groundwater and surface-water resources of an 80,000-acre ranch. Directed field investigations and interpretation of geologic, hydrogeologic, and hydrologic data. Designed and conducted public education program at request of client, and represented client in negotiations with Texas Natural Resource Conservation Commission.

City of Clearwater, Florida – Conducted investigation of native groundwater chemistry and potential for dissolution of limestone and mobilization of arsenic from injection of treated wastewaters and mixing of groundwater with treated wastewaters for proposed artificial recharge project. Investigation included an assessment of the potential to reduce the potential for the dissolution of arsenious sulfide minerals through the use of sodium bisulfide as an additive to treated wastewaters.

Culberson and Hudspeth Counties, Texas - Directed investigation of groundwater and surface water systems between the towns of Sierra Blanca and Van Horn, Texas to assess potential impact of application of treated sewage sludge (biosolids) on groundwater and surface-water resources of an 80,000-acre ranch. Directed field investigations and interpretation of geologic, hydrogeologic, and hydrologic data. Designed and conducted public education program at request of client, and represented client in negotiations with Texas Natural Resource Conservation Commission.

Escambia County, Florida – Represented client in an investigation involving the occurrence of elevated radiological activity in groundwater in the vicinity of a storm-water runoff pond at an electric power generating plant. Ash stored at the plant is washed into pond. Client wanted to renew the permit to operate the pond, but regulators required client to account for the high radiological activity in groundwater before they would issue another permit. Designed an investigation which involved analyses of samples of core from monitoring wells for uranium (U) and thorium (Th), and a series of column tests using solutions of different pH and ionic strength to determine whether the radionuclides could be traced to sediments or to the ash. Laboratory analyses indicated high concentrations of U and Th in clays, and nonparametric sign tests supported the conclusion that the U and Th concentrations in local sediments were higher than normal for sedimentary rocks of that type. Column tests showed that radionuclides were leached from sediments but not from ash. Column tests also showed a sharp drop of pH in all solutions in contact with clay. Final pH of any solution in contact with ash was much higher. Based on the results of this investigation, regulators eliminated all groundwater monitoring requirements for radiological activity at the plant.

Panola County, Texas – Conducted investigation of source of natural gas causing shallow water wells on property of Carthage High School to flow. Major oil producer was concerned that the gas might be traceable to nearby wells operated by the company and producing from Travis Peak and Cotton Valley formations. Samples of gas (analyzed for mole fractions of C1 – C6+ hydrocarbons and stable isotopes) collected from the water wells and from producing gas wells eliminated biogenic gas (lignite from Wilcox formation), along with thermogenic gas from Travis Peak and Cotton Valley formations. Based on normalized gas fractions, along with key stable isotope ratios of methane through propane fractions, Dr. Darling identified Blossom formation as probable source of gas.

Bossier Parish, Louisiana – Retained to provide assessment of gas well blowout on shallow water bearing sands overlying Sligo gas field. Conducted extensive geochemical sampling and analysis program. Concluded that impact was largely limited to deepest of six sands within 350 ft of surface, and that affected area of shallower sands used by local residents was much smaller than projected by experts working for plaintiffs. Worked with engineers to produce comprehensive work plan to remediate site. The work plan proposed technology to remediate site for less than \$4 million, in contrast with estimates of more than \$50 million by plaintiffs' expert. Case settled in mediation after submission of report.

Goliad County, Texas – Represented Goliad County Commissioners in case involving application to Texas regulatory agencies to develop an *in-situ* uranium leach mine. Review of geochemistry data revealed that exploration drilling liberates uranium, radium, and other metals from roll-front deposits, causing baseline data to indicate that groundwater is contaminated before exploration activities. Also wrote report to illustrate that Texas regulators routinely grant waivers for relaxed restoration standards at *in-situ* leach mines.

Lafayette Parish, Louisiana – Developed groundwater age-dating model for the Lafayette Utilities System (LUS). The project involved analyses of radiocarbon, carbon-13, tritium, oxygen-18, and deuterium to determine origin and probable ages of groundwater. The principal objectives were to determine potential for transport of contaminants to shallow sands of the Chicot aquifer, the sole source of water for LUS. The investigation formed the basis for refining the source-water protection plans of LUS and other public water suppliers of Lafayette Parish.

Iberia Parish, Louisiana – Retained as technical expert by attorneys in suit filed over claims of contamination of soil and shallow groundwater in Iberia oil and gas field. Investigation focused on occurrence and distribution of arsenic in soils and in shallow groundwater.

Fort Walton Beach, Florida – Developed geochemical model to account for factors affecting the speciation and transport of arsenic in groundwater in the surficial (sand and gravel) aquifer of Fort Walton Beach, Florida. The model focused on the role of redox chemistry as a primary factor underlying the distribution of oxidized and reduced species of arsenic. The geochemical model formed the conceptual foundation underlying the development of a transport model based on U.S. Geological Survey's program PHAST- a numerical code that simulates multi-component, reactive solute transport.

Jackson County, Florida – Developed geochemical model to illustrate that elevated arsenic in groundwater in vicinity of a coal ash storage pond is traceable to natural sources and not to ash or to seepage from pond. Model illustrated the role of reductive dissolution as a principal factor underlying periodic liberation of arsenic from ferric oxyhydroxides.

Bay County, Florida – Directed Investigation to identify source or sources of arsenic in groundwater of the surficial aquifer in vicinity of an electric generating power plant. Client was under an administrative order to account for the occurrence of arsenic and to develop a plan to minimize threats to sources of drinking water if the arsenic were traceable to fly ash or bottom ash. The investigation was designed to examine arsenic concentrations of formation materials and ash, and the potential to liberate arsenic from different materials under variable redox conditions. Analyses of clays and other fine-grained sediments within 100 ft of the surface demonstrated high naturally occurring concentrations of arsenic. Relying on data compiled over a 10-year period and on analyses conducted specifically for this investigation, Dr. Darling demonstrated that arsenic is liberated during periods when the shallow groundwater system is sufficiently reducing to destabilize metal oxide and to drive the reduction of arsenate to arsenite.

Hillsborough County, Florida – Conducted investigation at an industrial site of factors accounting for elevated concentrations of arsenic in the surficial aquifer south of Tampa, Florida and adjacent to Tampa Bay. Investigation illustrated that the surficial groundwater system is sufficiently reducing to destabilize metal oxide substrates and to drive reduction of arsenate to arsenite. Concentrations of arsenic in samples of groundwater from wells upgradient of suspected source area and in offsite locations were also greater than Primary MCL of 10 micrograms/liter. Finally, examination of laboratory analyses of material suspected to be the source of the contaminant revealed only one occurrence of arsenic – all others being listed as either not-detected or below the reporting limit.

Bay County, Florida – Principal investigator in study to identify sources of elevated radiological activity in groundwater in the vicinity of a fly ash disposal pond at an electric generating power plant in Bay County. Regulators suspected that radionuclides leached from fly ash were the sources of high gross-alpha, gross-beta, Ra-226, and Ra-228 in groundwater. Laboratory analyses of core samples demonstrated that surficial sediments have naturally-occurring high concentrations of the parent elements uranium (U) and thorium (Th). Results of leaching tests indicated little potential for release of radionuclides from fly ash; and plots of chloride versus gross-alpha and gross-beta showed a high degree of correlation between total dissolved solids (TDS) and radiological activity. The model developed for this project explained the elevated radiological activity as a function of cation-exchange reactions driven by high-TDS groundwater in contact with U- and Th-rich sediments along the shoreline of a bay adjacent to the ash pond. Represented client in negotiations with regulatory agency. As a result of the model developed for this project, regulators eliminated all groundwater monitoring requirements for radionuclides at the plant.

Webster Parish, Louisiana – Retained to provide expert report and testimony in case involving contamination of shallow groundwater and surface water by seepage of saline water discharged to a reserve pit during drilling of gas well. Directed installation of monitoring wells, and sampling program to evaluate impact on groundwater and surface water. Concluded that saline water is flushing from shallow sands under natural recharge and flow processes and that there is no basis for resorting to extraordinary remediation measures. The final report also demonstrated that there is no discernible impact of saline water on nearby pond.

Fulton County, Georgia – Conducted an investigation to identify the factor or factors accounting for low-pH groundwater at a wood-treatment plant in East Point, Georgia. The owners of the treatment plant had installed a system to remediate contamination caused by creosote, but low pH of groundwater reduced the effectiveness of the remediation system, and piping laid as part of the system became clogged with aluminum sulfate. Monitoring wells delineated areas near the plant where the pH of groundwater was 3.0 to 4.0 in an area where pH is normally 5.5 or greater, and sulfate concentrations ranging up to 1,400 to 6,000 milligrams per liter (mg/l) where the concentration is normally 20 mg/l or less. Field reconnaissance coupled with development of a local groundwater flow model indicated that the problem could be traced to an adjacent upgradient location of an abandoned battery plant. Mass-balance equations illustrated that sulfuric acid spilled from rail cars and storage tanks would have reacted with aluminosilicate rocks to mobilize enough aluminum to react with sulfate derived from sulfuric acid to produce the aluminum sulfate clogging flow lines and to account for high sulfate concentrations in groundwater. This effectively countered explanation by defendant's consultants that organic chemicals used to treat wood had reacted with sulfide minerals to cause low pH and high sulfate concentrations.

Bibb County, Georgia – Conducted investigation for a client interested in developing a spring to support a commercial bottled water operation. Initial tests by the **Georgia Department of Natural Resources** (GDNR) indicated spring water gross-alpha in excess of the drinking water standard. Client wanted to identify the source of radioactivity and to determine whether deeper artesian sands could be developed as a source of supply for the planned bottled water business. Proposed a drilling program to delineate local hydrostratigraphy and a sampling program to identify potential sources of radioactivity and the range of gross-alpha values. Laboratory analyses consistently showed elevated gross-alpha and acidic pH in spring water, but gross-alpha within the drinking water standard and higher pH measurements from deeper confined sands. Recommended developing deeper artesian sands instead of spring as source of supply. GDNR approved clients application for a license to produce groundwater from the deeper sand.

Liberty County, Texas – Retained to design and direct an investigation to support an application to the Texas Railroad Commission (TRC) for a permit to apply freshwater drilling mud on farmland in Liberty County, Texas. Landowner's initial application had been challenged by drainage district representatives who were concerned about potential for contamination of groundwater and surface water from infiltration

and runoff. The investigation involved evaluation of surface drainage, mapping of soils on the proposed site and adjacent properties, identification of wells within a one-mile radius of the site, measurement of groundwater levels, and construction of maps showing changes in groundwater levels in the Evangeline-Chicot aquifer over a 40-year period. Testified as expert witness for applicant at hearing conducted by TRC.

Hudspeth County, Texas – While employed by University of Texas Bureau of Economic Geology (BEG), conducted a three-year (1991 – 1994) hydrogeologic study of the Eagle Flat and Red Light basins of Hudspeth County, Texas, in conjunction with a site-characterization study of a proposed disposal facility for low-level radioactive waste. Responsible for development of conceptual flow model and associated geochemical models to explain variations in water chemistry along projected flow paths. Used naturally occurring radioactive isotopes and stable isotope data to delineate recharge areas and to develop a groundwater age-dating model. Isotopic models were used as basis to calibrate numerical flow and transport models.

Andrews County, Texas - Directed hydrogeologic and hydrogeochemical evaluation of the Ogallala aquifer in Andrews County, Texas (1998 – 1999) for Utah-based company interested in developing a treatment and storage facility for low-level radioactive waste. The objective was to assess the potential for the contamination of shallow groundwater by radioactive wastes. The field program involved geologic mapping in the vicinity of the site, the installation of 59 monitoring wells, and the collection of groundwater samples for laboratory analyses of major ions and selected stable isotopes and radioisotopes. Isotopic data were used to develop model explaining timing and distribution of recharge and residence time of groundwater.

Andrews County, Texas – Directed investigation to age-date groundwater of Ogallala and Dockum formations, as part of application by client to secure a license to operate a disposal facility for low-level radioactive waste (2006). Results of investigation were principal basis for estimating residence time of groundwater and to assess risk to local sources of drinking water.

Wake County, North Carolina – Geochemist on study (1994 – 1997) of a proposed low-level radioactive waste disposal site in Wake County, North Carolina. Wrote specific work instructions for collection of groundwater and surface-water samples for analyses of major ions, stable isotopes, unstable isotopes, and reduction-oxidation potential. Directed intensive field program to build geochemical and isotopic database to support evaluations of the proposed site, and developed geochemical transport and fate models. Responsible for designing groundwater tracer tests and identifying appropriate tracers for natural-gradient and forced-gradient tests in fractured-rock terrane. Served as outside technical reviewer for prime contractor during last year of project.

REPRESENTATIVE EXPERIENCE IN WATER PLANNING AND ECONOMICS

Evaluation of Surface-Water Resources Needed to Support Development of the Haynesville Shale of Northwestern Louisiana (2010) – Directed investigation of surface water resources in five-parish area of northwestern Louisiana for Shell Exploration & Production. The objective was to identify most reliable and most cost-effective sources of water to support natural gas production from the Haynesville Shale natural gas play. The investigation included evaluations of availability, water chemistry, and potential development and permitting problems.

Louisiana Comprehensive Water Management Plan, Part 1, Identification and Use Assessment of Louisiana Water Resources (November 2001 – June 2002) – Directed development of project proposal and workplan for Part 1 of water planning project. Worked on daily basis with staff to collect and evaluate data, and write chapters addressing background material, population and water use, groundwater resources, water management plans of other states, and technical and socioeconomic issues underlying

delineation of critical areas. Made periodic presentations to members of the Louisiana Groundwater Management Commission and the Louisiana Groundwater Advisory Task Force, and advised Commission and Task Force members on data requirements and institutional issues to ensure effective management of water resources in Louisiana.

Louisiana Comprehensive Water Management Plan, Part 2, Planning and Management Issues (July 2002 – December 2002) - Developed work plan for Part 2 of Water Management Plan in association with representatives of C.H. Fenstermaker & Associates. Concentrated efforts primarily on chapters related to water management strategies; surveys of public opinion regarding the preference for and feasibility of implementing strategies; recommended approaches to developing programs to promote public education, water conservation, and incentives to use surface water; and development of an emergency use and contingency plan. Also contributed heavily to chapters addressing legal issues (specifically water rights) and structure of agency recommended to manage water resources.

Clearwater Undergroundwater Conservation District, Bell County, Texas (2001) - As subcontractor to Turner Collie & Braden, Inc. (TC&B), directed a study of the groundwater resources of the Edwards and Trinity aquifers of Bell County, Texas, to assist the Clearwater Undergroundwater Conservation District in its efforts to develop a groundwater management system consistent with the guidelines of Texas' Senate Bill 1 water planning program. Wrote the proposal and the work plan, and then oversaw a program to develop the database and management models, which were developed as a user-friendly Geographic Information System format by TC&B. The study presented new hydrostratigraphic cross sections, potentiometric maps, estimates of the availability of groundwater, identification of primary recharge areas, estimates of average annual precipitation recharge, identification of potential sources of groundwater contamination, and recommendations to minimize long-term stresses on the aquifers of Bell County.

Far West Texas Water Planning Program (1998 – 2001) – Principal author of proposal to secure contract with the Far West Texas Regional Water Planning Group (FWTRWPG), and one of two co-authors of final report submitted to the Texas Water Development Board. Responsible for deriving estimates of the availability of groundwater resources and the development of policy recommendations to ensure the availability of groundwater in the counties of the Planning Region. Identified existing and potential threats to groundwater and surface water resources, and developed cost estimates for selected management strategies. Made regular presentations to update the public and members of FWTRWPG on progress of planning program.

San Antonio, Texas – Developed economic model for the San Antonio Water System (SAWS) to estimate market values of water rights in the southern Edwards aquifer region (Bexar, Medina and Uvalde Counties, Texas) based on agricultural production, economic data obtained from Texas Agricultural Statistics Service, and estimates of water used to irrigate farmland for different crops. The model was used as a basis to guide negotiations for the acquisition of water rights from landowners and the purchase of water by short-term or long-term contracts.

Hutchinson County, Texas – Technical representative and expert witness for defendant (oil producer) in a case predicated on the allegation that a landowner had suffered loss of income from sale of groundwater because of contamination of a small alluvial valley-fill aquifer by an oil and gas producer. Reviewed technical and economic documents prepared by plaintiff's consultants, depositions of plaintiff and plaintiff's experts, and published documents on hydrogeology and regional water planning needs. Also surveyed managers of undergroundwater conservation districts, and directors of public utilities of cities located in Texas panhandle and areas to the south to collect up-to-date information on status of regional water-resource needs, planned supply projects, and past and current water-supply contracts.

Del Rio, Texas - Retained to determine whether City of Del Rio should negotiate a long-term contract to purchase water from landowners with property 30 miles northeast of the city limits. Evaluated consultants' reports, and concluded that lower-cost and reliable sources of supply were available within city limits. Recommended that Del Rio not pursue negotiations further, and then proposed strategy for development of groundwater resources using City-owned property.

Live Oak County, Texas – Advised owners of ranch in Live Oak County, Texas in negotiations on price of groundwater sold to Diamond Shamrock refinery. Surveyed prices of recent transactions for groundwater and surface water in the vicinity of Live Oak County, and then proposed adjustment of original contract price based on Consumer Price Index over a 19-year period. Based on recommendations, Client re-negotiated price between \$60 and \$70 per acre-ft.

Guadalupe and Gonzales Counties, Texas – Advised owners of ranch in Guadalupe and Gonzales Counties, Texas in negotiations with a Metropolitan Water District in the vicinity of San Antonio regarding a proposal by the district to lease groundwater rights. Reviewed details of the contract proposed by the District to evaluate implications of leasing under the proposed terms. Outlined issues of concern, and recommended that owners of the ranch consider holding out under expectation that a larger neighboring water system (SAWS) might be willing and able to offer a higher price for a long-term lease.

REPRESENTATIVE EXPERIENCE IN AQUIFER CHARACTERIZATION AND GROUNDWATER DEVELOPMENT

Del Rio, Texas – Directed study of groundwater development potential in southern Val Verde County, Texas. Objective was to ascertain whether Edwards Formation and stratigraphic equivalents are capable of producing a sufficient volume of groundwater to be a principal source of supply for Del Rio. Project led to decision to develop two wells to supplement current surface-water source, along with recommendation to drill additional wells. Advised City in negotiations with landowners interested in selling water on a take-or-pay basis. Also represented City in negotiations with Texas Natural Resource Conservation Commission.

Brewster, Jeff Davis, and Presidio Counties, Texas – Principal author of proposal to conduct evaluation of the Igneous aquifer system of Brewster, Jeff Davis, and Presidio Counties, Texas as follow-up to Far West Texas Regional Water Planning (FWTRWPG) project. One of two principal authors of final report submitted to the FWTRWPG.

Ward, Pecos, Loving, and Reeves Counties, Texas – Conducted screening investigations in a four-county region of west Texas to identify areas where geologic, hydrogeologic, and hydrologic factors would support the construction of an assured isolation (above-ground storage) facility for low-level radioactive waste. On basis of exploratory drilling and mapping program, located an area in northern Ward County that met all criteria specified by the Texas Bureau of Radiation Control for development of a facility. Designed and directed final drilling and sampling program. Hydrogeologic cross-sections supplemented by core samples indicated low potential for contamination of groundwater, as the proposed site was underlain by 200 - 300 ft of low-permeability redbeds of the Dockum (Triassic) Group. Geologic interpretation also addressed potential impact of dissolution of deeply buried salt beds on long-term stability of surface features. Concluded that there is no direct or indirect hydrogeologic connection between the surficial formations and the aquifer providing drinking water for residents of Ward County.

Nolan County, Texas - Conducted hydrogeologic investigation to identify potential areas for development of groundwater in the vicinity of Sweetwater, Texas. Identified areas with best potential for development, and directed follow-up study of land and water values.

Winkler County, Texas – Technical consultant for independent oil and gas company in case based on allegation that oil producer had contaminated soil at 42 sites and groundwater at 3 sites at Scarborough oil field (Frying Pan Ranch) between 1998 and 2000. Retained specifically to address reliability of plaintiff's \$4.9-million damage model. Program of work involved evaluation of production history of oil field, detailed geologic mapping of oil field using historical air photos, development of maps using real-time GPS mapping system, and surveys of the dimensions of tank batteries, off-lease spills, and evaluation of inputs to plaintiff's damage model.

THESES AND SELECTED PUBLICATIONS, ABSTRACTS, ARTICLES, AND PRESENTATIONS

Theses and Dissertation

Darling, Bruce K. (1984), *The Depositional Environments of the DeQueen Formation (Trinity Group) in the Nathan Quadrangle of Southwestern Arkansas*: M.S. thesis, Geology Department, Univ. of Louisiana at Lafayette.

Darling, Bruce K. (1989), *An Analysis of Factors Affecting the Level of Barite Mining in the United States*: M.A. thesis, Energy and Mineral Resources (Mineral Economics), The Univ. of Texas at Austin

Darling, Bruce K. (1997), *Delineation of the Groundwater Flow Systems of the Eagle Flat and Red Light Basins of Trans-Pecos Texas*: Ph.D. dissertation, Department of Geological Sciences, The University of Texas at Austin.

Publications

Lock, B.E., Darling, B.K., and Rex, I.D. (1983), *Marginal Marine Evaporites, Lower Cretaceous of Arkansas*: Gulf Coast Association of Geological Societies Transactions, v. 33, p. 145 – 152.

Darling, B.K., and Lock, B.E. (1984), *The Lower Cretaceous Formations of Southwest Arkansas, and a Proposed Revision of Stratigraphic Rank for the Three Lowest Units*: Gulf Coast Association of Geological Societies Transactions, v. 34, p. 321 – 327.

Darling, B.K., Hibbs, B.J., Dutton, A.R., and Sharp, J.M., 1995, *Isotope Hydrology of the Eagle Mountains Area, Hudspeth County, Texas - Implications for Development of Groundwater Resources*, in Hotchkiss, W.R., Downey, J.S., Gutentag, E.D., and Moore, J.E., eds., *Water Resources at Risk*, American Institute of Hydrology, Minneapolis, MN, p. SL12-24.

Hibbs, B.J., and Darling, B.K. (1995), *Aquifer Testing and Characterization at the Proposed Low-Level Radioactive Waste Disposal Site, Hudspeth County, Texas*, in *Groundwater Management*: American Society of Civil Engineers, New York, p. 205 – 210.

Hibbs, B.J., and Darling, B.K. (1995), *Salinization of the Rio Grande Alluvial Aquifer in Hudspeth County, Texas*, in *Research Leads the Way*, Proceedings of the 24th Water For Texas Conference, P. 157 – 161.

Hibbs, B.J., and Darling, B.K., 1995, *Environmental Isotopes and Numerical Models for Understanding Aquifer Dynamics in Southwestern Basins*, in Cleveland, T.G., ed., *Advances in the Development and Use of Models in Water Resources*, AWWA, Herndon, VA, p. 195 - 200.

- Hibbs, B.J., Darling, B.K., and Ashworth, J.B. (1995), Interbasin Movement of Groundwater and Vertical Groundwater Flow, *in* Texas Water '95, First Int'l Congress on Water, Am. Soc. Civil Engineers, p. 267 – 277.
- Darling, B.K., Hibbs, B.J., and Sharp, J.M. Jr. (1998), Environmental Isotopes as Indicators of the Residence Time of Groundwaters of the Eagle Flat and Red Light Basins of Trans-Pecos Texas, *in* The Search Continues into the 21st Century, Proceedings of the West Texas Geological Society Fall Symposium, Midland, TX, p. 259 - 270.
- Hibbs, B.J., Darling, B.K., and Jones, I.C. (1998), Hydrogeologic Regimes of Arid-Zone Aquifers Beneath Low-Level Radioactive Waste and Other Waste Repositories in Trans-Pecos, Texas and Northern Chihuahua, Mexico, *in* Brahana et al. (eds), Gambling with Groundwater - Physical, Chemical, and Biological Aspects of Aquifer-Stream Relations, American Institute of Hydrology, Minneapolis, MN, p. 311-322.
- Darling, B.K. and Hibbs, B.J. (2001), The Aquifers of Red Light Draw, Green River Valley, and Eagle Flat, *in* Mace, R., Mullican, W.F. III, and Angle, T. (eds), The Aquifers of West Texas: Texas Water Development Board Report 356, Austin, TX, Chapter 16.
- Scanlon, B.R., Darling, B.K., and Mullican, W.F. III (2001), Evaluation of Groundwater Recharge in Basins in Trans-Pecos Texas, *in* Mace, R., Mullican, W.F. III, and Angle T. (eds), The Aquifers of West Texas: Texas Water Development Board Report 356, Austin, TX, Chapter 3.
- Hibbs, B.J., and Darling, B.K. (2005), Revisiting a Classification Scheme for U.S.-Mexico Alluvial Basin-Fill Aquifers, *in* Groundwater, V. 43, No. 5 (Theme Issue: Transboundary Groundwater), National Groundwater Association, pp. 750 – 763.

Abstracts

- Darling, B.K., and Lock, B.E. (1982), Sabkha or Subaqueous Intrastratal Origin of Chicken-Wire Gypsum, DeQueen Formation (Cretaceous), Arkansas: American Assoc. of Petroleum Geologists, v. 66 no. 5, p. 161.
- Darling, B.K., Sharp, J.M, and Hart, M. (1991), Delineation of Groundwater Systems by Cluster, Principal Components, and Multiple Discriminant Analyses: Geological Society of America, Rocky Mountains Section Annual Meeting, Albuquerque, NM, Abstracts with Programs.
- Hibbs, B.J., Darling, B.K., and Peckham, D.S. (1994), Isotope Hydrology and Simulation of Groundwater Flow in the Red Light Draw Bolson – a Southwestern Alluvial Basin: Geological Society of America, Abstracts with Programs (Annual Meeting), v. 26, p. A362.
- Hibbs, B.J., and Darling, B.K. (1995), Sources of Salinity in the Rio Grande Alluvial Aquifer: *New Waves*, The Research Newsletter of the Texas Water Resources Institute, v.8, no.2, p.10
- Darling, B.K., and Emerson, P. (2001), Removing Obstacles to Water Marketing: Abstract and presentation at Texas Water Conservation Association meeting in Austin, Texas, January 2001.
- Hibbs, B.J., Darling, B.K., and Hawley, J.W. (2001), Revisiting a Classification Scheme for Southwestern Alluvial Basin Aquifers: Geol. Soc. America Abs. with Programs (Cordilleran Sec.), v.33, p.A-39.

Darling, B.K., Hamilton, G.B., Stover., S.L., and Sonnier, B. (2002), Water Management Planning in Louisiana *in* Dutton S.P., Ruppel S.C., and Hentz, T.F. (eds), Gulf Coast Association of Geological Societies Transactions, v 52, p. 76.

Hibbs, B.J., and Darling, B.K. (2002), Revisiting a Classification Scheme for Southwestern Alluvial Basin Aquifers: SAHRA 2nd Annual Meeting, an NSF Science and Technology Center at the University of Arizona, (Poster Session) Abs. with Programs, R10.

Articles

Darling, B.K. (April, 2007), Texas Groundwater – Rule of Capture and Groundwater Management in Texas. *The Water Report*, Issue 38, p. 9 – 17.

Darling, B.K. (July 2007), Groundwater in Texas – Marketability and Market Value. *The Water Report*, Issue 41, p 18 – 23.

Selected Presentations

Determinants of the Market Value of Groundwater: Presentation at Texas Water Conservation Association, Houston, Texas (October 2001).

Water Planning in Louisiana: Presentation at Louisiana Water Quality Technology Conference, Alexandria and Baton Rouge, LA (December 2001).

Water Usage in Louisiana, and the Development of a Statewide Comprehensive Water Management Plan: Presentation to Lafayette, LA Rotary Club (April 2002).

The Louisiana Comprehensive Groundwater Management Plan: Presentation to Alexandria, LA Chamber of Commerce (May 2002).

Estimating the Economic Value of Groundwater – the Texas Experience: Presentation at Louisiana Mid-Continent Oil and Gas Association Environmental Affairs Conference, Baton Rouge, LA (Dec. 2002).

Update on Louisiana Groundwater Management Plan: Presentation at Louisiana Water Quality Technology Conference, Alexandria and Baton Rouge, LA (December 2002).

Groundwater Management Issues in Louisiana: Series of Three One-Hour Presentations for Lorman Educational Services, Bossier Parish, LA (August 2004).

Age-Dating Groundwater for the Lafayette Utilities System: Presentation at Quarterly Meeting of Groundwater Advisory Committee, Louisiana Department of Environmental Quality, Baton Rouge, LA (May 2005)

Preference-Feasibility Analysis as a Tool to Understand Rural-Urban Water Needs and Conflicts in Louisiana: Presentation at Louisiana Water Summit, Bossier City, LA (August 2005).

Understanding Groundwater Markets and Market Values of Water Rights in Texas: Presentation at Texas Water Law Conference, Austin, TX (September 2005).

Isotopic Indicators of Groundwater Age and Paleoclimatic Conditions in the West Texas System of Bolsons: Presentation at National Groundwater Association Water Summit, San Antonio, TX (April 2006).

Developing Water Resources in The Great Rift Valley of Kenya. Presentation made to academic institutions and professional organizations after trip to Kenya to conduct preliminary evaluation of potential to develop groundwater and spring water resources in the eastern Marakwet District.