List of Contributors

Bland, Douglas M.
Special Projects Manager
New Mexico Bureau of Geology and Mineral Resources
New Mexico Institute of Mining and Technology
76 Encantado Loop
Santa Fe, NM 87508
(505) 466-6696 Fax: (505) 466-3574
dmbland@comcast.net

Doug Bland has worked for the New Mexico Bureau of Geology and Mineral Resources since 2004, primarily as project manager for educational programs and conferences on natural resource topics, including decision-makers field conferences. He served as director of the Mining and Minerals Division of the New Mexico Energy, Minerals and Natural Resources Department from 1998 through 2002, where he was responsible for overseeing environmental protection and permitting of mine sites. He also held various technical and managerial positions in the Mining and Minerals Division between 1989 and 1998. His experience includes twelve years in the mining and petroleum industries. He holds B.S. and M.S. degrees in geology from Virginia Tech and the University of Wyoming.

Bowman, Robert S.
Professor of Hydrology & Department Chair
Department of Earth and Environmental Science
New Mexico Institute of Mining and Technology
801 Leroy Place
Socorro, NM 87801
(505) 835-5992 Fax: (505) 835-6436
bowman@nmt.edu

Robert Bowman teaches and performs research in hydrology and water chemistry in the hydrology program at New Mexico Tech. Much of his career has involved investigations of the fate of contaminants in soil and ground water, including movement of nutrients and pesticides below irrigated fields, leaching of metals from contaminated soils, and transport of solvents and fuels from spill sites. More recently he has turned his attention to surface water/ground water interactions in the Rio Grande valley. He is one of the scientific leaders of a statewide effort, funded by the National Science Foundation, to improve estimates of evapotranspiration in the Rio Grande riparian corridor. Prior to joining New Mexico Tech in 1987, he spent five years as a soil scientist with USDA's Agricultural Research Service in Phoenix. He holds an A.B. degree in chemistry from the University of California, Berkeley, and a Ph.D. in soil chemistry from New Mexico State University.

Cleverly, James
Research Assistant Professor, Hydrogeoecology Group
Department of Biology, University of New Mexico
MSC03 2020
1 University of New Mexico
Albuquerque, NM 87131
(505) 263-9536 Fax: (505) 277-6318
cleverly@sevilleta.unm.edu

James Cleverly is a research assistant professor in the biology program and heads the Hydrogeoecology Group at the University of New Mexico. Dr. Cleverly has led and participated in numerous projects evaluating bosque water use in Nevada, New Mexico, Colorado, Kansas, and Nebraska. His primary research is the study of physiological and ecological relationships between salt cedar and native riparian species, water relations, growth, carbon partitioning, competition, invasion of riparian habitats by salt cedar, evapotranspiration, restoration water salvage, climate, and water loss from the Middle Rio Grande's shallow aquifer to the atmosphere. He recently contributed to the regional water plan prepared for the New Mexico Mid-Region Council of Governments and the New Mexico Water Assembly, providing an evaluation of water salvage due to bosque restoration using state-of-the-art estimates of plant water use at various locations along the Middle Rio Grande. Partnerships that have supported this research include the National Aeronautic and Space Administration, the U.S. Fish and Wildlife Service, the New Mexico Interstate Stream Commission, the U.S. Bureau of Reclamation, and the National Science Foundation EPSCoR program. Dr. Cleverly has a B.S. in biology from the University of Utah and M.S. and Ph.D. degrees in plant physiological ecology (biological sciences) from the University of Nevada, Las Vegas.

Dahm, Clifford N.
University of New Mexico
Department of Biology
Albuquerque, NM 87131
cdahm@sevilleta.unm.edu
(505) 277-2850

Cliff Dahm is a professor at the University of New Mexico. His research in New Mexico has focused on stream and river ecosystem ecology, ground water/surface dynamics, biogeochemistry, geomicrobiology, ecohydrology, and restoration ecology. Cliff grew up in Idaho, where he worked and recreated in the wilderness areas of central Idaho. He presently teaches ecosystem studies, freshwater ecosystems, geomicrobiology, and limnology at the University of New Mexico. He received his Ph.D. in oceanography and aquatic ecology from Oregon State University. He also holds an M.A. in chemical oceanography from Oregon State University and a B.S. in chemistry from Boise State University.

deBuys, William
1413 2nd Street #6
Santa Fe, NM 87505
(505) 984-2871
wdebuys@earthlink.net

William deBuys is a historian and conservationist based in Santa Fe. His most recent books include *Salt Dreams: Land and Water in Low-Down California* (University of New Mexico Press, 1999) and *Seeing Things Whole: the Essential John Wesley Powell* (Shearwater Press, 2001). From 1991 to 1993 he chaired the Rio Grande Bosque Conservation Initiative.

Dello Russo, Gina
Ecologist
U.S. Fish & Wildlife Service
Bosque del Apache NWR
P.O. Box 1246
Socorro, NM 87801
(505) 835-1828 Fax: (505) 835-0314
gina_dellorusso@fws.gov

Gina Dello Russo is the refuge ecologist at the Bosque del Apache National Wildlife Refuge. Currently her duties include planning and implementing riparian restoration projects on the floodplain of the Rio Grande within the refuge (10 river miles) and coordinating with private landowners. Gina is also focal to the Save Our Bosque Task Force efforts on the 45 mile San Acacia reach, as well as collaborative programs on the Middle Rio Grande (160 river miles). She works extensively with other agencies, non-profit organizations, and private citizens to control invasive species and improve habitat diversity, the efficiency of water use by the natural system, habitat for endangered species, and fire protection. She has a diverse background in surface & groundwater hydrology, geology, and biology including 20

years of field experience on the Rio Grande in northern and central New Mexico. She is a graduate of the University of New Mexico where she studied biology with an emphasis on ecology and environmental science.

Ellis, Lisa M.
Department of Biology, University of New Mexico
Natural Connections
604 Wellesley Drive NE
Albuquerque, NM 87106
(505) 268-3944
lmellis@swcp.com

Lisa Ellis is the science coordinator at the Bosque del Apache NWR and one of the principal authors for the Bosque Education Guide and is a co-founder of the Bosque Ecosystem Monitoring Program. She runs a private consulting business doing various monitoring and educational projects, primarily along the Rio Grande. Lisa was the project manager for a long-term study of artificial flooding at the Bosque del Apache NWR. Her dissertation research focused on flooding and fire in the Middle Rio Grande bosque. She holds a B.A. in ecology and evolution from the University of California, Santa Barbara and M.S. and Ph.D. degrees in biology from the University of New Mexico.

Flanigan, Kevin
New Mexico Interstate Stream Commission
Springer Square Building
121 Tijeras NE, Suite 2000
Albuquerque, NM 87102
(505) 764-3865
Kevin.flanigan@state.nm.us

Kevin Flanigan is a senior hydrologist with the Rio Grande Bureau of the New Mexico Interstate Stream Commission. He has approximately 20 years of experience in hydrology and water resources engineering and water rights administration, with the majority of that experience in the Rio Grande basin of New Mexico. He has been with the Interstate Stream Commission for eight years, where his current responsibilities involve water resources management activities on the Middle Rio Grande focused primarily on ensuring compliance by New Mexico with the Rio Grande Compact. This includes review of reservoir and water operations by the U.S. Army Corps of Engineers, the Bureau of Reclamation and the Middle Rio Grande Conservancy District, management of basic hydrologic data collection activities and river maintenance and flood control activities, and review and analysis of various water planning studies and reports and water use plans and projects. He has a B.S. in civil engineering from the University of Michigan and an M.S. in hydrology from the New Mexico Institute of Mining and Technology. He is a registered professional engineer with the state of New Mexico and has been certified as a professional hydrologist by the American Institute of Hydrology.

Follingstad, Mary Helen, AICP
Executive Director
Santa Fe Regional Planning Authority
142 West Palace Avenue
P. O. Box 276
Sante Fe, NM 87504
(505) 995-6508
mfollingstad@co.santa-fe.nm.us

Mary Helen, a native New Mexican, was appointed as the executive director for the Santa Fe City and County Regional Planning Authority in June of 2006. Prior to that time Mary Helen managed the New Mexico Interstate Stream Commission's regional and statewide water planning programs from 1997 to 2006 and was the senior community planner for Santa Fe County from 1983 to 1997. She has been a member of the American Institute of Certified Planners (AICP) since 1989. Mary Helen has completed the Leadership Santa Fe course and is active with New Mexico First. She also volunteers with the Museum of New Mexico Women's Board, is the recent past president of the Tano Road Association, and is a member of the Santa Fe Extraterritorial Zoning Commission. Mary Helen holds a B.A. degree in fine arts from the University of Denver, M.A. degrees in fine arts from the University of Colorado and Saint Johns College in Santa Fe, and an M.S. in community and regional planning from the University of New Mexico.

Hall, G. Emlen
Professor of Law
School of Law, University of New Mexico
1614 1/2 Bayita Lane, NW
Albuquerque, NM 87107
(505) 277-2866
hall@law.unm.edu

G. Emlen Hall is a professor at the School of Law, University of New Mexico, where he teaches water law and edits the Natural Resources Journal. He has written two books on water issues, *Four Leagues of Pecos: A Legal History of the Pecos Grant from 1800 to 1936* (1984) and *High and Dry: The Texas–New Mexico Struggle for the Pecos River* (2002) published by the University of New Mexico, as well as many articles on the state's land and water. Prior to joining the UNM law faculty in 1983, he spent seven years at the Office of the State Engineer. During his time there, he wrote an administrative history of the Pecos River Compact from its inception in 1949 to 1974. This was the beginning of his research for *High and Dry*. When Hall first arrived in New Mexico in 1969, he wrote for and edited the *New Mexico Review*, a monthly investigative journal. He also practiced law in Pecos and served as village planner, attorney, and municipal judge for the Village of Pecos. He has worked for Northern New Mexico Legal Services and the New Mexico Land Grant Demonstration Project. Hall brings a background in water law and public land law to his teaching and writing. Professor Hall holds an A.B. from Princeton University and a J.D. from Harvard University.

Harding, Benjamin L.
Principal Engineer, Hydrosphere Resource Consultants
1002 Walnut, Suite 200
Boulder, CO 80302
(303) 443-7839
blh@hydrosphere.com

Ben Harding is a consulting engineer with Hydrosphere Resource Consultants in Boulder, Colorado. He has been practicing water resources engineering for more than 35 years, and during that time has had a diversity of assignments. Mr. Harding has conducted water availability studies at scales ranging from Boulder Creek to the entire Colorado River Basin. He was one of the principal investigators in the Severe Sustained Drought Study, which examined the water supply consequences of unprecedented drought in the Colorado River Basin. Mr. Harding has served as an expert witness in original jurisdiction interstate compact litigation and large toxic tort litigation. Recently, he has been working on projects to improve short- and long-term water supply forecasting for water providers and to allow planners to quantify uncertainty in estimates of future water supply. He has been a registered engineer in Colorado since 1979. Mr. Harding received his B.S. degree from the University of Colorado.

Harner, Mary J.
Post-doctoral Research Associate
University of Montana
Division of Biological Sciences
Missoula, MT 59812
mary.harner@mso.umt.edu
(406) 243-2393

Mary Harner is a post-doctoral research associate at the University of Montana. She completed her Ph.D. in biology in 2006 at the University of New Mexico, where she was a fellow in the Freshwater Sciences Interdisciplinary Doctoral Program. Her research focused on influences of flooding on riparian ecosystems along the Middle Rio Grande. Mary grew up along the Mississippi River in Alton, Illinois, and has spent much of her life exploring rivers. Her research focuses on riparian ecosystem ecology, with an emphasis on interactions between plants, soil, and shallow ground water. She holds an M.S. in environmental studies from the University of Montana, where she conducted research in association with the Flathead Lake Biological Station on the ecology of cottonwood trees, and a B.S. from Tulane University in ecology, evolution, and organismal biology.

Harris, Steve
Executive Director, Rio Grande Restoration
HCR 69, Box 3-C
Embudo, NM 87531
(505) 751-1269 or (505) 770-2502
Fax: (505) 776-1443
unclergr@laplaza.org

Steve Harris directs Rio Grande Restoration, a non-profit stream flow and watershed advocacy group that he founded in 1994. Steve is also the owner-operator of Far-Flung Adventures, a river outfitting company based on the Rio Grande. His experience as a river guide has enabled him to observe the workings of the Rio Grande first-hand. He has been a member of such private river protection efforts as the Rio Grande Alliance and Forgotten River Advisory Group and serves such public initiatives as the Middle Rio Grande ESA Collaborative Program's Water Acquisition and Management subcommittee, and the New Mexico Strategic River Reserve legislation and regional water planning group for Taos, Santa Fe, and Albuquerque. He resides in a riverside cottage in Pilar, from which he studies, speaks and writes about the history of the river and promotes awareness of the importance of the Rio Grande to people, communities, and ecosystems. Steve received a B.A. in journalism from the University of Oklahoma.

Hathaway, Deborah L.
Vice President, Hydrologist
S. S. Papadopulos & Associates
1877 Broadway, Suite 703
Boulder, CO 80302
(303) 939-8880 Fax: (303) 939-8877
dhathaway@sspa.com

Ms. Hathaway is a principal of S. S. Papadopulos & Associates, Inc., a water resource and environmental consulting firm, and has managed their western office since 1994. She is a hydrologist and water resource engineer with experience in modeling ground water and surface water systems, water rights, water-supply development, contaminant transport, ground water remediation, and regional water planning. She was lead investigator on the Middle Rio Grande Water Supply Study (2000, 2004) conducted for the Army Corps of Engineers and the New Mexico Interstate Stream Commission to support regional water planning in the Middle Rio Grande. Her experience with hydrology and water rights in New Mexico dates back to 1982. Ms. Hathaway worked for New Mexico State Engineer Steve Reynolds from 1982 to 1988. She earned a B.A. in liberal arts at St. John's College in Santa Fe, New Mexico, an M.A. in secondary science education from the University of New Mexico, and an M.S. in civil engineering (hydrology and water resources) from Colorado State University in Fort Collins, Colorado.

Johnson, Peggy S.
Senior Hydrogeologist
New Mexico Bureau of Geology and Mineral Resources
New Mexico Institute of Mining and Technology
801 Leroy Place
Socorro, NM 87801
(505) 835-5819
peggy@gis.nmt.edu

Peggy Johnson is a senior hydrogeologist with the New Mexico Bureau of Geology and Mineral Resources. She has twenty years of consultant and research experience in ground water hydrology and related fields. Her diverse background includes practical research in arid basin hydrogeology, karst hydrology, mountain-front recharge, surface water and ground water resource assessments, isotope hydrology, and water resource management and policy. During her 11-year tenure at the Bureau of Geology, Ms. Johnson has managed or contributed to regional hydrogeologic studies across north central New Mexico, including Placitas, the Espanola Basin, the Albuquerque Basin, and the Taos Valley. She is currently heading a hydrogeologic research project in the southern Sacramento Mountains aimed at improving the hydrologic balance in high-elevation watersheds. Ms. Johnson also serves on numerous water planning and policy committees and commissions, including the Socorro–Sierra Regional Water Planning Committee, the Upstream/Downstream project, the Interstate Stream Commission's Ad Hoc Committee for Regional and State Water Planning, and the New Mexico Water Quality Control Commission. She received her B.S. in geology from Boise State University (Idaho) and her M.S. in hydrology from New Mexico Tech.

Kelly, Susan
Associate Director, Utton Transboundary Resources Center
University of New Mexico School of Law
MSC11-6070
1 University of New Mexico
Albuquerque, New Mexico 87131-0001
(505) 277-0514
skelly@law.unm.edu

Susan Kelly is the associate director of the Utton Transboundary Resources Center at the School of Law, University of New Mexico. The Utton Center is a policy center created to help parties sharing a water resource to manage the resource within a legal framework instead of litigating over it. The center promotes the equitable and sustainable management and use of transboundary resources by providing impartial expertise and scholarship. The center approaches projects from a multi-disciplinary standpoint and also provides educational programs on legal issues concerning natural resources. Kelly is active in a variety of projects, including development of an adjudication water rights ombudsman program for the New Mexico courts, modeling alternative reservoir management scenarios through involvement in Middle Rio Grande Endangered Species Act issues, regional water planning and others. She represents Governor Richardson on several committees working on U.S.–Mexico border water issues. She is an attorney licensed in the state of New Mexico and also a member of the American Institute of Certified Planners. Her law degree is from the University of New Mexico and her undergraduate degree is from Arizona State University. She was formerly the water rights manager for the city of Albuquerque and is a long-time resident of New Mexico.

Klise, Geoff
620 Lafayette Dr. NE
Albuquerque NM 87106
(505) 284-2500
gklise@sandia.gov

Geoff Klise is a contractor at Sandia National Laboratories currently working with a collaborative group from southwest New Mexico to develop a

decision support model for the Gila and San Francisco Basins. He has assisted the Utton Center with papers on transboundary water issues and geographic information system support for the U.S.–Mexico border region. Prior to starting his masters program, he worked as an environmental consultant focusing on soil and ground water remediation in Washington and California and worked as a water resources hydrogeologist for the Washington State Department of Ecology reviewing applications to appropriate surface and ground water. He is licensed as both a geologist and hydrogeologist in Washington State. He received a Master of Water Resources from the University of New Mexico and a B.S. in environmental and engineering geology at Western Washington University.

Kreiner, Dick
100 Tavalopa Drive
Las Lunas, NM 87030

Dick Kreiner grew up on a dairy farm in Michigan. After graduating from high school he worked on the family farm for a couple of years before entering the Air Force. When he completed his 4 years with the Air Force, he went to college in Arizona and graduated from the University of Arizona with a Bachelors Degree in civil engineering in 1977. He then got a job with the Corps of Engineers at the Albuquerque District Office. His entire career was focused on water management. He gradually worked his way up to the reservoir control chief and held this position from 1987 to 2003. During his last year and a half before retirement he was the project manager representing the Corps of Engineers in the Middle Rio Grande Endangered Species Collaborative Program. He retired in January 2005. Dick always tried to balance flood control responsibilities with the management needs for human and riparian communities below Corps of Engineers reservoirs.

MacClune, Karen
Project Hydrologist
S. S. Papadopulos & Associates, Inc.
3100 Arapahoe, suite 203
Boulder, CO, 80303
(303) 939-8880
kmacclune@sspa.com

Karen MacClune is the vice president and principal hydrologist at S. S. Papadopulos & Associates in Boulder, Colorado. Karen conducts and directs a wide variety of hydrologic, water supply development, environmental, and ground water remediation projects and has over 12 years of experience designing and conducting basin-scale hydrologic studies. Her experience includes: application of water budgets and hydrologic models to address water planning questions, to evaluate water supply alternatives, and to assess ground water remediation requirements; compilation and organization of data to support conceptual and modeling analyses; quantification and/or estimation of water budget components; and application of past and projected future climatic data to questions of water availability and demand. Karen's current work on projects involving stakeholder communications, ground water modeling, water planning, climate change, and conjunctive surface water/ground water use in the Southwestern US provide her with broad perspectives on community and regional water issues. She has also worked for the Technical Division of the New Mexico Office of the State Engineer in Santa Fe, New Mexico and as the water resource engineering specialist and the water resource specialist in their Water Rights Division. Karen also worked for the Water Resources Division of the U.S. Geological Survey in Santa Fe, New Mexico. She earned her B.S. in mathematics at the Massachusetts Institute of Technology, and her M.S. in geology and Ph.D. in geophysics at the University of Colorado in Boulder.

McCord, Jim, P. E.
Principal Hydrologist and New Mexico Manager
Hydrosphere Resource Consultants
P.O. Box 445
Socorro, NM 87801
(505) 835-2569 Fax: (505) 835-2609
jtm@hydrosphere.com

In his 25 year-professional career, Dr. McCord has worked as a staff engineer for a geotechnical engineering consulting firm, as an assistant professor at Washington State University, as a senior member of the technical staff at Sandia National Labs (SNL), as hydrology group leader with D.B. Stephens and Associates, and (since 1999) with Hydrosphere Resource Consultants, managing their NM operation from their office in Socorro. With Hydrosphere, he has been involved in numerous water resource projects throughout New Mexico and Colorado, and his clients include the NM OSE, NM ISC, Valencia County, the pueblo of Isleta, the city of Boulder, the Colorado Attorney General, and several law firms across the western U.S. He co-authored the textbook *Vadose Zone Processes*, published in 1999. Dr. McCord received a B.S. from Virginia Tech and an M.S. and Ph.D. from New Mexico Institute of Mining and Technology. Jim and his wife Cecilia operate a 28 acre certified organic farm in Polvadera, and he is a founding board member for Rio Grande Agricultural Land Trust, dedicated to preserving open lands and wildlife habitat in central New Mexico.

Mitchell, Matthew
Rio Grande Agricultural Land Trust
Office of the Mayor
One Civic Plaza N.W., 11th floor
Albuquerque, NM 87102
riobirds@zianet.com

Matthew Mitchell is board president of the Rio Grande Agricultural Land Trust, currently serves on the board of the Save Our Bosque Task Force, and is president of the New Mexico Falconer's Association. He has been a raptor rehabilitator with Wildlife Rescue of New Mexico, Inc. for 25 years. Matt and his wife still operate the southwestern jewelry manufacturing business they started while at UNM. He built a home in rural Valencia County and later relocated to rural Socorro County near the Rio Grande and Bosque Del Apache NWR. He originally became involved with restoration of his own river-front property and then with local groups concerned with habitat restoration and limiting of new development in the Rio Grande valley. Matt aspires to protect as much riparian habitat and farmland from loss to development as he can while establishing a mosaic of native riparian habitat along the middle Rio Grande wherever feasible. Matt is a native New Mexican with a B.S. in biology from the University of New Mexico.

Mussetter, Robert A.
Mussetter Engineering, Inc.
1730 South College Ave, Suite 100
or P.O. Box 270785
Fort Collins, CO 80525
Cell: (970) 224-4612 Fax: (970) 472-6062
www.mussei.com
bobm@mussei.com

Bob Mussetter is a river engineering consultant with nearly 30 years of experience on a wide variety of rivers throughout the U.S. and internationally. His expertise includes the integration of hydraulic engineering, sediment transport theory, and fluvial geomorphology to address river engineering issues. He has completed and continues to work on a wide variety of issues throughout the Rio Grande system that involve flood capacity, water delivery, sediment transport, and solutions to associated problems that affect public safety and the health of the ecosystem. Bob is a registered engineer in ten states, including New Mexico. Aside from his consulting

activities, he has served on a variety of technical committees dealing with river issues, including a recent assignment as a member of the Adaptive Management Forum Scientific and Technical Panel that was formed by the California Bay-Delta Ecosystem Restoration Program (CALFED) to provide guidance to local scientists, engineers, and managers in finding and implementing appropriate means of restoring the ecosystem in tributaries to the San Joaquin and Sacramento River Basins. Bob has a Ph.D. in hydraulic engineering from Colorado State University.

Parody, Jennifer M.
Middle Rio Grande ESA/Rio Grande Silvery Minnow Coordinator
U.S. Fish and Wildlife Service
2105 Osuna NE
Albuquerque, NM 87113
(505) 248-6657 Cell: (505) 239-8352
jennifer_parody@fws.gov

Jennifer Parody has been with the U.S. Fish and Wildlife Service since 2004, first serving as species lead for the southwestern willow flycatcher, and since 2005 for the Rio Grande silvery minnow. Her primary responsibilities include coordinating Section VII consultations on the Rio Grande, representing the service to the Rio Grande Endangered Species Act Collaborative Program, and coordinating recovery activities for the silvery minnow. Prior to joining the U.S. Fish and Wildlife Service, she worked for the New Mexico State Land Office as their state biologist and in San Francisco with a private consulting firm. Both her master's and doctoral research examined songbirds and large-scale landscape processes. For her dissertation she worked on southwest rivers studying the habitat requirements of Bell's Vireo. Jennifer has a B.S. in resource policy and ethics from Cornell University, an M.S. in conservation biology and ecosystem management from the University of Michigan, and a Ph.D. in biology and evolutionary ecology from the University of New Mexico.

Price, L. Greer
Associate Director/Chief Editor
New Mexico Bureau of Geology and Mineral Resources
New Mexico Institute of Mining and Technology
801 Leroy Place
Socorro, NM 87801
(505) 835-5752
gprice@gis.nmt.edu

Greer Price is associate director at the bureau, where he directs the publications program. His experience includes seven years as a geologist working in the oil patch, ten years with the National Park Service, and four years as managing editor at Grand Canyon Association. He has served on the boards of the Publishers Association of the West and the New Mexico Geological Society Foundation. His focus for many years has been on the interpretation of geology for the general public. His career has involved teaching, writing, and field work throughout North America. He is the author of *An Introduction to Grand Canyon Geology*, and has a B.A. and an M.A. in geology from Washington University in St. Louis.

Robert, Lisa
35 Miguel Road
Los Lunas, NM 87031
(505) 865-1455
elksedge@earthlink.net

Lisa Robert is a native of Albuquerque's South Valley and a “perennial student” of the Rio Grande. She has covered state and local water issues for the past twenty years, publishing an independent newsletter for constituents of the Middle Rio Grande Conservancy District since 1987, and serving as editor of the *New Mexico Water Dialogue* from 1994 to 2001. She is the author of *The Middle Rio Grande Bosque Biological Management Plan Update: The* First *Decade*, a review of recent history and water policy, and their ecological consequences for the middle basin. She also lovingly farms five acres of floodplain near the historic community of Tomé.

Rosacker-McCord, Cecilia
Executive Director
Rio Grande Agricultural Land Trust
P.O. Box 40043
Albuquerque, NM, 87109
(505) 270-4421
ceciliam@sdc.org

Cecilia owns and operates a certified organic farm in Polvadera, New Mexico, which serves a number of Albuquerque's fine restaurants, grocery stores in Santa Fe and Albuquerque, as well as farmers' markets in Socorro and Albuquerque. She has served on the board of the New Mexico Farmer's Market Association for ten years and has served on the governing council for the New Mexico Food & Agriculture Policy Council for five years. In addition to farming, Cecilia is currently the executive director of Rio Grande Agricultural Land Trust, a non-profit organization dedicated to preserving New Mexico's family farms and ranches, open space, and wildlife habitat for future generations. She holds a B.S. from New Mexico Tech.

Samani, Zohrab
Professor, Civil Engineering
New Mexico State University
Box 30003, MSC 3CE
Las Cruces, NM 88003
(505) 646-2904 Fax: (505) 646-6049
zsamani@nmsu.edu

Zohrab Samani is a professor of civil engineering at New Mexico State University. His teaching and research interests include irrigation, hydrology and hydraulics, applications of remote sensing to water resource management, and alternative energy sources. Dr. Samani works frequently with the Winrock Foundation on irrigation management problems in central Asia.

Schmidt-Petersen, Rolf
Rio Grande Bureau, New Mexico Interstate Stream Commission
Office of the State Engineer
407 Galisteo Street
Bataan Memorial Building
P.O. Box 25102
Santa Fe, NM 87504-4102
(505) 827-6125

Rolf Schmidt-Petersen is the manager of the Rio Grande Basin Bureau of the New Mexico Interstate Stream Commission. His responsibilities on the Rio Grande include investigation, development, conservation, and protection of the Rio Grande water resources and stream system, interstate stream compact administration and compliance, and resolution of interstate and federal water resource issues affecting Rio Grande water resources. Projects conducted by the Rio Grande Bureau include working with Reclamation to construct and maintain the 22-mile long pilot channel through the Elephant Butte delta; aiding the federal government in maintaining the floodway of the Middle Rio Grande project; constructing and evaluating the success of in-river habitat for the Rio Grande silvery minnow; constructing hatcheries for the silvery minnow; conducting hydrologic investigations; developing and using numerical models to better understand and manage the river system; and serving as technical resource for the silvery minnow litigation and the litigation threatened by Texas on the Lower Rio Grande several years ago. Prior to working for the ISC, Mr. Schmidt-Petersen worked as a hydrogeologist for Daniel B. Stephens &

Associates, Inc. He has seventeen years of experience working in New Mexico on hydrology related issues. Mr. Schmidt-Petersen graduated from the New Mexico Institute of Mining & Technology with an M.S. in hydrology.

Scholle, Peter A.
Director and State Geologist
New Mexico Bureau of Geology and Mineral Resources
New Mexico Institute of Mining and Technology
801 Leroy Place
Socorro, NM 87801
(505) 835-5294
scholle1@nmt.edu

Peter Scholle is the director and state geologist for the New Mexico Bureau of Geology and Mineral Resources. Peter has had a rich and diverse career in geology: nine years with the U.S. Geological Survey, four years directly employed by oil companies (plus many additional years of petroleum consulting), seventeen years of teaching at two universities, and now a career in New Mexico state government. His main areas of specialization are carbonate sedimentology and diagenesis as well as exploration for hydrocarbons in carbonate rocks throughout the world. He has worked on projects in nearly twenty countries, with major recent efforts in Greenland, New Zealand, Greece, Qatar, and the Danish and Norwegian areas of the North Sea. A major focus of his studies dealt with understanding the problems of deposition and diagenesis of chalks, a unique group of carbonate rocks that took on great interest after giant oil and gas discoveries in the North Sea. His career has also concentrated on synthesis of sedimentologic knowledge with the publication of several books on carbonate and clastic depositional models and petrographic fabrics. He and his wife have published many CD-ROMs for geology, oceanography, and environmental science instructors. He has been president of the Society for Sedimentary Geology and treasurer of the American Geological Institute. He is currently past president of the Association of American State Geologists. Peter Scholle received a B.S. in geology from Yale University and continued his studies at the University of Munich on Fulbright/DAAD Fellowships and at the University of Texas at Austin. Scholle received M.S. and Ph.D. degrees in geology from Princeton University.

Skaggs, Rhonda K.
Dept. of Agricultural Economics & Agricultural Business
New Mexico State University
Box 30003, MSC 3169
Las Cruces, NM 88003
(505) 646-2401 Fax: (505) 646-3808
rskaggs@nmsu.edu

Rhonda Skaggs is a professor of Agricultural Economics and Agricultural Business at New Mexico State University. Her teaching and research interests include agricultural policy, agricultural structure and natural resource management, the future of agriculture, irrigation economics, and U.S.–Mexico cattle industry issues.

Titus, Frank
2864 Tramway Circle NE
Albuquerque, NM 87122-2289
(505) 856-6134
aquagadfly@aol.com

Frank Titus arrived in Albuquerque 51 years ago to work for the U.S. Geological Survey. In the next 37 years he was scientist and educator for the USGS and the New Mexico Institute of Mining and Technology, manager of Environmental Impact Statements across the U.S. and Canada, then back to Albuquerque as hydrology manager on the federal Uranium Mill Tailings Remedial Action Project. Titus says he “selectively retired” in 1993. Thereafter, his career focus has been on wise management of water and environment. In this role he has been: science advisor to State Engineer Tom Turney; facilitator on three decision-maker field conferences; in several TV specials on Rio Grande water; on the Middle Rio Grande Water Assembly; and a member of numerous advisory committees and boards of directors of non-governmental organizations, including the Water Dialogue. He has published numerous Op Ed columns in regional newspapers, co-authored a booklet entitled *Taking Charge of Our Water Destiny*, lectured on water affairs to numerous public groups, and often testified on water before committees of the state legislature.

Towne, Leann
Manager, Water Management Division
Albuquerque Area Office
U.S. Bureau of Reclamation
555 Broadway NE, Suite 100
Albuquerque, NM 87102
(505) 462-3579 or (505) 235-3616
ltowne@uc.usbr.gov

Since 1999 Leann has worked in the Bureau of Reclamation's Albuquerque Area Office, which has responsibility for projects on the Rio Grande, and Pecos and Canadian rivers. She is currently the Water Management Division Manager with responsibility for daily water operations and long-term water management for the Upper Rio Grande Basin above Elephant Butte Reservoir, the Pecos River Basin in New Mexico, and various other projects and programs. She deals with a number of water management issues that have significant implications for New Mexico, including meeting endangered species needs and delivery of water to senior users, such as the pueblos. Leann has worked for the U.S. Bureau of Reclamation since graduation, beginning her career in Durango, Colorado. During more than sixteen years of service with the Bureau of Reclamation, she has worked on various aspects of numerous projects, including water operations and management, facility maintenance and rehabilitation, and safety of dams. Leann grew up in New Mexico and graduated from New Mexico State University with a B.S. in civil engineering.

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11R	William L. Graf
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66	Information was provided by Viola Sanchez of the U.S. Bureau of Reclamation, Kevin Flanigan of the New Mexico Interstate Stream Commission, and Robert Gold of the U.S. Geological Survey.
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77, 78, 79	Bosque del Apache National Wildlife Refuge
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98, 99R, 100	Office of the State Engineer
99L	Bureau of Reclamation
Back cover:	Clockwise from top left: William Stone, Adriel Heisey, Jim Bones, Adriel Heisey, Adriel Heisey, James McCord.

ACRONYMS

AWRM	Active Water Resource Management
CALFED	California Bay–Delta Ecosystem Restoration Program
CREATE	Center for Rapid Environmental Assessment and Terrain Evaluation
EDAC	Earth Data Analysis Center
EPSCoR	Experimental Program to Stimulate Competitive Research
ESA	Endangered Species Act
ET	evapotranspiration
FWS	U.S. Fish and Wildlife Service
GIS	Geographic Information System
HIA	historically irrigated acres
ISC	Interstate Stream Commission
LFCC	Low Flow Conveyance Channel
LTER	Long Term Ecological Research Center
MRG	Middle Rio Grande
MRGCD	Middle Rio Grande Conservancy District
NASA	National Aeronautics and Space Administration
NMISC	New Mexico Interstate Stream Commission
NWR	National Wildlife Refuge
OSE	Office of the State Engineer
PACE	Purchase of Agricultural Conservation Easement
PIA	practically irrigable acreage
PIRG	Public Interest Research Group
SWCD	Socorro Soil and Water Conservation District
URGWOM	Upper Rio Grande Water Operations Model
WATERS	Water Administration Technical Engineering Resource System
WRRI	Water Resources Research Institute

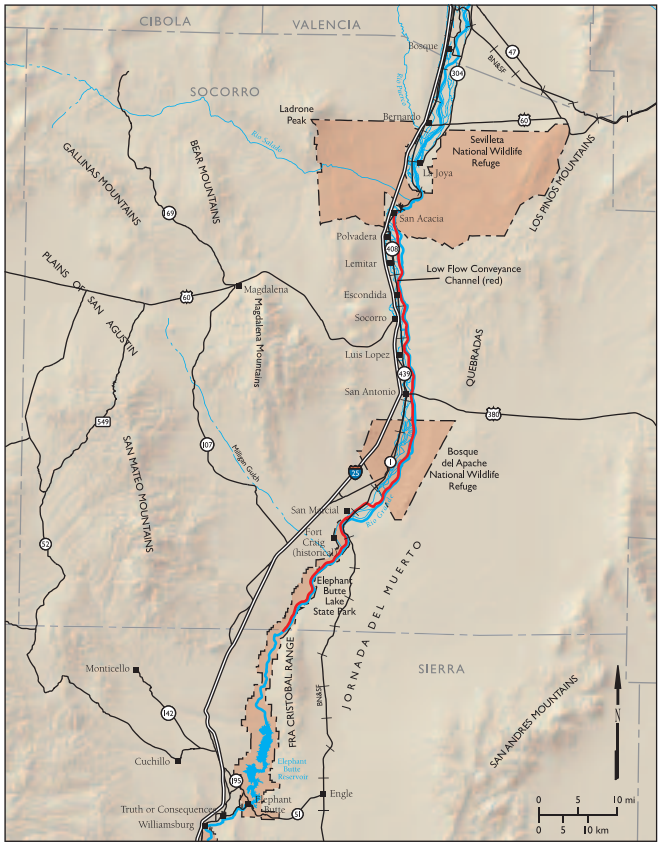
GENERALIZED GEOLOGIC MAP

The Rio Grande here follows the axis of the Rio Grande rift, one of the most striking geologic features in New Mexico. The rift is a complex of down-faulted blocks of crystalline and pre-Tertiary sedimentary rocks overlain by sedimentary basin fill. Rifting began here approximately 30 million years ago. Tributary drainages have contributed much of the alluvium that has been reworked into the floodplain of the Rio Grande. It is these younger Quaternary alluvial sediments that make up the shallow aquifer in the floodplain. Outside the floodplain the regional aquifer is primarily alluvial deposits of the (older) Santa Fe Group. The Santa Fe Group in this region ranges in thickness from 1,500 to 6,500 feet.

The uplifted flanks of the rift are composed of cores of Proterozoic basement overlain by sediments of Paleozoic and Mesozoic age. Paleozoic sediments of Pennsylvanian and Permian age are well exposed in the San Andres Mountains to the southeast and in the Los Pinos Mountains just east of Sevilleta National Wildlife Refuge. The mountain ranges to the west (including both the San Mateo Mountains and the Magdalena Mountains) contain extensive deposits of mid-Tertiary volcanic rocks, remnants of explosive volcanic activity that occurred throughout much of southwest New Mexico from 35 to 20 million years ago. Many of the lower-elevation areas on the map are covered by Quaternary alluvial or eolian (windblown) sediments. The large patch of Quaternary volcanic rocks on the floor of the Jornada del Muerto southeast of Fort Craig are young (780,000-year-old) basalts. The predominantly north/south orientation of the mountain ranges on both sides of the rift reflects the east-west extension of the crust that is characteristic of the Rio Grande rift.

Elephant Butte Reservoir is shown on the geologic map near its full capacity, extending to the northern boundary of Elephant Butte State Park near Fort Craig. Today the reservoir is considerably smaller in extent, closer to what is shown on the topographic map. The Low Flow Conveyance Channel (on the west side of the Rio Grande between San Acacia and Elephant Butte) is shown in red on both maps. The infrastructure along this stretch of river is shown in more detail on maps on pages 28 and 38.

This map was designed to accompany the full-page map on page viii of this volume and includes the Middle Rio Grande from the Socorro/Valencia County line to Elephant Butte Reservoir. It was excerpted by Kathy Glesener and Glen Jones from the Geologic Map of New Mexico (1:500,000), published in 2003 by the New Mexico Bureau of Geology and Mineral Resources. The digital elevation model was created from 10-meter data and provides a topographic overlay for the geologic map, as well. The complete state geologic map is available for purchase from the New Mexico Bureau of Geology and Mineral Resources. Call (505-835-5490) or visit our Web site at www.geoinfo.nmt.edu to order.



Qv		Quaternary volcanic rocks
Qa		Quaternary alluvium
Qe		Quaternary eolian sediments
QTs		Quaternary–Tertiary Santa Fe Group
Tv		Tertiary volcanic rocks
Ti		Tertiary intrusive rocks
Ts		Tertiary sediments
K		Cretaceous rocks
TR		Triassic rocks
P		Permian rocks
IP		Pennsylvanian rocks
Pz		Older Paleozoic rocks
X		Proterozoic rocks