RIO GRANDE WATER CLARIFICATION AND VIRUS INACTIVATION UTILIZING ALUMINA POLYCATIONS

Tom A. Stewart, Sandia National Laboratories, tstewar@sandia.gov; 505-284-0745

Dan Trudell, Sandia National Laboratories, detrude@sandia.gov

May Nyman, Sandia National Laboratories, mdnyman@sandia.gov; 505-284-4484

Presentation Abstract 3

In line with the national and world-wide water crisis, Albuquerque is turning toward alternative water sources. Under the auspices of the San Juan Chama Drinking Water Project, Albuquerque will soon be treating river water for residential use. Part of the treatment process is a ferric flocculation to remove turbidity (predominantly clays and natural organic matter). We are currently investigating the efficacy of soluble alumina polycations for water clarification in comparison to the ferric chloride as well as removal of viruses from both river samples (wild-type bacteriophage) and controlled laboratory samples (MS-2 bacteriophage and *E. Coli*).

Alumina polycations we are investigating include $[(AlO_4)Al_{12}(OH)_{24}(H_2O)_{12}]^{7+}$ (Al_{13}), the related $[(GaO_4)Al_{12}(OH)_{24}(H_2O)_{12}]^{7+}$ ($GaAl_{12}$) and $[(GeO_4)Al_{12}(OH)_{24}(H_2O)_{12}]^{8+}$ ($GeAl_{12}$), and $[Al_{30}O_8(OH)_{56}(H_2O)_{26}]^{18+}$ (Al_{30}). River water samples were dosed with two to ten mg Al/L, and clarity and bacteriophage reduction was measured. Laboratory water samples spiked with MS-2 bacteriophage or *E. Coli* were dosed with the alumina clusters and log-reduction of the micro-organism was determined. In investigating the key factors of efficacy of pathogen inactivation/sequestration, we compared the relative stability and charge density of the clusters. ^{27}Al and ^{71}Ga MAS NMR (magic angle spinning nuclear magnetic resonance), transmission electron microscopy (TEM), and DLS (dynamic light scattering) studies were also carried out to aid in understanding and thus optimizing pathogen inactivation/water coagulation behavior of alumina polycations.

Contact: May Nyman, Sandia National Laboratories, mdnyman@sandia.gov, P.O. Box 5800 MS-0750, Albuquerque, NM 87185-0750, 505-284-4484, Fax 505-844-7354

IDENTIFICATION OF AQUIFER PROPERTIES USING INVERSE ANALYSIS OF LONG-TERM WATER-SUPPLY PUMPING DATA

Velimir Vesselinov, Los Alamos National Laboratory, EES-6 MS T006, vvv@lanl.gov

Dylan Harp, Los Alamos National Laboratory, EES-6 MS T006, dharp@lanl.gov

Presentation Abstract 4

Water-supply production at wellfields is frequently characterized by substantial temporal and spatial variability. In general, different production wells are operated and rested at different times, and the total production is controlled by demand, which peaks in the summer and decreases in the winter. During the wellfield operation high-frequency water-level data are also commonly collected in the production and nearby observation wells. In a way, such a scenario can be viewed as a single prolonged and data-intensive pumping test which includes multiple pumping and observation wells. All these data can be interpreted simultaneously using simple analytical models. The analytical models allow the identification of correlations between the pumping and water-level variability. Here we discuss the high-frequency pressure and water-supply pumping data acquired during the water-supply production near the Los Alamos National Laboratory and their interpretation by means of an analytical model.

Contact: Velimir Vesselinov, LANL, vvv@lanl.gov, 505-665-1458

STOCHASTIC ANALYSIS OF WATER OPERATIONS IN NEW MEXICO'S RIO GRANDE BASIN

Jesse Roach, Sandia National Laboratories, P.O. Box 5800 MS 1350, Albuquerque, NM 87185-1350; jdroach@sandia.gov; 505-284-9367

Vince Tidwell, Sandia National Laboratories, P.O. Box 5800 MS 0735, Albuquerque, NM 87185-0735; vctidwe@sandia.gov; 505-844-6025

Presentation Abstract 5

Long term management of water resources in the Rio Grande basin in New Mexico requires an understanding of the ability of the storage infrastructure to handle natural variations in water supply. The operational flexibilities in the system are captured comprehensively in the Upper Rio Grande Water Operations Model (URGWOM) suite of tools, which includes both daily and monthly timestep planning models; however, to this point the treatment of climate variability has been limited to a single "representative" climate sequence. This talk will discuss expansions to the treatment of climate variability in the URGWOM planning process. Tree ring data from the basin representing centuries of climate record was used to generate hundreds of climate traces, which were turned into climate sequences defined by years from the historic record between 1950 and 2005. These sequences were run through the monthly timestep URGWOM Planning Model to generate distributions of results for key water management parameters. This talk will summarize the development of the monthly model, the climate scenarios, and present initial results from this stochastic analysis of water operations in the Rio Grande in New Mexico.

Contact: Jesse Roach, Sandia National Laboratories, jdroach@sandia.gov, P.O. Box 5800 MS 1350, Albuquerque, NM 87185-1350, 505-284-9367

SIMULATION OF GROUNDWATER FLOW IN THE SOUTHERN JORNADA DEL MUERTO BASIN, NEW MEXICO

Praveena Allena, Civil Engineering, NMSU, Box 30001, MSC 3CE, Las Cruces, NM 88003; praveena@nmsu.edu; 575-202-8758

B. V. N. P. Kambhammettu, NM Water Resources Research Institute, NMSU, Box 30001, MSC 3167, Las Cruces, NM 88003-8001; phani@nmsu.edu; 575-202-5028

J. Phillip King, Civil Engineering, NMSU, Box 30001, MSC 3CE, Las Cruces, NM 88003; jpking@nmsu.edu; 575-646-5377

Presentation Abstract 7

The City of Las Cruces and other municipal areas in the Lower Rio Grande (LRG) administrative basin have been growing quite rapidly in recent years. Jornada del Muerto Basin is the potential groundwater source for the water supply needs to the city of Las Cruces and is part of the LRG region. The purpose of the present study is to construct the groundwater flow model for the southern Jornada Basin and to predict the groundwater fluctuations under induced stress conditions. The Basin is surrounded by the San Andres Mountains to the east, Organ Mountains from south to southeast, and a chain of mountains formed by Rincon, San Diego, Seldon, Doña Ana, Goat, and Tortugas to the west. A three layer model is described based on the hydrogeologic framework provided by Hawley and Kennedy (2004). The conceptual model for the southern Jornada Basin up to 33º N Latitude is constructed using Arc GIS 9.2 and is simulated using MODFLOW with Groundwater Vistas as the graphical interface. Underflow across the northern boundary, aquifer properties to the north of the Point of Rocks, geothermal flow in the lower portion of the basin, and the leakage to the Mesilla Basin above the Jornada horst are considered as calibration parameters. The model is simulated under transient conditions for the period 1968-2007. The response of the basin is estimated for the predictive runs based on the effectiveness of the model.

Contact: Praveena Allena, Civil Engineering, New Mexico State University, praveena@nmsu.edu, Box 30001, MSC-3CE, Las Cruces NM 88003-8001, 575-202-8758, Fax 575-646-6049

MODELING OF A GROUNDWATER SURFACE FROM SPARSE DATA USING GEOSTATISTICAL ANALYST®

B.V.N.P. Kambhammettu, NM Water Resources Research Institute, NMSU, Box 30001, MSC 3167, Las Cruces, NM 88003-8001; phani@nmsu.edu; 575-202-5028

Praveena Allena, Civil Engineering, NMSU, Box 30001, MSC 3CE, Las Cruces, NM 88003; praveena@nmsu.edu; 575-202-8758

J. Phillip King, Civil Engineering, NMSU, Box 30001, MSC 3CE, Las Cruces, NM 88003; jpking@nmsu.edu; 575-646-5377

Presentation Abstract 8

Geostatistical techniques have the capability of producing a prediction surface and some measure of the capability of predictions from the data measured at random locations. In the present study, the Geostatistical Analyst® tool in Arc GIS 9.2 was used in preparing the continuous surface of water table elevations for the Carlsbad area alluvial aquifer located in southeast New Mexico. Water table elevations in the 38 observation wells for the years 1996 and 2003 show the data were normally distributed, leading to the application of geostatistical interpolation. Omni-directional and directional semi-variograms at 22.5^{o} intervals were prepared to obtain the two perpendicular axes having maximum difference in drift. The directional semi-variogram for both the data sets reveals that the groundwater flow is in the 67.5^{o} (measured clockwise from North) direction. The presence of trend in the data set has resulted in the application of universal kriging. Different theoretical semi-variogram models with first and second order of drift were fitted to select the final model for geostatistical interpolation. The kriged contour maps along with the estimation variance were prepared for both the data sets in order to analyze the spatial and temporal variation of the groundwater surface for the study area. Results of statistical analysis conclude that the decrease in the water table from 1996 to 2003 is in between 0.6 and 4.6 m at 90% confidence. The contour map of estimation variance for both the data sets concludes that the error in the estimation of the water table is significant in the west and southwest portions of the aquifer due to the absence of monitoring wells.

Keywords: geostatistics, estimation variance, semi-variogram, universal kriging

Contact: B.V.N.P. Kambhammettu, phani@nmsu.edu, NM Water Resources Research Institute, NMSU, Box 30001, MSC 3167, Las Cruces, NM 88003-8001, 575-202-5028, Fax 575-646-6418

ADSORPTION EQUILIBRIUM OF ARSENIC, URANIUM, AND FLUORIDE ON NATURAL ZEOLITE

Lucy Mar Camacho, Chemical Engineering, NMSU,
Las Cruces, NM 88003; lcamacho@nmsu.edu; 575-646-1214

Arely Torres, Chemical Engineering, NMSU,
Las Cruces, NM 88003; arely@nmsu.edu

Shuguang Deng, Chemical Engineering, NMSU,
Las Cruces, NM; 88003; sdeng@nmsu.edu

Presentation Abstract 9

Two clinoptilolite zeolites naturally produced in New Mexico and Colorado were used to study the adsorption potential for arsenic, uranium, and fluoride, treated separately, from drinking water. Standard solutions with constant element concentrations were prepared and adjusted to pH values for highest adsorption. Initial and final pH and concentration in the solutions were measured versus time during seven days for each of the elements. Equilibrium experiments were also run in a shaker for seven days at selected pH to determine the adsorption uptake by the zeolites. Duplicate samples were run for all the experiments.

ICP-MS measured arsenic and uranium, while ion-selective electrode measured fluoride. Langmuir and Freundlich models were applied to determine equilibrium adsorption. XRD, SEM, EDS, XRF, and N2-Adsorption were applied to determine chemical, physical, and pore-structure properties.

Preliminary results on Colorado zeolite indicated that best adsorption is obtained at pH values of 5.5, 7.0, and 6.0 for arsenic, uranium, and fluoride respectively. SEM photographs on both zeolites showed groups of regular crystals interconnected through micro pores. Major components of Colorado zeolite are Si, Al, Na, K, Ca, Fe, and O. St Cloud zeolite contained the same elements as Colorado zeolite except sodium. Adsorption/desorption isotherms for Colorado zeolite presented a sharper hysteresis loop, indicating a more heterogeneous pore distribution, which was in agreement with SEM observed structure. Based on quantitative XRF analysis, silica to alumina ratio of 4:1 was calculated for both zeolites. Langmuir isotherm represented well the adsorption equilibrium for the elements.

Contact: Lucy Mar Camacho, Chemical Engineering, New Mexico State University, lcamacho@nmsu.edu, University Avenue, Las Cruces, New Mexico 88003, 575-646-1214

TRANSPORT OF NITRATE AND CHLORIDE IN SOIL COLUMNS

Amir Gonzalez, Plant and Environmental Science, NMSU, MSC 3Q, PO Box 30003, Las Cruces, NM 88003; amgonz4@nmsu.edu; 787-461-9761

Manoj K. Shukla, Plant and Environmental Science, NMSU, MSC 3Q, PO Box 30003, Las Cruces, NM 88003; shuklamk@nmsu.edu; 575-646-2324

Presentation Abstract 10

The excessive use of fertilizers containing nitrate and chloride is one of the causes for groundwater pollution. The purposes of this research were to: 1) study the fate and transport of nitrate and chloride in soil columns under different pore water velocities (0.1, 0.5, 1, and 1.5 cm/hr), and 2) study the anion exclusion process and compare the anion exclusion for nitrate and chloride. The transport behavior of nitrate and chloride was studied in 10 cm long columns packed with a sandy soil and loam soil. A pulse of 200 mL of 0.1 M $Ca(NO_3)^2$ and 0.1 M CaC_{l2} solutions was applied to the soil columns. The chloride and nitrate concentrations in the effluent solution were measured, and the CXTFIT program was used to determine the equilibrium and non-equilibrium transport parameters, including retardation factor (R), dispersion coefficient (D), anion exclusion volume (èex), and mobile and immobile fractions. Initial results showed that nitrate is more mobile than chloride. The èex decreased and D increased with increasing porewater velocity. Further experiments are required to confirm the initial results and evaluate the effect of pore water velocity on the èex. This research will provide information to understand the behavior of nitrate and chloride in the root zone. The results from this research will increase our understanding of transport behavior of nitrate for some soils of southern NM and could be useful to design improved irrigation systems to reduce nitrate leaching through soil profiles.

Contact: Amir Gonzalez, Plant and Environmental Sciences, New Mexico State University, amgonz4@nmsu.edu, MSC 3Q, PO BOX 30003, Las Cruces, NM 88003,
787- 461-9761

EFFECT OF WASTEWATER EFFLUENT ON AS(V) SORPTION IN THREE DESERT SOILS

Sylvia Nemmers, Plant and Environmental Science, NMSU, 2037 Corn Dr., Las Cruces, NM 88001; snemmers@nmsu.edu; 505-312-1121

April Ulery, Plant and Environmental Science, NMSU; aulery@nmsu.edu; 575-646-2219

Manoj K. Shukla, Plant and Environmental Science, NMSU; shuklamk@nmsu.edu; 575-646-2324

Presentation Abstract 11

Chronic low-level exposure to arsenic has been found to increase the risk for cancer and other serious diseases. In January 2006, the EPA lowered the MCL for arsenic in drinking water to 10 ppb. This affected many communities and forced them to develop procedures for lowering arsenic in their drinking water. Disposal of arsenic residuals is a problem that must be considered when developing such a procedure. A simple and low cost solution is to land apply the arsenic concentrates with the municipal wastewater effluent. To ensure the usefulness of this disposal method, experiments were performed to assess arsenic sorption parameters when As(V) is added as part of the wastewater stream. In this study, breakthrough curve experiments were performed using As(V) in the presence and absence of wastewater effluent on three soils collected from a land application facility near Columbus, NM. Equilibrium and non-equilibrium models were fit for both treatments to investigate their ability to describe As(V) sorption over time. Dispersion coefficients, retardation factors, partition coefficients, and percent mass recovery values were obtained. Application of As(V) in treated wastewater resulted in minor changes in the sorption parameters for the Soniota soil (sandy loam), when compared to the values for As(V) applied in buffer. The Hondale (clay loam) and Verhalen (clay) soils showed large changes in the sorption parameters, including decreases in retention coefficients and large increases in percent mass recovery values when As(V) was applied with wastewater effluent.

Contact: Sylvia Nemmers, Plant and Environmental Science, NMSU, snemmers@nmsu.edu, 2037 Corn Dr., Las Cruces, NM 88001, 505-312-1121

TRENDS IN STREAM CHEMISTRY IN THE SAGUACHE CREEK WATERSHED AND ITS IMPLICATIONS ON CONCEPTUAL MODELS OF RUNOFF GENERATION IN LARGE WATERSHEDS

Marty D. Frisbee, Earth and Environmental Science, New Mexico Tech, 801 Leroy Place, Socorro, NM 87801; mfrisbee@nmt.edu; 575-835-5484

Fred M. Phillips, Earth and Environmental Science, New Mexico Tech, 801 Leroy Place, Socorro, NM 87801; phillips@nmt.edu; 575-835-5540

Presentation Abstract 12

Considerable advances have been made in understanding runoff generation at the hillslope and small catchment scales, yet our understanding of runoff generation in large watersheds greater than 1000 km^2 remains poor. Small-scale runoff mechanisms are well documented in the literature, and each of these mechanisms can uniquely affect the chemistry of the runoff that they produce, thus providing insight into the controls on runoff generation. Despite the great variety in runoff mechanisms observed at smaller scales, chemical fluxes derived from runoff often become damped as watershed scale increases. Recently, two interrelated hypotheses were proposed for this phenomenon. One study suggested that this behavior was controlled by the integration of shallow subsurface macropores and bedrock fractures and was damped by the release of stored water in the riparian matrix (integration process hypothesis). The other study suggested that water chemistry from hillslopes approached a median concentration as scale increased due to mixing of different waters within the hillslope (central limit theorem hypothesis). Both of these studies lend support to the idea that watersheds are the accumulation of small-scale runoff producing elements in the watershed. More importantly, both of these studies reject the increasing deep groundwater hypothesis, which states that concentrations of chemical constituents in stream water should continue to increase as basin size increases due to increasing contributions of deep groundwater. Recent models of residence time distributions provide contradictory evidence suggesting that chemical constituents can be temporally persistent in large watersheds. Likewise, current research in the Saguache Creek watershed (1600 km^2) in the San Juan Mountains of southern Colorado has shown that beyond an accumulated basin area of about 367 km^2, concentrations of Ca^{2+}, Na^+ and Cl^- do increase linearly with increasing basin area. These results may provide evidence for the increasing deep groundwater hypothesis and have strong implications for the conceptual models of runoff generation in large watersheds.

Contact: Marty D. Frisbee, Earth and Environmental Science, New Mexico Tech, mfrisbee@nmt.edu, 801 Leroy Place, Socorro NM 87801, 575-835-5484, Fax 575-835-6436

COMPARISON OF NET RADIATION BETWEEN GROUND MEASUREMENT AND SEBAL ESTIMATE IN ARID RIPARIAN AREA

Sung-ho Hong, New Mexico Tech, 801 Leroy Place, Socorro, NM 87801; hong@nmt.edu

Jan M.H. Hendrickx, New Mexico Tech, 801 Leroy Place, Socorro, NM 87801; hendrick@nmt.edu

Jan Kleissl, University of California, San Diego, CA 92093; jkleissl@ucsd.edu

Rick G. Allen, University of Idaho, Kimberly, ID 83341; rallen@kimberly.uidaho.edu

Presentation Abstract 13

Ground measured net radiation (Rn) is normally obtained with a net radiometer at a height of about 2 – 3 m above the canopy that covers typically a ground area on the order of 10 m^2. The SEBAL estimated Rn with Landsat 7 imagery at the time of satellite overpass is calculated from reflectances in the visible, near-infrared, and mid-infrared bands from a 900 m^2 pixel and the emittance in the thermal band from a 3600 m^2 pixel. Although the Rn ground observation is based on a measurement area at least two orders of magnitude smaller than the SEBAL Rn, this difference will not matter much for homogeneous areas; however, for heterogeneous areas it may cause serious bias. In heterogeneous arid riparian areas, since radiometers are typically placed over the canopy of interest, it may cause under-representation of surrounding bare soil or ground cover in the angle of view. Therefore, ground measured Rn is expected to be biased towards the Rn of the vegetation of interest in heterogeneous arid riparian areas. The objective of this study is to compare the SEBAL Rn derived from Landsat to net radiometer measurements in NM riparian areas. Results of this study show that the difference between ground measured instantaneous Rn and the one determined by SEBAL is quite large. The instantaneous Rn mean relative difference (MRD) between ground measurement and SEBAL estimate is 14.6%. In heterogeneous pixels, the SEBAL Rn seems more reliable than the ground measured one due to its more representative footprint.

Contact: Sung-ho Hong, New Mexico Tech, hong@nmt.edu, 1013 Lee Trevino Dr., Belen, NM 87002, 505-835-5466

WILL THE MINUTE SYSTEM WORK TO MODERNIZE THE INTERNATIONAL BOUNDARY AND WATER COMMISSION?

Annelia Tinklenberg, INTERA, Inc., 6000 Uptown Blvd. NE, Suite 100, Albuquerque, NM 87110; atinklenberg@intera.com; 505-246-1600

Presentation Abstract 14

The International Boundary and Water Commission (IBWC) was created in 1944 by the Treaty Regarding Utilization of Waters of Colorado and Tijuana Rivers and of the Rio Grande. The IBWC was given the authority to manage surface water along the US-Mexico border. Changes along the border (increasing population growth, environmental degradation, sanitation inadequacies, and stress on groundwater) have increased the challenges of administering the 1944 Water Treaty. Recent drought and Mexico's water debt have revealed vague language in the 1944 Water Treaty and its subsequent Minutes. Most critics suggest that the current mandate, structure, and jurisdiction of the IBWC are not adequate to handle the complexities of water management on the border. Some critics of the IBWC suggest a new Minute could resolve some of these obstacles, and the Minute system of the 1944 Water Treaty is seen as an avenue through which treaty reform and extensions can be made legally. An analysis of the Minute system and of the limitations of the institutional and political structures surrounding the IBWC was made to determine if it is indeed an adequate reform mechanism. Even though the Minute system may produce treaty-compatible reforms, other factors limit their usefulness. The Berlin Rules, the most recent and comprehensive set of customary international water law written by the International Law Association, provide sufficient guidelines for changes the IBWC can take. The IBWC can modernize itself through its Minute system by utilizing the Berlin Rules and its principles to achieve sound binational management of an international watercourse.

Contact: Annelia Tinklenberg, INTERA, Inc., atinklenberg@intera.com, 505-246-1600, Fax 505-246-2600

IMAGING FLOW AND TRANSPORT THROUGH A SUBHORIZONTAL FRACTURE USING GPR

Nedra D. Bonal, formerly at the University of Texas at Austin, presently at Sandia National Laboratories, PO Box 5800, MS 0750, Albuquerque, NM 87185-0750; nbonal@sandia.gov; 505-845-7486

Terence T. Garner, formerly at the University of Texas at Austin, presently at ExxonMobile, Houston, Texas

John M. Sharp, Jr., Geological Sciences, University of Texas at Austin, Geology Building 2.106, 23rd Street at San Jacinto Blvd., Austin, Texas 78705; jmsharp@mail.utexas.edu; 512-471-3317

Clark R. Wilson, Geological Sciences, University of Texas at Austin, Geology Building 2.106, 23rd Street at San Jacinto Blvd., Austin, Texas 78705; clarkw@maestro.geo.utexas.edu; 512-471-5008

Presentation Abstract 15

Water resources are often threatened by contaminants migrating along preferential pathways. Therefore, an understanding of flow path geometry is important for modeling flow and transport. Additionally, subsurface flow is dominated by fracture networks, and channeling of flow within a fracture plane is a major factor in solute transport. A field test was designed to image flow channeling in situ through a subhorizontal fracture in a granite outcrop using ground penetrating radar (GPR). Fluids of varying salinities (tracers) were pumped into the fracture at steady-state. High-frequency (1500 MHz) GPR profiles were collected when the fracture was dry and during injection of each tracer within the fracture to identify changes in radar signal associated with fluid salinity. Signal amplitude variations have been used to identify fluid locations in similar studies using much lower frequencies (200 MHz and lower). However, for the site parameters and frequencies used in this study, amplitude variations were not suitable. A correlation method was used to quantitatively relate changes in fracture filling-fluids with changes in radar signal. Combining GPR profiles throughout the survey area provided a 3D interpretation of flow and transport geometry, which was ground-truthed by comparison to injection and discharge locations. Fracture aperture may also be estimated using high-frequency GPR when the fracture is entirely saturated. Results of this study show that tracer was concentrated in the center of the survey area where fracture aperture was large.

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Contact: Nedra D. Bonal, formerly at the University of Texas at Austin, presently at Sandia National Laboratories, nbonal@sandia.gov, PO Box 5800, MS 0750, Albuquerque, NM 87185-0750, 505-845-7486, Fax 505-844-7354

ANALYSIS OF LAND USE IN THE SOCORRO AND SAN MARCIAL BASINS

Nabil Shafike, Interstate Stream Commission, 121 Tijeras NE Suite 2000, Albuquerque, NM 87102; nabil.shafike@state.nm.us; 505-764-3866

David Jordan, INTERA, Inc., 6000 Uptown Blvd. NE Suite 100, Albuquerque, NM 87110; djordan@intera.com; 505-246-1600

Presentation Abstract 16

The Socorro and San Marcial basins are located in central Socorro County, New Mexico. The sixty-mile reach of the Rio Grande located between San Acacia and Elephant Butte reservoir experiences high water depletions that impact New Mexico's ability to deliver its obligation under the Rio Grande compact to Elephant Butte reservoir. Under the Rio Grande compact, New Mexico is obligated to deliver a specified amount of water to Elephant Butte reservoir based on the flow at Otowi gage at northern New Mexico. Therefore, a historical investigation of the land use in the San Acacia river reach has been conducted. This study builds on the Land Use Trend Analysis (LUTA) work done by the Bureau of Reclamation as part of the Middle Rio Grande Study during 1997. The Reclamation LUTA analysis covered the middle valley area from Cochiti dam to the Valencia/Socorro county line. This work extended the LUTA study to Elephant Butte reservoir. To investigate how changes in land use affect the water depletion in the San Acacia reach, analysis of historical aerial photography for the years 1935, 1955, 1972, 1992, and 2005 was conducted. Aerial photographs were digitized, and general land-use classification similar to what was used in the Rio Grande Joint Investigation (RGJI) was followed. Results indicate that riverbed and open water areas decreased significantly, while irrigated and urban areas have shown moderate increase.

Contact: Nabil Shafike, New Mexico Interstate Stream Commission, nabil.shafike@state.nm.us, 121 Tijeras NE Suite 2000, Albuquerque, NM 87102, 505-764-3866, Fax 505-764-3893

TIMING, DISTRIBUTION, AND MECHANISMS OF MONSOON RECHARGE TO CARBONATE AND CLASTIC AQUIFERS IN THE SANDIA AND MANZANITA MOUNTAINS, NEW MEXICO

Kurt J. McCoy, U.S. Geological Survey, 5338 Montgomery NE, Suite 400, Albuquerque, NM 87109; kjmccoy@usgs.gov; 505-830-7925

Daniel McGregor, Bernalillo County Public Works, 2400 Broadway SE, Building N, Albuquerque, NM 87102; dmcgregor@bernco.gov; 505-848-1578

Presentation Abstract 17

Recent population growth in the Sandia and Manzanita Mountains near Albuquerque, NM, has led to increased construction of homes and businesses with commensurate demands on groundwater supplies. Along the eastern flanks of both mountain ranges, uplift associated with the Rio Grande rift has exposed the Pennsylvanian-age Madera Limestone, the principal aquifer in the area. The adjacent clastic aquifers of Permian and Cretaceous age are downthrown to the east in a graben structure bounded by the Tijeras and Gutierrez Faults. Planning for future withdrawals from the Madera and downgradient clastic aquifers requires a fundamental knowledge of the distribution, timing, and mechanisms of infiltration following both winter and summer recharge events.

This study focuses on cross-correlation analysis of precipitation, water-level, and geochemical data to evaluate the response of aquifers in the Sandia and Manzanita Mountains to rainfall during 2 years of above-average monsoonal precipitation. Long, persistent lag-time responses of 1 to 6 months following monsoon events suggest that (1) recharge along arroyos reaches phreatic zones via slow diffusion through low-permeability units, or (2) that steeply dipping bedding may limit the velocity of groundwater following regional flow gradients. The lag time between precipitation input and response of water levels or solute concentrations was largest near regional fault zones bounding unique hydrostructural domains. These results suggest regional faults hydrologically isolate clastic aquifers from groundwater recharge originating at high elevations in the Madera Limestone. Several wells drilled in clastic units appear to be isolated from input from individual precipitation events, suggesting they are located in areas where groundwater depletion could be a concern to resource managers.

Contact: Kurt J. McCoy, U.S. Geological Survey, kjmccoy@usgs.gov, 5338 Montgomery NE, Suite 400, Albuquerque, NM 87109, 505-830-7925, Fax 505-830-7998

WHAT CAN BE DONE?
STEPS IN RESTORING RIVERINE AND FLOOPLAIN HABITAT FUNCTIONS IN THE MIDDLE RIO GRANDE UNDER CURRENT CONSTRAINTS

Grace M. Haggerty, New Mexico Interstate Stream Commission, 121 Tijeras NE, Suite 2000, Albuquerque, NM 87102; grace.haggerty@state.nm.us; 505-765-2053

Anders Lundahl, New Mexico Interstate Stream Commission, 121 Tijeras NE, Suite 2000, Albuquerque, NM 87102; anders.lundahl@state.nm.us; 505-765-2054

Amy Louise, New Mexico Interstate Stream Commission, 121 Tijeras NE, Suite 2000, Albuquerque, NM 87102; amy.louise@state.nm.us; 505-765-2054

Page Pegram, New Mexico Interstate Stream Commission, 121 Tijeras NE, Suite 2000, Albuquerque, NM 87102; page.pegram@state.nm.us; 505-764-3890

Peter Wilkinson, New Mexico Interstate Stream Commission, Room 101 Bataan Memorial Bldg, PO Box 25102, Santa Fe, NM 87504-5102; peter.wilkinson@state.nm.us; 505-827-5801

Joseph Fluder, SWCA Environmental Consultants, 5647 Jefferson St. NE, Albuquerque, NM 87109; jfluder@swca.com; 505-254-1115

Presentation Abstract 18

There are numerous physical, economic, and political constraints on the middle Rio Grande that tend to limit the amount and extent of habitat restoration that can be accomplished. However, steps can be made within these sideboards that appear to have a positive effect for the endangered species in the region with relatively low impact on human water users. The creation of effective spawning and recruitment habitat for the endangered Rio Grande silvery minnow in the middle Rio Grande is the main focus of recent habitat restoration efforts by the NMISC. Such work is an important component of the reasonable and prudent alternatives in the 2003 biological opinion, which provides ESA coverage for water users in the basin. Various restoration techniques have been implemented and monitored since 2006 on nonPueblo lands between Angostura and Isleta diversion dams. Shown are the criteria and methodologies used by the NMISC to select appropriate techniques and sites. Monitoring of the restoration projects already indicates some intriguing results. The NMISC is also beginning restoration work in the Isleta Reach below the Pueblo of Isleta in collaboration with the MRGCD. Because this reach is subject to drying during irrigation season, restoration activities in this reach will emphasize creation of refugial areas that can be maintained as wetted habitat throughout the year and enhancement of spawning habitat in the same geographic area.

Contact: Grace Haggerty, NM Interstate Stream Commission, grace.haggerty@state.nm.us, 121 Tijeras NE, Suite 2000, Albuquerque, NM 87102, 505-765-2053, Fax 505-764-3893

EGG AND LARVAL RETENTION MECHANISMS MINIMIZE DOWNSTREAM DISPLACEMENT OF PELAGIC SPAWNING MINNOW POPULATIONS

C. Nicolas Medley, New Mexico Interstate Stream Commission, Room 101 Bataan Memorial Building, PO Box 25102, Santa Fe, NM 87504-5102; nic.medley@state.nm.us; 505-827-5811; 505-827-6188

Ann M. Widmer, SWCA Environmental Consultants, Denver, CO

Jon W. Kehmeier, SWCA Environmental Consultants, Denver, CO

Orrin B. Myers, Division of Epidemiology and Biostatistics, New Mexico Environmental Health Center, University of New Mexico, Albuquerque, NM

Richard A. Valdez, SWCA Environmental Consultants, Logan, UT

Joseph Fluder, SWCA Environmental Consultants, Albuquerque, NM

Presentation Abstract 19

Pelagic spawning minnows (PSM) broadcast semi-buoyant eggs during high flows associated with spring snowmelt or coincident with the ascending limb of flood hydrographs associated with summer rains. Eggs and newly hatched larvae drift downstream until they are entrained in low-velocity habitats. Results of recent studies on the Rio Grande and Pecos River in New Mexico suggest that PSM have evolved life histories that take advantage of environmental conditions during spawning to maximize egg and larval retention and minimize downstream population displacement: 1) Timing egg release coincident with the ascending limb of a flood hydrograph promotes egg retention, as eggs are retained concomitant with water storage during flood wave attenuation; 2) Eggs broadcast in wide, shallow river reaches with accessible floodplain habitats drift shorter distances, suggesting that the greater availability of low-velocity transient storage areas is important in enhancing egg retention; 3) PSM eggs sink quicker in clear, warm water, allowing eggs to selectively settle in low-velocity, productive floodplain habitats; 4) Gravid PSM have been documented on inundated floodplain habitats during spawning season, suggesting that adult fish may preferentially spawn in low-velocity floodplain habitats thereby reducing or eliminating downstream egg drift. The available evidence suggests that the current threat of downstream population displacement is caused by the loss of propagule retention mechanisms in degraded river reaches. We recommend that conservation actions focus on reestablishing important hydrologic attributes and reconnecting naturally functioning river channels to active floodplains.

Contact: Grace Haggerty, NM Interstate Stream Commission, grace.haggerty@state.nm.us, 121 Tijeras NM, Suite 2000, Albuquerque, NM 87102, 505-765-2053, Fax 505-764-3893

ON HYDROLOGIC RESIDENCE TIME AND DYNAMICALLY CHANGING HYDROLOGIC SYSTEMS

Jesus D. Gomez, Hydrology, New Mexico Tech, 801 Leroy Place, Socorro, NM 87801; jdgomez@nmt.edu; 575-418-1502

Matthew N. Baillie, Hydrology, New Mexico Tech, 801 Leroy Place, Socorro, NM 87801; baillie@nmt.edu

John L. Wilson, Hydrology, New Mexico Tech, 801 Leroy Place, Socorro, NM 87801; jwilson@nmt.edu

Presentation Abstract 20

Spatial and temporal variability of weather and climatic forcings induce a dynamic response in hydrologic systems. Regional groundwater systems and stream hyporheic zones are examples of hydrologic systems driven by forcings varying at several time scales, such as daily, seasonal, interannual, decadal, and longer. Hydrologic systems are characterized by flow paths and residence time distributions. Residence times vary in space, with positions further along flow paths exhibiting older ages. If the hydrologic flow system is in steady state the flow paths do not change in time and water present at a given point has a stable mean residence time. But hydrologic flow paths and residence times can change dynamically with weather and climate temporal variability. Traditionally, this dynamic response is ignored and residence times are evaluated as if the flow was in steady state. A simple transient flow and transport model and the mean-age mass concept are used to illustrate the effect of dynamically changing systems on residence-time estimation.

Contact: Jesus D. Gomez, Hydrology, New Mexico Tech, jdgomez@nmt.edu,
801 Leroy Place #2005, Socorro, NM 87801, 575-418-1502

OBSERVATIONS OF HYPORHEIC EXCHANGE IN A SMALL MOUNTAIN CATCHMENT (VALLES CALDERA, NM) USING TEMPERATURE SENSORS

Matthew N. Baillie, Hydrology, New Mexico Tech, 801 Leroy Place
Socorro, NM 87801; baillie@nmt.edu; 520-245-9413

John L. Wilson, Hydrology, New Mexico Tech, 801 Leroy Place
Socorro, NM 87801; jwilson@nmt.edu; 575-835-5634

Presentation Abstract 21

We deployed over 100 temperature/light sensors in a small (about 3.7 km^2) mountain catchment in the Valles Caldera National Preserve of New Mexico in an effort to understand water exchange between a stream and its hyporheic zone. Temperature was recorded from November 2006 through May 2008 at a three-hour interval along approximately 2.5 km of the eastern fork of La Jara Creek. Daily temperature fluctuation of water is damped as it spends time in the subsurface (e.g., in the hyporheic zone). Therefore, we expect locations of upwelling hyporheic water to exhibit a damped daily temperature fluctuation, with the degree of damping dependent on the amount of streamflow, the amount of upwelling, and the temperature fluctuations of both. Temperature results confirm this expectation, and we can use these inexpensive and elegant temperature sensors to find locations of groundwater upwelling in mountain stream systems. The temperature and light intensity data have other uses as well: the onset and cessation of snow cover can be determined by these data, as can the presence and absence of flow in the stream. These data, cheap and easy to collect, can be valuable to our understanding of catchments in mountainous areas by helping us understand the location, extent, magnitude, and dynamics of flow and exchange in stream systems.

Contact: Matthew N. Baillie, Hydrology Program, New Mexico Tech, baillie@nmt.edu, PO Box 2021, Socorro, NM 87801, 520-245-9413

SIMULATION OF SURFACE-WATER / GROUND-WATER INTERACTION IN THE MIDDLE RIO GRANDE VALLEY AS PART OF THE RIO GRANDE WATER OPERATIONS MODEL

D. Michael Roark, U.S. Geological Survey, 5338 Montgomery Blvd. NE, Suite 400 Albuquerque, NM 87109; mroark@usgs.gov; 505-830-7954

Nabil Shafike, New Mexico Interstate Stream Commission; nabil.shafike@state.nm.us

Presentation Abstract 22

Flows of the Rio Grande in New Mexico's Middle Rio Grande Valley, which extends from Cochiti Dam to Elephant Butte Reservoir, are affected by the interaction between the surface-water and ground-water systems. This interaction is complicated by a series of diversions to canals and drains adjacent to the river, irrigation-water return flow to the river, deep ground-water pumping, and riparian evapotranspiration. A physically based water-management model of the river system is critical to management of the water in the Rio Grande for numerous needs such as irrigation diversion, riparian consumption, Endangered Species Act requirements, flood control, and compact deliveries. The Upper Rio Grande Water Operations Model (URGWOM) is a comprehensive surface-water model that is used for managing the water of the Rio Grande by linking reservoir operations to downstream demands and flows. Physical processes represented in URGWOM include reservoir operations, channel routing, reach loss or gain, evaporation, precipitation, crop and riparian vegetation consumption, and diversion and return flow. This presentation provides an overview of recent updates to URGWOM to better simulate the physical processes of interaction between the surface-water and ground-water systems in the Middle Rio Grande Valley.

Contact: D. Michael Roark, USGS, mroark@usgs.gov, 5338 Montgomery Blvd. NE, Suite 400 Albuquerque, NM 87109, 505-830-7954

WEB TECHNOLOGY FOR PUBLIC PARTICIPATION AND POLICY DEVELOPMENT IN ENERGY-WATER SUSTAINABILITY

Gordon N. Keating, Earth and Environmental Sciences Div., Los Alamos National Laboratory, MS D452, PO Box 1663, Los Alamos, NM 87545; gkeating@lanl.gov; 505-667-5902

Donatella Pasqualini, Earth and Environmental Sciences Div., Los Alamos National Laboratory, MS D452, PO Box 1663, Los Alamos, NM 87545; dondy@lanl.gov; 505-667-0701

Frank Perry, Earth and Environmental Sciences Div., Los Alamos National Laboratory, MS D452, PO Box 1663, Los Alamos, NM 87545; fperry@lanl.gov; 505-667-1033

Marc Witkowski, Earth and Environmental Sciences Div., Los Alamos National Laboratory, MS D452, PO Box 1663, Los Alamos, NM 87545; witk@lanl.gov; 505-665-8332

Hans-Joachim Ziock, Earth and Environmental Sciences Div., Los Alamos National Laboratory, MS D462, PO Box 1663, Los Alamos, NM 87545; ziock@lanl.gov; 505-667-7265

Presentation Abstract 23

We are developing an interactive web portal for engaging the public and guiding policy development concerning water and energy sustainability in Sonoma County, California. In order to attain the county's stated goal of a 25% reduction in greenhouse gas emissions below 1990 levels by 2015 (exceeding reductions required by California's 2006 law AB32), the Sonoma County Water Agency (SCWA) is pursuing an agenda of zero net CO_2 emissions in the production of the 12 MW of electric power required for water supply, distribution, and wastewater treatment. In addition, the SCWA is developing an interactive web portal to interest, inform, enlist, and retain input from the SC citizenry, with the goal of mapping out a course towards energy sustainability and resilience, carbon neutrality, and economic vitality, given projections of future climate change. The approach for the web portal includes interactive functionality (e.g., discussions, blogs, comments, surveys) via a content management system (CMS), CO_2 data visualization, technical articles, an interactive system dynamics model, and social networking. User activity and viewpoints will be analyzed by a mixture of qualitative and semi-quantitative methods. Challenges include attracting and retaining users, harvesting meaningful input, and measuring changing opinions to provide actionable policy input.

Contact: Los Alamos Unlimited Release LA-UR-08-4376, Gordon N. Keating, Earth and Environmental Sciences Division, Los Alamos National Laboratory, gkeating@lanl.gov, MS D452, PO Box 1663, Los Alamos, NM 87545, 505-667-5902, Fax 505-667-1628

DEIONIZED WATER LEACHES OF MINE WASTE ROCK: METHODOLOGY AND APPLICATIONS

Eric S. Osantowski, Chemistry, New Mexico Tech, 801 Leroy Place, Socorro, NM 87801; eosantow@nmt.edu; 575-835-6641

Michael J. Pullin, Chemistry, New Mexico Tech, 801 Leroy Place, Socorro, NM 87801; mpullin@nmt.edu; 575-835-6185

Virginia T. McLemore, New Mexico Bureau of Geology and Mineral Resources, New Mexico Tech, 801 Leroy Place, Socorro, NM 87801; ginger@gis.nmt.edu; 575-835-5521

Presentation Abstract 24

Chemical extractions are often used to study elemental speciation as well as biogeochemical cycling in complex environmental systems such as soils and mining environments. In this investigation, a deionized water leach method was developed to provide insight into the extent of weathering of various geologic zones within a mine rock pile and to identify possible secondary mineral phases present. Method development investigated the dependence on particle size and leaching durations. We found that the difference in leached ion concentrations from materials of different particle sizes could be accounted for by the particle surface area. We also found that the majority of analytes measured reached a pseudo-steady state after two hours of leaching. The developed method was applied to a weathering profile from the exterior to the interior of a mine rock pile at the Questa molybdenum mine. The leachate composition was found to be dependent on the location within the pile. The leachates from the exterior units of the pile have a lower pH and a higher conductivity than samples of the interior portion of the pile, suggesting the presence of weathering products such as jarosite that can store acid during dry periods. Saturation indices of the leachates were determined using equilibrium calculations. We found that the leachates from the exterior of the piles are saturated with respect to several aluminum- and iron-bearing secondary minerals. This research shows that this method can be a useful tool in determining readily mobilized elements in dry climates, where obtaining pore-water geochemistry is difficult.

Contact: Eric S. Osantowski, Department of Chemistry, New Mexico Tech, eosantow@nmt.edu, 801 Leroy Place, Socorro, NM 87801, 575-835-6641, 575-838-0530, Fax 575-835-5364

PILOT TESTS OF COAL BED METHANE PRODUCED WATER DESALINATION TECHNOLOGIES NEAR NAVAJO DAM, NEW MEXICO

Malynda Cappelle, Sandia National Laboratories, PO Box 5800, MS0754, Albuquerque, NM 87185-0754; macappe@sandia.gov; 505-844-1288
Randy Everett, Sandia National Laboratories, PO Box 5800, MS0754, Albuquerque, NM 87185-0754; rlevere@sandia.gov; 505-844-2933;
William Holub Jr., Sandia National Laboratories, PO Box 5800, MS0754, Albuquerque, NM 87185-0754; weholub@sandia.gov; 505-844-9918;
Allan Sattler, Sandia National Laboratories, PO Box 5800, MS0706, Albuquerque, NM 87185-0754; arsattl@sandia.gov; 505-844-2875;
Frank McDonald, Biosphere Environmental Sciences and Technologies, 5101 N College Blvd Ste 5061, Farmington, NM 87402, fmcd_best@hotmail.com
Rebekah Miller and others, ConocoPhillips San Juan Operating Unit, 3401 E. 30th Street, Farmington, NM 87402; Rebekah.E.Miller@conocophillips.com

Presentation Abstract 25

Partnering with ConocoPhillips, Biosphere Environmental, New Mexico State University (NMSU), and the US Department of Agriculture (USDA), Sandia National Laboratories is performing pilot studies at a coal bed natural gas (CBNG) pad site near Navajo Dam, NM.

In the extraction of natural gas from coal-seam beds, there is a considerable amount of brackish water (water quality can range up to 60,000 mg/L TDS or higher) produced from a CBNG well. This produced water could pose environmental problems if untreated and is typically disposed of via injection wells or other disposal methods. The expenses for hauling off and disposing of produced water could restrict the production of natural gas from coal beds. In this project, the produced water from the CBNG well is desalinated to less than 1000 mg/L TDS and is studied by NMSU and the USDA for rangeland and riparian improvement.

Pilot equipment includes ultrafiltration (UF), followed by reverse osmosis (RO). Preliminary pilot work has effectively demonstrated a proof of concept for low energy brackish water desalination. Using a single reverse osmosis membrane in sub-optimal conditions (high fouling-tendency, single membrane, and most of the time without the benefit of an UF), good quality water was produced for the rangeland/riparian improvement study. Future work will further study the operational aspects of a similar system and may examine the potential for nanofiltration membranes.

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Contact: Malynda Cappelle, Sandia National Laboratories, macappe@sandia.gov, malynda7@gmail.com, PO Box 5800, MS 0754, Albuquerque, NM 87185-0754, 505-844-1288, Fax 505-844-7354

PILOT TESTS OF HYBRID DESALINATION USING REVERSE OSMOSIS AND ELECTRODIALYSIS AT THE BRACKISH GROUNDWATER NATIONAL DESALINATION RESEARCH FACILITY

Malynda Cappelle, Sandia National Laboratories, PO Box 5800, MS0754, Albuquerque, NM 87185-0754; macappe@sandia.gov; 505-844-1288

Randy Everett, Sandia National Laboratories, PO Box 5800, MS0754, Albuquerque, NM 87185-0754; rlevere@sandia.gov; 505-844-2933

William Holub Jr., Sandia National Laboratories, PO Box 5800, MS0754, Albuquerque, NM 87185-0754; weholub@sandia.gov; 505-844-9918

Thomas Davis, University of South Carolina, Columbia, SC 29208; DAVISTH@engr.sc.edu

Presentation Abstract 26

Partnering with Zero Discharge Desalination, Inc., Sandia National Laboratories is performing pilot studies at the Brackish Groundwater National Desalination Research Facility in Alamogordo, NM.

Inland brackish desalination is becoming more commonplace in recent years. A major complication arises when reverse osmosis is used, due to the need for disposal of the concentrate stream. This stream can be anywhere between 25-50% of the water fed to the system. Typical means of disposal are injection wells and evaporation ponds, both of which can be expensive. The system being piloted functions by using electrodialysis-metathesis (EDM) on the concentrate stream of the reverse osmosis system. This allows extraction of the salts as a solid stream and allows for increased water efficiency (up to 95%). In many cases, salts can be sold to offset other disposal costs.

Pilot equipment includes cartridge filters, followed by reverse osmosis (RO) and EDM. Preliminary pilot work has effectively demonstrated a proof of concept for brackish water desalination in Texas and California. On two different types of brackish feed water, good quality water was produced. Current work will further study the operational aspects of a similar system on the Alamogordo water, which is comprised primarily of calcium sulfate. The calcium sulfate (gypsum) will be concentrated and extracted as a solid precipitate and will be analyzed for potential use in producing wall board.

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Contact: Malynda Cappelle, Sandia National Laboratories, macappe@sandia.gov, PO Box 5800, MS 0754, Albuquerque, NM 87185-0754, 505-844-1288, Fax 505-844-7354

MULTIPLE USE WATER CONSERVATION: CREATING NEW WATER SUPPLY FOR COMMUNITIES AND MAINTAINING AGRICULTURE

Eddie C. Livingston, Livingston Associates, 500 Tenth Street, Suite 300, Alamogordo, NM 88310; elivingston@livingston-associates.com; 575-439-8588

Presentation Abstract 27

Multiple Use Water Conservation (MUWC) is a new concept in water resources creation and conservation and is subtitled “because water should be used more than once.” Future municipal water requirements for 26 New Mexico communities total almost 108,000-acre feet. One alternative for supplying these communities with water is through MUWC. The MUWC concept allows the use of agricultural water for municipal purposes first, then irrigation of the farm using the reclaimed wastewater flows. Commercial and industrial applications may also be included in this “use it, reuse it, and use it again” philosophy. Multiple uses of the same agricultural water are accomplished by reclaiming the water each time prior to the final use as farm irrigation. Farm irrigation is always maintained as the terminal use. MUWC examples are presented, showing municipal water right multipliers of more than 300%. A study developed in conjunction with the City of Alamogordo demonstrated that 25,000 acres of MUWC program-participating farms can create 100,000 acre-feet of new municipal water supply.

A pilot-scale MUWC program was also conducted and included agricultural well pumping, municipal use, car wash operation, and farm irrigation. 93,000-gallons of water uses were realized from a 31,000-gallon agricultural diversion. A conceptual MUWC project for Alamogordo is also presented, showing that a municipal diversion of 430 ac-ft creates 1,000 ac-ft of additional municipal water supply, at a cost of $560 per acre-foot. An analysis on water rights administration for the MUWC concept is discussed, along with language for modifying existing water law.

Contact: Eddie C. Livingston, Livingston Associates, elivingston@livingston-associates.com, 500 Tenth Street, Suite 300, Alamogordo, NM 88310, 575-439-8588, Fax 575-439-1332

ATTENUATION OF HEXAVALENT CHROMIUM IN THE VADOSE ZONE AND REGIONAL AQUIFER, LOS ALAMOS, NEW MEXICO

Mei Ding, EES-6, Los Alamos National Laboratory, MS J514, Los Alamos, NM 87544; mding@lanl.gov; 505-667-7051

Patrick Longmire, EES-6, LANL; plongmire@lanl.gov; 505-665-1264

D. Vaniman, EES-6, LANL; dvaniman@lanl.gov; 505-667-1863

D. Broxton, EES-9, LANL; broxton@lanl.gov; 505-557-2492

D. Katzman, LANL Water Stewardship project; katzman@lanl.gov; 505-667-6333

John Bargar, Stanford Synchrotron Radiation Lab; bargar@slac.stanford.edu; 650-926-4949

Presentation Abstract 28

Adsorption coefficients of Cr(VI) in vadose zone and aquifer materials were measured as part of ongoing environmental investigations that address fate and transport of chromium(VI) originating in Sandia Canyon, Los Alamos, NM. Here, we present our initial findings of the characterization of vadose zone and regional aquifer materials with regard to their Cr(VI) retention capacity. We also present an assessment of the role of naturally occurring adsorbents present in the subsurface media such as clay minerals, ferric (oxy)hydroxide, and calcium carbonate on the adsorption of Cr(VI) under relevant field conditions. The results of our studies (1) directly assess the relation between mineralogical and geochemical characterization and transport behavior of Cr(VI) in the hydrogeological setting of interest, (2) provide site-specific adsorption and precipitation parameters obtained through experiments to refine the fate and transport modeling of chromium in the vadose zone and regional aquifer, and (3) reveal the mechanisms of chromate retention processes within the geomedia of interest.

Contact: Mei Ding, Los Alamos National Laboratory, mding@lanl.gov, MS J514, Los Alamos, NM 87545, 505-667-7051, Fax 505-665-4955

A COMBINED STOCHASTIC-DETERMINISTIC APPROACH TO ESTIMATE UPSCALED STREAMBED CONDUCTANCE FOR STREAM-AQUIFER INTERACTION MODELING

James T. McCord and **Jodi Clark**, AMEC-Hydrosphere, 115 West Abeyta, Suite A, Socorro, NM 87801; jim.mccord@amec.com; 575-835-2569
Subhrendu Gangopadhyay, AMEC-Hydrosphere, 1002 Walnut Street, Suite 200 Boulder, CO 80302; subhrend.gangopadhyay@amec.com; 303-443-7839
Shaden Musleh, AMEC-Hydrosphere, 1002 Walnut Street, Suite 200, Boulder, CO 80302; shaden.musleh@amec.com; 303-443-7839

Presentation Abstract 29

We have developed a method to estimate effective streambed conductance using a stochastic description of aquifer heterogeneity for stream-aquifer interaction modeling. The starting point for this technique is generation of random hydraulic conductivity fields typical of sandy alluvial deposit, and these random hydraulic conductivity fields were processed through a MODFLOW model of the aquifer domain (80 ft deep, 120 ft wide, and 100 ft thick; 1 layer, 400 rows each 0.2 ft thick, and 120 columns each 1 ft wide) to generate hydraulic heads (an ensemble of 100 realizations were developed). The upper and left corner of the domain was simulated to be a streambed and the lower right corner of the domain to simulate a drain or a well. The aquifer was modeled as a confined system where the head in the source constant head cells was set at 110 ft, and the head in the sink was set at 100 ft. A mean head field from the 100 realizations was developed for each of the 400 x 120 model cells of the domain. This model was run in steady state mode and will be referred to as the stochastic heterogeneous model. Furthermore, flow zones were identified (a total of five) corresponding to regions where flow gradients were primarily horizontal, vertical, and intermediate.

An effective property model was next developed using a coarser discretization (1 layer, 9 rows with the first and sixth 5 ft thick and the remaining seven each 10 ft thick, and 12 columns each 10 ft wide), and conductivity values for the different zones were estimated using the parameter estimation option of the MODFLOW 2000 code. Constant head boundary was retained for the upper left corner but the drain cells from the stochastic heterogeneous model were replaced by the MODFLOW well package with a total pumping rate equal to the ensemble mean flux of the stochastic heterogeneous model. The remaining model boundaries were specified as no flow, similar to the stochastic heterogeneous model. Hydraulic conductivity and anisotropy values for the flow zones were estimated using MODFLOW 2000. The fitted horizontal hydraulic conductivities ranged between 270 and 300 ft/d, and the fitted vertical conductivity ranged between 50 and 130, depending on statistical anisotropy in the correlation structure and presence of clay layers. The leakance calculated from the conductivity along columns below the constant head boundary can be used to estimate streambed conductance for the MODFLOW river package. This value was estimated at about 20/day.

To refine the streambed leakance estimation from the inverse model, the cells adjacent to the constant head cells were assigned to river cells, and a set of runs were carried out by decreasing the streambed leakance from 20/d to 5/d (reduced at the rate of 5/d). For each of these runs, simulated versus observed heads were analyzed using scatter plots. Best fit (slope and intercept nearing 1 and zero respectively) with the observed heads was obtained for the case of leakance equal to 5/d.

Contact: Jim McCord, AMEC-Hydrosphere, jim.mccord@amec.com, 115 West Abeyta, Suite A, Socorro, NM 87801, 575-835-2569, Fax 575-835-2609

HOW MUCH WATER DOES MESILLA VALLEY AGRICULTURE CONSUME?

Zohrab Samani, Civil Engineering, NMSU; zsamani@nmsu.edu

A. Salim Bawazir, Civil Engineering, NMSU; abawazir@nmsu.edu

Max Bleiweiss, Entomology, Plant Pathology, and Weed Science, NMSU; mbleiwei@nmsu.edu

Rhonda Skaggs, Agricultural Economics, NMSU; rskaggs@nmsu.edu; 575-646-2401

Presentation Abstract 30

Research at New Mexico State University has led to the development of the Regional ET Estimation Model (REEM) for agricultural and riparian vegetation (Samani et al. 2005, 2006, 2007). REEM uses remotely sensed satellite data to calculate ET as a residual of the energy balance. REEM recently was used to create a video display that illustrates a full year of agricultural ET in New Mexico's Mesilla Valley. This presentation will show the video and include speaker narration to introduce and explain what the viewers are watching.

Contact: Rhonda Skaggs, Agricultural Economics, NMSU, rskaggs@nmsu.edu, MSC 3169, Box 30003, Las Cruces, NM 88003, 575-646-2401, Fax 575-646-3808