DEVELOPMENT AND TESTING OF A MULTI-AGENCY, MULTI-FUNCTION WATER OPERATIONS MODEL

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Presentation Abstract 1
(presented by **Gail Stockton**)

More than a few lessons have been learned in the development and testing of the Upper Rio Grande Water Operations Model (URGWOM). The multi-agency water operations model for meeting daily reservoir operations requirements, and its planning version, for broader planning applications, were developed with the recognition that success is dependent on the confidence that the stakeholders have in the model. Each step of the technical development, review, testing, and documentation has been conscientiously undertaken with that precept in mind; as well as, to meet the objectives of the development agencies. This presentation demonstrates some technical problems and challenges that are being addressed to build stakeholder confidence in this very complex hydrologic model. Specifically, these are related to: functions of the model, model development input data, technical review, accounting rules development, data sharing, model and data quality, and documentation.

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REGIONAL GROUNDWATER AVAILABILITY MODELING OF THE SOUTHERN OGALLALA AQUIFER OF WEST TEXAS AND EASTERN NEW MEXICO

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Presentation Abstract 2

The Southern Ogallala aquifer underlies approximately 30,000 square miles of the High Plains of western Texas and eastern New Mexico. Groundwater development of the aquifer began during the early 1900s, although large-scale pumping started during the 1940s. The availability of water is critical to the economy of this region, as 95 percent of groundwater pumped is used for irrigated agriculture. The first comprehensive groundwater flow models of the Southern Ogallala aquifer were developed during the early 1980s by the US Geological Survey and the Texas Water Development Board (TWDB). Regional modeling efforts since that time have consisted primarily of updates and some enhancements to the original TWDB model.

As part of a comprehensive state-wide planning process adopted by the State of Texas, a new groundwater flow model (termed groundwater availability model, or GAM) was developed for the entire Southern Ogallala aquifer in Texas and New Mexico. The purpose of the model is to determine the adequacy of existing groundwater supplies to meet projected demand over a 50-year planning horizon. The model consists of a predevelopment calibration to average aquifer conditions prior to 1940, a transient calibration for the period 1940 through 2000, and predictive simulations for the period 2001 through 2050. A new hydraulic conductivity field for the aquifer was developed based upon the correlation of hydraulic conductivity to interpreted depositional systems. Simulated recharge rates are significantly different for pre- and post-development conditions, most likely due to changes in land use.

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ESTIMATION OF EVAPORATIVE AND ENRICHMENT PROCESSES ON THE RIO GRANDE AND PECOS USING PHREEQC AND ISOTOPE MEASUREMENTS

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Presentation Abstract 3

Cation and anion measurements made by the USGS on the Rio Grande and Pecos rivers are used in the PHREEQC geochemical model to estimate potential precipitation and dissolution processes on the Rio Grande and Pecos valleys from the headwater regions to outflow into Lake Amistad. Stable isotopes in water (2H and 18O) from precipitation measurements between the Gulf Coast and Del Rio and on sampling points on the two rivers are used to evaluate the PHREEQC model estimates on water evaporation between river segments. Results are also presented on potential mixing processes that may be occurring within Lake Amistad.

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HIGH-RESOLUTION, MULTI-SCALE MODELING OF WATERSHED HYDROLOGY

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Presentation Abstract 4

Hydrologists have long recognized that the interaction of climate, topography, soils and vegetation leads to observable spatial and temporal patterns in hydrological response in watersheds. Our understanding of these complex relationships is aided through numeric models that best represent our current knowledge of the physical processes occurring within basins. The aim of this presentation is to introduce a modeling framework for studying land-surface and subsurface hydrologic response to meteorological forcing. The computational model has several distinguishing features that will be highlighted: (1) coupled unsaturated and saturated zones through a dynamic water table, (2) coupled energy and hydrologic balance at the land surface, (3) topographically-driven soil moisture redistribution, radiation and evapotranspiration. Accurate topographic representation with minimal computational expense is achieved through the use of a triangulated irregular network (TIN) terrain model.

Methods for deriving the multiple-resolution TIN terrain within geographic information systems (GIS) will be discussed. By integrating topography, land-surface properties and rainfall measurements, obtained from remote sensing (RS), the distributed model has been used in a variety of studies, including multi-year flood simulations in operational watersheds, flood forecasting with radar-based rainfall forecasts and sensitivity studies on terrain resolution and coupled surface-subsurface catchment response. Most importantly, the tool provides a complete description of the spatio-temporal variability and organization of the underlying hydrologic processes (e.g., soil moisture, runoff, water table position, evapotranspiration). To illustrate the model capabilities and future prospects, an illustrative example will be presented for the Río Puerco river basin (16,000 km2) in New Mexico.

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A FARM PACKAGE FOR MODFLOW-2000: ESTIMATING SUPPLEMENTAL WELL PUMPING IN A SURFACE-WATER DOMINATED IRRIGATION SETTING

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Presentation Abstract 5

When a groundwater modeling program such as MODFLOW-2000 is used to aid the conjunctive management of surface-water dominated irrigation systems, a FARM package is necessary. This package logically integrates, on a farm-by-farm basis, surface water delivery (DEL), farm delivery requirement (FDR), and supplemental well pumping required to sustain the crops growth.

The central algorithm of the FARM Package (FMP) calculates an economic budget between FDR and DEL. The FDR will be modeled by the FMP based on crop consumptive use, crop-effective precipitation, evapotranspiration losses from groundwater, and on-farm efficiency. The DEL is dependent on the diversion from the river, conveyance losses, and the delivery requirement per reach and will be simulated by a new version of the stream flow routing package (SFR1) (PRUDIC, D., 2003). Both packages will be linked.

MODFLOW-2000 combined with SFR1 and FMP will determine supply (DEL) and demand (FDR) per farm and irrigation season, and distinguish between a positive or negative economic budget (DEL - FDR). In the latter case supplemental groundwater pumping will be required and determined by the program. If the available supply of surface-water and groundwater still does not meet the irrigation demand, then either deficit-irrigation will occur, or acreage-reduction might be necessary. The program allows for both scenarios.

The FMP will be tested by a pilot project located within the domain of the Rincon-Mesilla Groundwater Model developed for the New Mexico-Texas Settlement Commission for the Lower Rio Grande of New Mexico. The pilot project area is a section of the Elephant Butte Irrigation District (EBID).

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ESTIMATING RUNOFF USING NEXRAD RADAR DATA IN RURAL NEW MEXICO

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Presentation Abstract 6

This study seeks the most effective temporal resolution of 6-minute, 30-minute accumulated, 1-hour accumulated, and 1-hour snapshots of NEXRAD (NEXt Generation RADar) data in order to predict peak storm flows and flow accumulations. The primary purpose of this evaluation is to consider if lower temporal resolution is acceptable to estimate peak discharge by using Soil Conservation Service (SCS) Curve Number Loss, the SCS Unit Hydrograph, and the Muskingum-Cunge routing methods. Geographical Information technologies and Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS) software are used to determine peak flows and flow accumulations. Information is primarily from the USGS, USDA-NRCS, the NWS and the NCDC. The higher temporal resolution, NEXRAD Level II 6-minute data, is the most accurate method to estimate peak flow. In two of the three cases that use NEXRAD Level II 6-minute data, the peak flows are 48 and 28 minutes within the estimated peak flow with less than 3 and 7 percent difference respectively. The third case had anomalous propagation that results in an overestimated peak flow rate and longer duration. Furthermore, all three lower temporal resolutions are acceptable to derive total volume of flow, but are not sufficient to predict peak flow rate. Although the study results are promising, the lack of high temporal resolution precipitation gauges to correlate the NEXRAD Level II radar data limits the accuracy and reliability of using NEXRAD Level II data.

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GROUNDWATER MODELING AND WELLHEAD PROTECTION FOR EAST MESA AQUIFER

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Presentation Abstract 7

Wellhead protection is part of the EPA 1986 amended Safe Drinking Water Act that mandates development of wellhead protection programs in order to protect the public supply wells from potential contamination. Wellhead protection (WHP) means the protection of groundwater from contamination in a specified area (wellhead protection area, WHPA), surrounding public water supply wells. The WHP amendment requires that land use controls be considered as an essential part of a groundwater protection program prohibiting specific types of commercial, industrial, and agricultural activities in areas surrounding well sites as one of a number of protective measures to prevent contamination. In a joint project between New Mexico State University and City of Las Cruces Utility Department, a program was developed to identify the WHPA for the aquifer of East Mesa which provides part of the drinking water supplies for Las Cruces as well as several surrounding communities. In this project, USGS MODFLOW groundwater model was coupled with PATH3D which is a particle tracking model, to delineate the protection zones around the City wells. In addition, to modeling, comparison was made with other WHPA delineation methods. It was concluded that the extent and technical and economical implication of WHPA depends on the delineation method, the interpretation of the result and the method of construction of the water supply well.

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MODELING FINE SEDIMENT DYNAMICS IN THE UPPER COLORADO RIVER DURING SPRING RUNOFF AND SUMMER BASEFLOWS: IMPLICATIONS FOR BIOLOGICAL PRODUCTIVITY

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Presentation Abstract 8

Flow recommendations for the listed endangered native fish species in the Upper Colorado River upstream of Grand Junction, Colorado are based, in part, on the hypothesis that flushing of fine sediment from the gravel and cobble bed will increase primary biological productivity, and thus, the carrying capacity for the listed fish species. Studies primarily in West Coast rivers and mountain streams, have shown that flushing of fine (primarily sand- and fine-gravel-sized) sediment to appreciable depths requires mobilization of the framework gravels that comprise the bed of the channel. The results of this investigation, conducted in the 15-Mile Reach of the Colorado River, indicate that the model of fine sediment infiltration into the framework gravels, and subsequent mobilization of the gravels to flush the fines, may not be directly transferable to the Colorado River system. In contrast to the relatively clear streams and rivers, the Colorado River system carries a high load of fine (silt/clay-sized) sediment, particularly during short-duration thunderstorm events that occur during the late summer baseflow period when the runoff is derived from the lower elevation portions of the basin that are underlain by highly erodible sedimentary rocks. Although most of the annual sediment load in the river is transported during the snowmelt runoff period, the summer storm events and resulting runoff have a major impact on the spatial and temporal dynamics of in-channel fine sediment (silt/clay-sized) deposition and erosion that strongly influence the biotic assemblages in the river and their productivity. A more appropriate paradigm, therefore, may be that fine sediment dynamics during the baseflow season are controlled by the presence or absence of a temporally variable supply of silts and clays that deposit on the bed surface in low energy zones within the channel. Integrated physical and biological field studies and 2-dimensional hydrodynamic modeling (RMA-2V) of the Clifton reach have identified shear stress values for fine sediment deposition (<1.4 Nm-2) and subsequent remobilization (>1.4 Nm-2), which are very similar to those reported in the literature for low plasticity index sediments. Deposition of fines during the thunderstorm-driven events significantly reduces the number of macroinvertebrates and periphyton that are the food base for the native fishes. Periodic mobilization of the framework gravels that comprise the bed of the river during the snowmelt runoff when the critical shear stress for bed mobilization is exceeded creates a disturbance regime that also results in remobilization of deposited fines. However, delivery of sufficient water to the reach to ensure removal of the fine sediment deposits from runs, or to provide an adequately sized area where deposition will not occur within riffles, may be the key to ensuring biological productivity during the baseflow portions of the year. Hydrodynamic modeling provides a means of identifying the required flows.
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SYSTEM DYNAMICS MODELING AND ITS ROLE IN COMMUNITY-BASED WATER PLANNING

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Presentation Abstract 9

Sandia National Laboratories, in cooperation with the Middle Rio Grande Water Assembly, Mid-Region Council of Governments, and the University of New Mexico Utton Transboundary Resource Center are developing a system dynamics model to assist in formulating a sustainable water use plan for Bernalillo, Sandoval, and Valencia counties. Model objectives include developing a framework for: quantitatively evaluating tradeoffs, in terms of water savings and costs, between alternative water conservation strategies; engaging the public in the decision process; and explaining the complexity in the regional water system. Ultimately, the water plan must balance the available supply, subject to considerable temporal variability, with the demands from urban development, irrigated agriculture, evapotranspiration along the Rio Grande's riparian corridor, and evaporative losses from the Rio Grande and associated reservoirs. Supported by a community-mediated process, the system dynamics model has been used to create a series of sustainable water management plans, which are currently being aggregated into a single basin plan. To evaluate the value of the model in the planning process and to determine public perceptions about this model, a series of surveys were conducted. When asked about models in general, 65% of respondents disagreed that models are too complex for them to use to get information. After seeing the specific model discussed here, 62% said that the model is an appropriate tool to use in making water policy decisions. Our experience with this model in this process suggests that it can be an effective and accepted public planning tool.

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TWO-DIMENSIONAL HYDRODYNAMIC MODELING OF THE RIO GRANDE TO SUPPORT FISHERY HABITAT INVESTIGATIONS

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Presentation Abstract 10

Two-dimensional (2-D) hydrodynamic modeling is being used to develop hydraulic information to support an analysis of potential changes in aquatic habitat with changes in discharge at eight sites in the Middle Rio Grande and Rio Chama. The work is being performed for the U.S. Army Corps of Engineers as part of the Upper Rio Grande Basin Water Operations (URGWOPs) Review and Environmental Impact Statement (EIS).

In traditional habitat simulation modeling, the distribution of depth and velocity at a particular site that is used in the habitat evaluation is typically estimated using one-dimensional modeling techniques, which assume that the flow follows essentially parallel streamlines. The Middle Rio Grande and Rio Chama have wide, braided channels with multiple, diverging flow paths and considerable variability in depth; thus, the one-dimensional approximation is subject to considerable error. To provide improved estimates of the flow patterns within the study sites over a range of flows, hydraulic conditions are being quantified using RMA2 with the BOSS Surface Water Modeling System graphical user interface. RMA2 is a depth-averaged, finite element model that computes water-surface elevations and horizontal velocity vectors in a 2-D flow field. Although many technical challenges have been encountered in the modeling, the results are believed to be a significant improvement over those that could be obtained from a 1-D analysis, and the approach has the potential for wide application to aquatic habitat simulation.

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NUMERICAL SIMULATION OF GROUNDWATER FLOW FOR WATER RIGHTS ADMINISTRATION IN THE CURRY AND PORTALES VALLEY UNDERGROUND WATER BASINS, NEW MEXICO

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Presentation Abstract 11

A two-dimensional, finite-difference numerical model of the one layer Curry-Portales Groundwater Basin was developed to simulate water level declines due to current and future groundwater diversions in the High Plains aquifer (Ogallala Formation). The flow model is well calibrated and is used to compute future water level declines and remaining saturated thickness due to existing and future levels of water use. The model is considered the basin administration model and is used in preparing the drafted basin guidelines.

The Ogallala Formation is the principle aquifer in the basin and together with the younger reworked Ogallala is called the High Plains aquifer. Unconsolidated sand, silt, clay, and gravel are the primary sediments forming the aquifer. These sediments overlay the Triassic and Cretaceous age rocks that were eroded in the early Tertiary leaving incised paleovalleys. The saturated Ogallala Formation varies in thickness from 0 to more than 200 feet in some areas of eastern Curry County and western Texas. The High Plains aquifer in the Curry-Portales Basin is unconfined and groundwater flow is in a southeasterly direction, subparallel to regional topographic and depositional gradients.

The model was used to predict the 2040 saturated thickness of the High Plains aquifer if the current groundwater production rates continued into the future. At this level of production, large areas would de-watered in most of the Portales Valley and Curry County, New Mexico, as well as parts of Bailey County in Texas, particularly west of Muleshoe. Concentrated pumping in Curry and Roosevelt Counties in New Mexico as well as Bailey County in Texas would de-water large portions of the most productive areas of the basin as early as the year 2010. Parts of the basin where the remaining 1990 saturated thickness is less than 50 feet would not sustain continued pumping beyond 2010.

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NUMERICAL SIMULATION OF GROUNDWATER FLOW FOR WATER RIGHTS ADMINISTRATION IN THE LEA COUNTY UNDERGROUND WATER BASIN NEW MEXICO

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Presentation Abstract 12

A two-dimensional, finite-difference numerical model was developed for the one layer Ogallala Aquifer in Lea County. A steady state and transient calibrations were performed to estimate aquifer parameters: recharge, hydraulic conductivity, evapotranspiration, natural discharge, and specific yield. The model is well calibrated and has been used for water rights administration as well as the Lea County water regional plan. The model is considered the basin administration model and is used in preparing the drafted basin guidelines.

The principal source of water for agricultural, municipal, and industrial uses in Lea County is the High Plains aquifer. The Ogallala Formation is the principal aquifer of the High Plains in Lea County. Unconsolidated sand, silt, clay, and gravel are the primary sediments of this Formation. This Formation overlies a pre-Ogallala erosional surface developed on Cretaceous and Triassic rocks. Triassic rocks composed of fine-to coarse-grained sand, clay, and shaleare known to yield small amounts of water in local areas. Groundwater in the High Plains aquifer is unconfined and flows southeasterly, paralleling regional topographic and depositional gradients.

The effect of continued current withdrawals on water levels in the aquifer were projected to the year 2040. Under current withdrawal rates, water level declines of 0.5 to 2.5 and 2 to 4 feet per year were simulated in New Mexico and Texas respectively. In New Mexico, the year 2040 remaining saturated thickness ranged from less than 50 feet to more than 100 feet. Some areas located along the New Mexico/Texas state line are de-watered by the year 2040. In Texas, in Yoakum County where the current saturated thickness is less than 50 feet, some areas will be de-watered as early as 2010.

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USING THE OSE'S ADMINISTRATIVE GROUNDWATER MODEL TO EVALUATE WASTEWATER REUSE ALTERNATIVES IN THE MIDDLE RIO GRANDE

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Presentation Abstract 13

Managing water resources for adequate supply, while minimizing hydrologic and economic impacts, is becoming increasingly difficult in the Middle Rio Grande. The cost of water rights is rising while their availability is decreasing. Demonstrating "no-adverse-impacts" to surrounding water users is another challenge. The City of Rio Rancho is considering a new treated wastewater reuse alternative - groundwater injection and surface infiltration, both of which provide effective use and reduced groundwater consumption. Recharging the aquifer is intended to produce beneficial hydrologic and economic impacts for both the larger community and the City by slowing water table declines and reducing water-rights acquisitions.

GRAM, Inc. used the Office of the State Engineer's Administrative Groundwater Model for the Middle Rio Grande Basin to perform simulations of wastewater reuse scenarios. Simulation results were evaluated and ranked for desirability. Scenario performance measures, addressing hydrologic issues such as shallow-aquifer drawdown, river depletion, average water-level decline rate, and disposition of injected-water were assessed. The number of performance measures was large because hydrologic impacts are varied and spread across a large geographical area encompassing the Jemez River, the Rio Grande and several municipalities. Two measures were designed to indirectly address non-hydrologic issues such as public perception and economic impact; however, issues such as engineering viability, capital cost and water quality were not included. This analysis distilled complex hydrologic-impact information into a form suitable for water resource managers and community planners to use in evaluating wastewater reuse alternatives. The City is currently pursuing funding to support a pilot test of the injection/infiltration concept.

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MODELING THE SENSITIVITY OF SHALLOW GROUNDWATER ELEVATIONS IN A RIPARIAN AREA TO RIVER FLOW AND REGIONAL GROUNDWATER CONDITIONS

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Presentation Abstract 14

A groundwater flow model was developed to simulate the impacts of changes in river operations and regional groundwater conditions on the shallow groundwater environment in riparian areas. This modeling study was conducted along the San Joaquin River in California. Because the San Joaquin River setting is hydrologically similar to the Rio Grande in New Mexico, concepts derived from these sensitivity analyses can be related to our understanding of riparian groundwater conditions and seepage losses on the Rio Grande.

The MODFLOW code was applied to the near-river area (riparian zone) along the San Joaquin River for a distance of approximately 150 miles. In this application, alternate river conditions are based on HEC-2 model-generated water surface profiles. River boundary conditions are identified corresponding to a wide range of river discharge profiles. Alternate regional water use conditions are represented by regional groundwater elevations at the boundary of the riparian zone groundwater model. Representative low, average and high regional groundwater conditions are derived from the historic record. The model is used to illustrate the sensitivity of river seepage and groundwater elevations to present and antecedent river discharge profiles and to regional groundwater conditions. The model results illustrate the dynamic and transient nature of surface water/groundwater interactions. Further, examination of the sensitivity of shallow groundwater conditions and surface water exchanges to river flow and regional groundwater conditions illustrates the need to develop process-based methods for quantifying surface water/groundwater exchanges, rather than adopting empirical functions that may not be applicable under conditions of interest.

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GROUNDWATER PATHWAY ANALYSIS FOR THE PAJARITO PLATEAU

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Presentation Abstract 15

The groundwater pathway analysis for the Pajarito Plateau will prioritize contaminated sites at Los Alamos National Laboratory based on their potential risks to groundwater receptors. This project has several components: screening to identify high priority sites, quantification of source-term, simulations of vadose-zone and regional aquifer transport, and risk assessment. The analysis predicts contaminant migration from the source to a potential receptor. In particular, contaminant concentrations reaching supply wells are input to a risk assessment model that predicts risk over the next 100 years. The analysis also estimates the likelihood that contaminants will be detected by regional monitoring wells prior to reaching water supply wells.

The screening method overlays contaminant maps onto a map of vadose-zone, groundwater travel-time predictions. Contaminated areas with vadose-zone travel times of 100 years or less require further analyses. Screening identified five high-priority watersheds across the plateau.

This study focuses on Mortandad Canyon. A preliminary bounding calculation found that a more detailed probabilistic assessment is required to properly evaluate risk from this canyon. The probabilistic approach considers uncertainty in conceptual models, source term, infiltration rates, hydrologic properties, and other parameters. This approach estimates the potential groundwater risk from the site, including uncertainty. It also identifies the most important conceptual models and parameters controlling groundwater risk. Such information is used to guide site characterization activities, identify potential corrective actions, and determine monitoring requirements.

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REVIEW AND VERIFICATION OF CULEBRA TRANSMISSIVITY FIELDS, WASTE ISOLATION PILOT PLANT

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Presentation Abstract 16

The Waste Isolation Pilot Plant (WIPP) is a geologic repository for disposal of transuranic waste and is operated by the US Department of Energy (DOE). The repository is located at a depth of 655 m in the Permian age salt beds of the Salado Formation, 40 km east of Carlsbad, NM. The site began receiving waste in March 1999, following initial certification by the Environmental Protection Agency (EPA). The WIPP Land Withdrawal Act requires a recertification of the project every five years.

Observed increases in the monitoring well head values have raised concerns about the validity of the steady-state flow model used for performance assessment during the initial certification. The DOE is revisiting the modeling of the Culebra Member, and the Environmental Evaluation Group (EEG), in its oversight role, has begun an independent analysis of the flow and transport system and its ramifications on recertification.

This presentation discusses the ongoing analysis by EEG. Tasks completed to-date include a review of geological controls as well as validation of the transmissivity fields used as the basis for flow and transport modeling. Validation included an analysis of residuals resulting from the DOE's regression modeling as well as the use of multiple indicator kriging for a check on the geostatistical simulation of multiple transmissivity fields.

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METHODS FOR ESTIMATING GROUND-WATER RECHARGE AND IMPLEMENTATION OF RECHARGE IN CALIBRATION OF GROUND-WATER FLOW MODELS

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Presentation Abstract 17

Recharge is typically estimated when developing a conceptual model for a ground-water system, and is based on assumptions about the system that conform with the law of mass balance. Questions such as these have been key topics for researchers that are predicting the availability of ground-water supplies:

Does recharge occur or not in arid regions of New Mexico?
How does it occur spacially?
What are the rates and frequency of recharge?

Past methods for estimating recharge have included water budget analysis, empirical relationships, and calculations using Darcy's Law. Most of these methods provide results that lack detail about the distribution of recharge. More recently, recharge estimating methods have included detailed watershed and climate data analysis to better define the rate and distribution of recharge.

Ground-water recharge originates from infiltration of surface water either directly through the land surface or locally at alluvial fans or along stream channels, and the estimate of recharge requires some analysis of climate data and watershed characteristics. Typically there is a lack of localized climate and stream gaging data for estimating recharge for individual watersheds and extrapolation of data is made based on relationships of precipitation with elevation. Key factors to consider in recharge analysis and model calibration include seasonal and long-term variations in recharge, and the distribution of recharge.

Use of watershed analysis to estimate storm-water runoff may provide the best estimate of recharge in Basin and Range terrain that receives very little snowfall, and using the surplus precipitation method with redistributed runoff may provide the best estimate of recharge in Basin and Range terrain that receives significant annual snowfall.

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MODELING AVAILABLE MINNOW HABITAT AS A FUNCTION OF RIVER DISCHARGE FOR THE PECOS RIVER

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Presentation Abstract 18

Sandia National Laboratories is providing technical assistance to farmer members of the Carlsbad Irrigation District (CID) to better plan the storage, delivery, and application of water to the Carlsbad Project. The surface waters along the Pecos River are allocated by the state of New Mexico to three major entities: 1) The State of Texas - each year a percentage of water from the natural river flow must be delivered to Texas as governed by the Interstate Streams Commission; 2) CID farmer members - a fixed portion of water must be delivered to the farming members of the CID; and 3) wildlife - an amount of water must be allocated to support the wildlife habitat in the Pecos River, most notably, the endangered Pecos Bluntnose Shiner Minnow. The Pecos Bluntnose Shiner Minnow habitat preference is under investigation by other state and national agencies and preliminary work has established that water depth, water velocity, and sediment activity (dunes, ripples, etc.) are the key parameters influencing minnow habitat preference. The amount of water (river flow rate) necessary to maintain a preferable habitat to support this species has yet to be determined. With a limited amount of water in the Pecos River and its reservoirs, it is critical to allocate water efficiently such that habitat is maintained, the farmers of the CID are supported, and New Mexico meets its commitments to the State of Texas. This study investigates the relationship between flow rate in the river and water depth, water velocity, and sediment activity. The goal is to establish a predictive tool that supports informed decisions about water management practices along the Pecos River that will maximize water available for agriculture and the State of Texas while maintaining the aquatic habitat.

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MODELING GROUNDWATERS OF THE SAN JUAN BASIN OF NORTHWESTERN NEW MEXICO: NAVAJO WATER RIGHTS ADJUDICATION

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Presentation Abstract 19

The US Department of Justice and the US Bureau of Indian Affairs are formulating claims on behalf of the Navajo Nation, the Ute Mountain Indian Tribe, Indian Allottees, and various federal agencies in the water rights' adjudication process of the San Juan River Basin. In support of this effort, a groundwater model has been developed to assess areas of potential groundwater development.

Model development uses GIS software to import and analyze well logs from petroleum, coal, and water development and to present model results. These data were used to define the geometry of the sixteen model layers. USGS stream-flow records provided groundwater base flow estimates for the San Juan River and its tributaries. Recharge zones were delineated based on precipitation, evaporation, vegetation, and elevation data. The USGS MODFLOW computer code along with the PEST parameter estimation routine was used for model calibration. Hydraulic heads from 233 wells and estimated groundwater discharges to the San Juan River and its tributaries were used as metrics for model calibration.

The model has been calibrated to steady-state conditions. Results indicate that most groundwater flows to the San Juan River discharging with lesser flows to the Rio Grande Basin and the Little Colorado Basin. The model is most sensitive to recharge in the higher elevations and the assumed hydrologic connections between rivers and adjacent aquifers.

The model is being calibrated to transient conditions. Once transient calibration has been achieved, the model's telescoping ability will be employed to analyze potential water development projects for the Navajo Nation.

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ARE SLOPE AND BEDROCK TOPOGRAPHY IMPORTANT INFLUENCES ON PERCOLATION INTO MOUNTAIN BEDROCK?

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Presentation Abstract 20

Recent modeling studies (Guan and Wilson, 2002, 2003) suggest that land surface slope and bedrock topography, especially bedrock surface depressions, are strong secondary controls on the amount of water that partitions from the land surface into underlying bedrock of semiarid mountain blocks. These steady flow vadose zone simulations also confirm conventional opinion that climate and bedrock (matrix and fracture) permeability are the primary controls. While the secondary control of slope was expected, with steeper slopes leading to more interflow in the thin soil layer above the bedrock and thus less deep percolation, the influence of depressions in the bedrock surface was unexpected. The depressions apparently concentrate moisture, locally increase matric potentials, and focus percolation into the bedrock beneath the depressions. More recent steady state and transient simulations suggest that these secondary controls may not be so important after all. There are a number of measures of deep percolation over a range of climate and geological conditions, and depending on which measures one examines conclusions can change. For example, should the measure be a percentage of available water, or the amount of water itself? How should the percentage of available water be measured, as the surface infiltration itself or also as a function of interflow? Considering several measures of water partitioning to the bedrock, and several approaches representing bedrock fracture permeability, this paper revisits the effects of slope and bedrock topography.

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REGIONAL GROUNDWATER FLOW MODEL FOR TAOS, NEW MEXICO

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Presentation Abstract 21

OSE is developing a regional four-layer groundwater flow model to administer water rights and study water resources near Taos, NM. Implemented in MODFLOW, the transient transmissivity model covers part of Taos County and is within the Rio Grande Underground Water Basin. The model encompasses 225-square miles from the Rio Grande to the Sangre de Cristo Mountains and from Rio Hondo to the confluence of the Rio Grande and Rio Pueblo de Taos.

The model simulates water-bearing zones to a depth of about 3000 feet. Layer 1 represents the youngest alluvial fan deposits derived from the Sangre de Cristo Mountains. Reworked alluvial fan materials and other basin fill deposits are modeled in layer 2. Pliocene Servilleta basalt flows with interbedded sediments are represented in layer 3. Layer 4 corresponds to Miocene Santa Fe Group sediments composed of fluvial, eolian, and lacustrine clays, silts, sands and gravels.

Eight streams are represented using the MODFLOW stream-routing package. Springs emanating from Buffalo Pasture are simulated using the drain package. Mountain front and areal recharge from precipitation are included via the recharge package. Groundwater accretions (i.e., water entering the groundwater system from acequia/ditch seepage, irrigation return flow, and deep percolation) are modeled using injection wells.

Local aquifer test results are represented in fifteen transmissivity zones. Transmissivity ranges from approximately 50 ft^2/day in basalt to 6000 ft^2/day in alluvial fan deposits.

The calibration well data set was assembled from the USGS Groundwater Site Inventory, state well records, consultant reports, and a Bureau of Indian Affairs database.

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INFILTRATION ENHANCEMENT BY FAULT CATCHMENT AND CONDUIT BEHAVIOR IN ARID AND SEMI-ARID VADOSE-ZONE SANDS

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Presentation Abstract 22

Recent property measurements and 1D modeling suggest that in dry climates deformation band faults can significantly enhance infiltration through vadose-zone sands. Under conditions wetter than a system-specific crossover point, infiltration through sand dominates, whereas infiltration through faults dominates under drier conditions (faults act as conduits). We extended the 1D model to investigate the effect of fault dip and water exchange between fault and protolith, 2D aspects. We numerically simulated steady, gravity-driven, variably saturated flow (infiltration) through 2D faulted and unfaulted sand beds in which normal faults have either 90_ or 65_ dips. Governing matric potentials spanned a wet to dry range of climatic conditions. Simulated 2D matric potential and flux density distributions reveal that faults with dips < 90_ induce preferential flow for governing matric potentials both above (wetter) and below (drier) the crossover point, but by different mechanisms. Under dry conditions faults, whether vertical or not, act as conduits (capillary wicks) by localizing preferential flow, corroborating earlier 1D fault models. Under wet conditions, non-vertical faults become catchments by intercepting and channeling water, creating a zone of enhanced water content just above the fault - hanging wall contact. The enhanced moisture content and preferential flow depend on matric potential, fault length, dip, and sand hydraulic properties. Under wet climates, fault catchment behavior could increase infiltration through vadose-zone sand beds. Catchment behavior should also occur along large-displacement faults containing clay cores, extensive cementation, or numerous zones of deformation bands, and for other geometrically similar geologic features like clastic dikes.

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USING AIRBORNE LASER MAPPING DATA TO PARAMETERIZE AND TEST POST-FIRE SEDIMENT TRANSPORT PREDICTIONS

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Presentation Abstract 23

The May 2000 Cerro Grande Fire burned the headwaters of many of the canyon streams draining through the Los Alamos National Laboratory (LANL) and adjacent lands on the Pajarito Plateau in Northern New Mexico. The fire increased observed flood magnitudes by one to two orders of magnitude above pre-fire conditions, and flooding increased sediment scour and deposition in a number of canyons draining the Plateau. Some of the canyons in the vicinity of LANL contain contaminated sediments. A set of experimental and modeling activities was undertaken to assess the long term potential for increased offsite migration of contaminated sediments. HEC6T, a one-dimensional sediment transport model, was used to predict potential redistribution and offsite transport of contaminated floodplain sediments.

The HEC6T predictions were calibrated against high-resolution Airborne Laser Mapping (ALM or LIDAR) data, collected before and after a 1440 cfs flash flood in Pueblo Canyon, which is contaminated with low levels of legacy plutonium. The pre-flood ALM data were used to parameterize the initial channel geometry for the model, and the difference DEM created from the pre-flood and post- flood ALM surveys was used to test the pattern and quantity of scour and deposition predicted for the 1440 cfs event. The sequential ALM data sets were found to have many problems, but after an extensive data correction activity, the predicted and observed (ALM) patterns of scour and deposition show reasonable correspondence in our test reach. Testing the model with sequential ALM raised the question "Is ALM the whole truth?". Not yet.

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REMOTE SENSING – SNOWMELT RUNOFF FORECASTING SYSTEM IN THE RIO GRANDE BASIN

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Presentation Abstract 24

Rapid economic development, population growth and increasing demand for water in the Rio Grande basin has placed tremendous stress upon the watershed's limited water supplies. This program will improve water managers' decision-making by (1) implementing real-time, NASA and NOAA driven hydrological models, (2) develop a user-friendly Website for stakeholders to access the models, and (3) demonstrating how other forecasting models can be used in conjunction with the hydrological models to increase the efficacy of water management decisions. Principal models include: Snowmelt Runoff Model (SRM) and Semi-distributed Land-Use Runoff Processes (SLURP) model.

The risk management information system developed by the project will be useful to a broad range of decision makers, including but not limited to urban and regional planning boards, recreational facilities planners, game and fish managers, federal resource managers, irrigation district managers, farmers and ranchers and the research community. Decision makers will have the necessary tools to perform "what ifs" to determine the range of impacts resulting from decisions under various conditions. This effort also can be used as a pilot to be applied to other drainages both within our own region (e.g., Pecos Drainage and Upper and Lower Colorado Drainages) and external to our region (e.g., Pacific Northwest, California and elsewhere worldwide). To ensure that the education and outreach component of the project is successful, NMSU College of Agriculture and Home Economics' Extension Service will play a critical role in delivering this tool to the end-users.

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THE IMPORTANCE OF CONSIDERING GROUNDWATER QUALITY IN DEFINING SUSTAINABLE USE: A CASE STUDY USING 3-D FLOW AND TRANSPORT MODELS TO ASSESS WATER RESOURCES IN NORTHERN NEW MEXICO

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Presentation Abstract 25

The Española Basin in northern New Mexico comprises the principal aquifer for drinking water supplies in the region. Both natural and anthropogenic sources of groundwater contamination exist in the basin and there is concern that water quality will deteriorate in the future due to rapid population growth in the region and declining water levels in the aquifer. We are using 3-D basin-scale flow and transport models to predict possible changes in the concentration of naturally-occurring major elements such as sodium and chloride and trace elements such as arsenic and uranium that will occur as water levels decline and deeper, more saline waters are drawn towards the surface. Our results indicate that for some locations in the basin, current rates of pumping will not significantly affect either groundwater quality or quantity; however, for some locations deterioration in groundwater quality may occur relatively soon if current rates of pumping continue. We find that because the relationship between groundwater extraction rates and water quality is very strong in some locations groundwater management strategies that do not account for changing water quality may overestimate sustainable use.

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LOS ALAMOS NATIONAL LABORATORY LOW-HEAD WEIR: CHALLENGES IN MODELING BROMIDE TRANSPORT THROUGH AN UNSATURATED FRACTURED BASALT

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Presentation Abstract 26

We present results and preliminary analysis from a bromide tracer test associated with a low-head weir in Los Alamos Canyon. The weir was built after the Cerro Grande fire to mitigate off-site movement of potentially contaminated sediment, which was expected to increase dramatically due to watershed damage further up the drainage. After construction, concerns about downward transport through fractured basalt from temporarily ponded water behind the weir prompted the Laboratory to install three monitoring boreholes. In conjuction with the monitoring plan, a bromide tracer test was designed to study transport. Prior to the summer rainy season of 2002, a solution of potassium bromide was sprayed onto the ponding area behind the weir. Bromide sampling was initiated in May 2002 and is ongoing. An 86 m vertical borehole with water sampling ports at 4-screened intervals (from 27 m to 82 m) provides high resolution temporal data of bromide concentration within the unsaturated zone beneath the weir. Data from the 4-sampling ports show that the initial transport to depth is quite rapid (60 m in a few days), and that three observed ponding events have had a large impact on subsurface transport. Additionally, the data show that the bromide concentrations at all depths peaked within 1/2 year and are now decreasing. A simple model is used to demonstrate that the transport is most likely within the relatively low porosity, highly fractured sections of the basalt. Finally, we discuss the limitations of such modeling in light of the heterogeneous nature of the unsaturated zone at this site.

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EFFECTS OF MEASUREMENT ERROR AND WELL NETWORK GEOMETRY ON THE ESTIMATION OF THE HYDRAULIC GRADIENT

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Presentation Abstract 27

Local estimates of hydraulic gradients are made from limited well sampling using the three-point method developed by Silliman and Frost. This work attempts to quantify the effects of measurement error and of the selection of the wells used in the estimate for a generalized site. The area, side length, shape, and orientation of the triangle formed by the three wells used in the estimate are all potential sources of error. Measurement errors are generated about the mean (true) value of the hydraulic head at each of three wells using random, normally distributed deviates with specified variance. Results show that the error in the calculated gradient increases with the ratio of measurement error to head drop. For example, to avoid errors in the estimate of the magnitude of the gradient greater than 5% due to measurement error alone, the head drop within the triangle must be at least two orders of magnitude more than the largest expected measurement error. If the regional or local gradients at a site can be estimated, this information can be used to establish a minimum distance between wells used to make additional estimates for a monitoring network. This screening criterion is expected to alleviate the problems associated with small triangle areas and small angles, but orientation remains an issue. Data from the Waste Isolation Pilot Plant site are used as a case study to test the practicality of this approach.

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-AC04-94-AL-85000.

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CHALLENGES AND LESSONS IN REGIONAL INTEGRATED HYDROLOGIC MODELING - A CASE STUDY

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Presentation Abstract 28

The unique hydrologic conditions of west-central Florida are described as high and quick-changing water table profiles, numerous environmental features such as wetlands and surface water bodies, temporally and spatially variable rainfall patterns, high and variable evapotranspiration (ET), as well as a heterogeneous, sinkhole interconnected karstic aquifer system. There is ubiquitous communication between the surface and groundwater system, which requires rigorous simulation of the hydrologic system with a full-cycle, or integrated, hydrologic model.

Tampa Bay Water, Florida's largest wholesale water supplier, has pioneered development, application and implementation of a unique integrated surface-ground water simulation model to operate multi-wellfield water supply facilities in west-central Florida. The main components of the public domain Integrated Hydrologic Model (IHM) are the HSPF and MODFLOW programs.

An integrated hydrologic model (using the IHM code) was developed for water resources planning for Pinellas, Hillsborough, Pasco, Hernando, and Citrus Counties. It covered approximately 4,000 square miles, and was calibrated using 3-day stress periods from 1989 through 1998. Wetlands, lakes, and rivers were all represented in the HSPF surface water model and linked to the MODFLOW groundwater model.

Given the amount of complexity several issues were encountered as follows: long run times, imprecise GIS data, poorly defined temporal and spatial variability of rainfall data, operating system limitations on storage, developing adequate water budget constraints, and simply interpreting a very large amount of output. Database and GIS tools were developed that greatly aided in analyzing the output, but fundamental data limitations remain even in this highly characterized area.

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AQUEOUS GEOCHEMISTRY OF URANIUM, LOS ALAMOS AND SURROUNDING AREAS, NEW MEXICO

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Presentation Abstract 29

This presentation provides analytical results for groundwater obtained during four characterization sampling rounds conducted at several regional aquifer and perched-intermediate wells at Los Alamos National Laboratory. Springs discharging in White Rock Canyon and in the Sierra de los Valles have also been sampled as part of this investigation. Uranium is a trace element of interest because natural background generally is less than 0.002 mg/L depending on the reactive-phase mineralogy of aquifer material, aqueous chemistry, and age and residence time of groundwater. Uranium has been processed at Los Alamos National Laboratory since the early 1940s for a variety of purposes.

Analytical results for the wells show that solute concentrations are presently below maximum contaminant levels (MCLs) established by the EPA, including uranium (MCL of 0.030 mg/L), within the regional aquifer. Groundwater collected from the regional aquifer and perched zones at Los Alamos National Laboratory is dominantly a calcium-sodium-bicarbonate type and is relatively oxidizing.

Geochemical calculations using the computer program MINTEQA2 were performed to evaluate solute speciation, mineral equilibrium, and adsorption/desorption in assessing uranium aqueous chemistry and transport. Results suggest that the regional aquifer approaches equilibrium with respect to amorphous silica phases or volcanic glass and $CaCO^3$ and is undersaturated with respect to $USiO^4$, $UO^2(OH)^2$, $MnCO^3$, and $SrCO^3$. Groundwater shows variable saturation with respect to $Ca(UO^2)^2(Si^2O^5)^3.5H^2O$ (haiweeite), based on silica activity and pH. Surface complexation modeling (diffuse layer) of U(VI) shows that ferrihydrite partly adsorbs uranyl carbonato species, which is in agreement with experimental and field observations.

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APPLICATION OF A LINEAR GROUNDWATER RESERVOIR MODEL TO SIMULATE LOSSES ON THE DUNLAP TO ACME REACH OF THE PECOS RIVER, DEBACA AND CHAVES COUNTIES, NEW MEXICO

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Presentation Abstract 30

This paper describes the theory, development, and fitting of a linear groundwater reservoir model for computing Pecos River losses in the reach from Dunlap to Acme. This reach is located at the southern end of the Upper Critical Habitat for the threatened Pecos Bluntnose Shiner (PBNS), and it is also the reach of the river most susceptible to experiencing flow intermittency. The Pecos River RiverWare Operations model needs to adequately account for flow intermittencies to be useful for ongoing re-operations analysis in support of conserving the PBNS. Currently, the RiverWare model employs an empirical statistical model to compute those losses, and this linear groundwater reservoir model was developed as a physically-based alternative approach.

This approach involves simulating a groundwater system that interacts with the river in the reach between Dunlap and Acme. For developing the model, we conceptualized an alluvial aquifer entrenched in a bedrock aquifer, with the river flowing on top of (and interacting with) the alluvial aquifer. For this conceptualization, we can employ mass balance considerations to develop a simple linear model. The resulting model parameters needed to implement this approach include: an alluvial storage volume and effective porosity, a stream-alluvial aquifer transfer term, a bedrock-alluvial aquifer interaction term, a constant head in the bedrock aquifer, an areal recharge term, and an evapotranspiriation term. Model calibration involved taking gaged Dunlap flows as input, and computing Acme flows accounting for: tributary inflows, routing effects along the approximately 30- mile reach, and the linear groundwater reservoir loss model. The computed Acme flows were then compared to the Acme gage data, and the linear reservoir model parameters were adjusted until the sum of the squared residuals (between the model and the data) were minimized simultaneous with matching the observed probability of intermittency at Acme (8.69% of recorded flows at Acme are zero). Predicted flows by the best-fit model do a better job (than the current RiverWare loss model) of reproducing Acme gage data, both on an overall, as well as seasonal, basis.

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TELESCOPIC MODEL OF GROUNDWATER/SURFACE WATER INTERACTIONS NEAR SAN ANTONIO, NEW MEXICO

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Presentation Abstract 31

According to the Rio Grande Compact, New Mexico is obligated to deliver a specified amount of water to satisfy demands in New Mexico and Texas below Elephant Butte reservoir. Because of this, a finite volume of water is available to New Mexico north of Elephant Butte for habitat preservation and agricultural, industrial, and domestic uses. Previous investigations have observed significant seepage losses (up to 23 cfs/mile) from the Rio Grande to the shallow aquifer between Socorro and the Bosque del Apache. Recently, the Interstate Stream Commission and the Army Corps of Engineers have funded the collection of detailed hydrologic information in this reach including floodplain geologic cross sections; monthly groundwater elevations; monthly surface water elevations in drains, canals, and the river; surface water flow data; precipitation records; aquifer pump tests; seepage runs; and five water chemistry snapshots in 2002 and 2003, including the stable isotopes ^{2}H and ^{18}O. In conjunction with this data collection, local-scale modeling of a 6-mile reach of the Rio Grande and valley alluvium between Brown Arroyo and San Antonio is aimed at determining the causes of surface water loss and investigating methods for maximizing river conveyance. Grid cell size is 100 by 100 feet. Simulations include alternative river channel locations, riparian vegetation changes, and changes in river/aquifer interactions. This model is a telescopic version of a regional model of the Rio Grande reach from San Acacia to Elephant Butte reservoir that is being developed by the New Mexico Interstate Stream Commission.

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PECOS RIVER DECISION SUPPORT SYSTEM: THE HYDROLOGIC MODELING TOOL

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Presentation Abstract 32

The New Mexico Office of the State Engineer (OSE) and Interstate Stream Commission (ISC), in collaboration with the U.S. Bureau of Reclamation, has developed a functional suite of models, a Decision Support System ("DSS"), which can simulate much of the groundwater and surface water hydrology and operations associated with the Pecos River from Santa Rosa Reservoir to the New Mexico-Texas Stateline. The need for these models arose from OSE administration of groundwater resources, negotiations involving the adjudication of the Pecos River, ongoing EIS processes, and the State's need to determine how the Pecos River system can be managed to ensure our Compact obligations to Texas are met. The model suite consists of

- RiverWare surface water model of the Pecos River;
- Carlsbad Area Groundwater Model (CAGW);
- Roswell Artesian Basin Groundwater Model (RABGW);
- Data Processing Tool (DPT); and
- Red Bluff Accounting Model (RBAM).

The models are linked via the outputs of one model providing inputs to another.

These models have been extensively tested. As part of these tests, the models were calibrated to reproduce the hydrologic history of the Pecos River system. The models are based on the best available scientific data and standard, well-accepted methods. These tools should provide reasonable and useful estimates of the effects of management changes contemplated for the Pecos. This paper provides an overview of the modeling tools, and two companion papers are presented that illustrate applications of the DSS.

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THE "FISH RULE": MODELING PECOS RIVER OPERATIONAL POLICY TO ACHIEVE MINIMUM INSTREAM FLOWS FOR THE ENDANGERED PECOS BLUNTNOSE SHINER

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Presentation Abstract 33

In 1987, the Pecos Bluntnose Shiner (PBNS) was listed as federally threatened under the Endangered Species Act. In response to a 1991 USFWS biological opinion on Pecos River operations, a rulebased RiverWare model was built to evaluate potential modified river operations, the extent to which they might impact the PBNS, and the impacts on basin water users and interstate compact obligations.

Minimum flow targets have been proposed in certain reaches of the Pecos River for purposes of recovering the endangered PBNS. To address this issue in the Pecos River RiverWare Model (one component of the Pecos River Decision Support System which is the focus of a companion paper), we developed an algorithm (the "Fish Rule") to control Sumner Reservoir operations in order to meet the target minimum flows at the "Pecos River near Acme" gage. The Acme gage is located at the lower end of the reach most susceptible to intermittency.

To develop the "Fish Rule," a statistical relationship between flows below Sumner Reservoir and at the Acme gage was developed. This relationship provides the basis for determining what flows are required below Sumner to meet target flows at Acme. Two "fish rules" currently exist to evaluate operational alternatives:

1) The "Bypass" fish rule, bypasses additional water through Sumner Reservoir to meet target flows at Acme, only to the extent that it is available as part of the natural inflows to Santa Rosa and Sumner reservoirs. No releases of previously stored water are made.
2) The "Take from Storage" fish rule, releases additional water from Sumner Reservoir storage necessary to meet target flows at Acme.

We evaluate the results of the Fish Rule-modified operations in terms of impacts to flow duration curves at Acme, increased depletions to basin water supplies, and departures from stateline flow obligations for the Pecos River Compact.

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ESTIMATING THE IMPACT OF PRIORITY CALL WELL ADMINISTRATION ON PECOS RIVER FLOWS USING MODFLOW, RIVERWARE AND THE DPT DATABASE SYSTEM

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Presentation Abstract 34

Changes in groundwater pumping in the Pecos River Basin in New Mexico may have a rapid and significant impact on state line deliveries to Texas, and hence on NM's Compact credit or debt. Prior analysis and modeling indicate pumping of supplemental irrigation wells in the Carlsbad Irrigation District (CID) and other wells in this area exert a major influence on Pecos River flows. The NM Office of the State Engineer, Hydrosphere, and INTERA are using surface and groundwater models to simulate scenarios with curtailed pumping to explore the potential effects of well administration by priority calls.

Surface water deliveries to the CID (developed with RiverWare) were combined with hydrologic and pumping data to generate input for the MODFLOW Carlsbad Area Groundwater Model (CAGW). Hydrosphere developed a Data Processing Tool (DPT) that creates CAGW input files representing the effects of Pecos River priority calls on pumping in the basin for six priority call scenarios and a baseline. The six call scenarios were based on simulation of two different call dates (1/2/1937 and 1/1/1947) applied to three combinations of well groups (supplemental vs. primary vs. both). The CAGW output for each run was summarized as simulated annual gains to the Pecos River.

Given the uncertainties related to unadjudicated water rights and likely legal challenges, it is impossible to determine with certainty what the effect of priority administration would be. This process provides a reasonable way to estimate the effects of a call and can be used for planning by water resource managers.

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PECOS RIVER DSS SYSTEM: APPLICATION FOR LOWER PECOS ADJUDICATION SETTLEMENT

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Presentation Abstract 35

As part of the Pecos River Adjudication Settlement negotiations, the Pecos River Decision Support System, which includes one surface water model, two groundwater models and one water accounting model, as well as associated data processing tools, (PRDSS; ref to companion paper) was used to evaluate and refine proposed management actions. The Settlement Terms anticipate a combination of land retirement and groundwater pumping with the objectives of: a) permanent compliance with the Pecos River Compact Amended Decree, and, b) avoiding the need for priority administration of water in the basin. Central to achieving these objectives is maintaining the surface water supply for the Carlsbad Irrigation District (CID). Maintaining the surface water supply to CID is important because of a) their seniority in the basin and b) CID water use directly impacts stateline flows, and hence Compact compliance.

Two model scenarios were developed for the evaluation. The Baseline scenario represents essentially current operational conditions in the basin. The Settlement scenario simulates the operation of the system under the proposed settlement terms. Simulation of the two scenarios, and evaluation of their results, provides an estimate of the changes in water supply that would be expected if the settlement terms were implemented.

The model results indicate that implementation of the Settlement Agreement will, among other things:

1) Increase the total annual surface water supply available to CID irrigators.
2) Significantly increase the CID system's resiliency to dry years.
3) Minimize the chances of a priority call by CID, through augmentation pumping to meet supply targets.
4) Provide for the direct delivery of water from Avalon dam to the stateline to help the State of New Mexico meet its Pecos River Compact obligations.

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