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DIVISION OF WATER RESOURCES
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People, Water and Stewardship

Engineering, Technology, and Investigations

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2001 Annual Report

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Engineering, Technology, and Investigations

Executive Summary

The Engineering, Technology, and Investigations (ETI) organization is comprised of a multi-disciplined staff of engineers, geologists, hydrologists, technicians and support staff. We are an integral part of nearly every activity within the Division of Water Resources spanning a broad spectrum of technical and engineering responsibilities.

The key resource and critical component necessary for the accomplishment of all that is discussed in the following is the highly skilled, dedicated and innovative staff. An organization chart and staffing are provided as Exhibit A. Several of the Staff were recognized during 2001 for the outstanding performance and contribution to DWR's mission. Chuck Roberts was recognized as the Professional of the Year at the 2001 annual meeting. In the area of professional development and contribution to the science, Glenn Graham, George Van Slyke, Ray Bennett published technical papers in conference proceedings. Several staff participated in activities to foster teamwork in the accomplishment of DWR's mission, the staff was recognized for individual achievements at our annual staff meeting on December 17, 2001. Several staff members were recognized by the State Engineer for their Outstanding Customer Service in 2001. Thanks to all of the ETI staff.

The Dam Safety Branch also experienced a challenging and exciting 2001. A total of 682 inspections occurred in 2001. In spite of our best efforts in the dam safety program, we continue to experience serious incidents at dams. Seven dams experienced serious problems during 2001. The number of incidents involving dams is of concern. In order to improve the dam safety program a review of the rules and regulations, evaluation of existing dams, risk assessment pilot project, risk profiling processes and other procedures were initiated during 2001. The State Engineer submitted an Annual Report on the Dam Safety Program to the Legislature November 1, 2001. The Colorado Dam Safety Program is among the best in the country. The highly skilled engineers and support staff responsible for the accomplishment of the Dam Safety Program continue to be recognized as exceptional assets to DWR and State of Colorado through their accomplishments and teamwork.

In addition, several federal grants were applied for and obtained through the National Dam Safety Program. These grant funds were used for technical training, improved software and equipment. Our three-year plan includes the continued advanced

training in Dam Safety Engineering, which includes in-house training on risk analysis, engineering geology, hydrologic and hydraulic analysis, as well as needed training on software programs. Additional training for DWR staff and dam owners is also included, consistent with the DWR LRP.

The Modeling Branch staff continued efforts to revise and update data to the Hydrologic Institutional Model (HIM) for the Kansas v. Colorado litigation and Arkansas River Administration. Significant effort was expended on the management of the RGDSS and SPDSS development, Ray Bennett continues to demonstrate his excellent management and technical skills in coordinating with the Division Office and contractors on this important project. Although the summary of these activities is abbreviated, the effort and importance immense. The high level of skill and technical competence of the staff is the key to success in this area.

The Geotechnical Services Branch staff provide expert advise to both internal and external customers in the disciplines of geology, hydrogeology, engineering geology, geophysics, well construction and satellite assisted surveying (GPS). The Geotechnical Services Branch provides assistance to staff throughout the DWR. Special investigation projects included Arkansas Repayment Water Sources, Jefferson County Mountain Ground Water Study, Denver Basin Deep Core Hole, and a cooperative Denver Basin Mapping with USGS. Other activities include technical support to the Ground Water Commission and Oil and Gas Commission.

The Hydrographic and Satellite Monitoring Branch is responsible for providing leadership and technical management and maintenance of the statewide network of stream gauges, stage/discharge relationships, stream flow records, and satellite-linked stream flow monitoring. David Hutchens joined the branch as a telecommunication/electronics technician. Significant activities include substantial coordination with USGS and CWCB, conversion of the SMS, completion of the Hydrographic Program review, first Colorado Streamgaging Symposium, and organizational improvement.

Supporting the Board of Examiners for Water Well Construction and Pump installation Contractors has provided both great satisfaction and distress for the BOE staff team. A great deal of the success is due to the excellent work by Dave McElhaney, Gina Antonio, Michael Schaub along with Linda Bassi, and Susan Schnieder of the Office of the Attorney General. Their knowledge, skills and dedication were and are greatly appreciated. Of particular noteworthiness is the support by the Division staff of water commissioners, well commissioners and other support staff to the DWR-AG team in accomplishing the Board's objectives.

Dam Safety Branch

The mission of Colorado's Dam Safety Program, is to prevent loss of life and property damage, determine the safe storage level and protect the state's water supplies, from the failure of dams, within the resources available. A staff of twelve trained, well-qualified engineers supports the Dam Safety Program. The program protects the public in relation to the design, construction, and operation of dams and reservoirs by working with dam owners and designers to achieve compliance with state dam safety statutes. A detailed annual report on all of the Dam Safety Program accomplishments and activities is provided to the Legislature each November.

The program includes the enforcement of a comprehensive set of regulations, policies, and procedures for the construction, operation, and maintenance of dams, and emergency preparedness. Determining the safe storage level and, if necessary, restricting the storage in the reservoir to the safe level provides for the public safety. The safe storage level is determined by the review and approval of engineered plans for the construction and repair of dams and regular safety evaluations of existing dams and reservoirs by professional engineers.

The Dam Safety Program currently schedules an engineering inspection of Class 1 (high hazard) dams annually, Class 2 (significant hazard) dams biannually, and Class 3 (low hazard) dams every six years. Due to limited resources in 2001 the staff utilized a risk profiling methodology to delay inspections on those facilities that historically have been well maintained, are in satisfactory condition and are subject to regular observation. A total of 682 inspections occurred in 2001. Inspections were slightly less this year than prior years due to limited staff support in Division 5 and 6. Several of the staff assisted with the necessary dam inspections in Division 5 and 6 accomplishing the inspections of the critical dams.

The determination of safe storage level has resulted in water storage restrictions at 198 reservoirs resulting in an estimated 132,115 AF of reduced storage. There were five (5) new dams for which design data was reviewed, thirty-four (34) plans were submitted and reviewed for modifications, repairs, and enlargements. Six hydrology studies were reviewed and approved for spillway design. Approximately \$22.3 million of construction was accomplished resulting in \$45,928 in fees collected for the review and filing of submitted plans.

We had seven serious incidents at dams this year they ranged from excessive seepage, slope stability problems, to sinkholes. The latter are evidence of piping erosion in the dam's foundation and/or embankment. A brief description of each incident is provided in Exhibit B. Because of this continuing occurrence of incidents at dams, we are seeking ways and means to improve our program to reduce serious dam incidents. One of the areas we will pursue is to better predict the performance of dams, or the risk of having an incident, using risk assessment tools like risk profiling and failure modes and consequences analysis. These tools along with the traditional dam safety program activities will help us identify those dams that have a greater propensity for incidents,

providing us with greater knowledge in order to take actions to minimize problems, thus improving public safety.

Federal Dam Safety Coordination

Since the dam safety program audit in 1998, and our reduction in participating in the routine inspection of federal dams, we have been pursuing the execution of Memorandums of Understanding (MOU) with the several federal agencies that own dams in Colorado. The purpose of the MOU's are to assure that we maintain communications and exchange of information related to the safety of the federally owned dams and thus the safety of the public. To date we have finalized the MOU with the US Bureau of Land Management, Army Corps of Engineers and the US Air Force Academy. We are still working at finalizing the MOUs with the Bureau of Reclamation (revised), and the U.S. Forest Service.

Extreme Precipitation Study

The State Engineer and the Colorado Water Conservation Board (CWCB) continued the process to study extreme precipitation in the mountainous areas of Colorado. The Phase I report was completed in May 1997 by the Department of Atmospheric Sciences, Colorado State University (CSU), and it contains a list of recommended extreme storms that will be used for modeling research, and can be used for site specific analysis of extreme events for project studies.

The Phase II and Phase III parts of the project were combined in 1998 and an Evaluation Committee (EC) awarded the contract to CSU. The principal scientists for CSU are Dr. William Cotton and Dr. Thomas McKee. The project will take about three years, with the completion date set for June 30, 2001. A volunteer Technical Review Group, which is made up of Mr. Jimy Dudhia, National Center for Atmospheric Research; Dr. David Mathews and Mr. Louis Schriener, US Bureau of Reclamation; Mr. Stephen Spann, Consulting Engineer, are assisting us with the review of the project outcomes.

Background

Mountainous regions such as Colorado are notorious for being susceptible to flash floods and extreme precipitation events. These events can occur when moisture-rich lower tropospheric air flows into high terrain by either large-scale flow patterns and/or solenoidal circulations resulting from heating of elevated terrain. As this air flows into high terrain, it undergoes orographic ascent, cools to saturation, and often leads to convective instabilities. Extreme precipitation can then occur as a result of localized terrain-induced heavy precipitation in widespread storm systems, and/or from strong convective storms. Moreover, complex mountainous terrain includes deep canyon systems, which can channel rainfall runoff producing deadly and damaging flash floods. Current methodologies of probable maximum precipitation (PMP) (Hansen et al., 1988) and flood estimation have been shown to be

incompatible with paleohydrographic results when applied to high mountainous terrain. Using stratigraphic and geomorphic evidence, Jarrett (1993) and Jarrett and Costa (1983) conclude that there is little evidence of extreme rainfall and floods above 7500 ft elevation. These studies suggest that current PMP estimates may overestimate high elevation rainfall potential by a factor of two. This overestimate, if supported by further studies, has major economic consequences as it effects the design and construction of dams at elevations above 7500 ft. Our plan is to apply a three-dimensional (3D) convective storm model to develop a new method of estimating extreme precipitation and to develop concepts of how extreme precipitation varies with altitude in Colorado. The model which we shall use is the Regional Atmospheric Modeling System (RAMS; Pielke et al., 1992) developed at Colorado State University (CSU) under the direction of Dr. William Cotton. Our preferred procedure is to perform interactive nested grid simulations of the evolving large- scale or synoptic state of the atmosphere, the corresponding mesoscale circulations that are driven by flow over complex terrain and by surface heating over the regions, and the explicit formation and evolution of convective storms. The procedure is analogous to that used in our research case studies, and is an extension of those used daily in our real-time forecast model. In a sense this procedure simulates the evolution of the "representative" soundings and circulations at the location and time of convective storm formation. The data from our Phase I report entitled Colorado Extreme Storm Precipitation Data Study, May 1997 will be used to perform simulations using the RAMS parallel processing cluster developed for this project.

Current Status

CSU is presently in their 36th month of their proposed 30-month timetable. They were granted a no cost extension to complete the simulations of historic events. They have been doing the simulation of historical flood events that were identified in the Phase I report after spending a lot of time calibrating the new model with the RAMS parallel cluster. They have produced six progress reports to date and the Technical Review Group (TRG) has met three times to review and discuss the results with CSU. All of the progress reports have been reviewed by the TRG and comments sent to Dr. Cotton. At the July 2001 meeting, the TRG found that the progress was very encouraging. The most significant problem is the model not able to determine the exact storm location of historical extreme events. Dr. Cotton proposes to use a spatial interpolation program, "Krieking", to produce a mapping over Colorado of extreme precipitation estimates (rain plus hail). In his November 2001 report, Dr. Cotton reported that they have performed simulations for two additional extreme events that occurred in 1997 and 1999 to add to the recommended list of storms. CSU is preparing their final report and mapping with the expectation of submitting their final report by March 2002. The TRG will review the final report, and make recommendations on whether or not the model can be used for predicting extreme events. One of the tasks that has not been completed by CSU is to conduct hearings on the results in order to gain credibility and acceptability of the model. For a complete picture of the results of their research, you can visit their Web Page at rams.atmos.colostate.edu/precip-proj/index.html.

National Dam Safety Program Assistance Grants

The Water Resources Development Act of 1996 established the National Dam Safety Program (NDSP) under the Director of the Federal Emergency Management Agency (FEMA) as the coordinator of the Program. A primary goal of the program is to encourage the establishment and maintenance of effective State dam safety programs, and to provide financial assistance incentives to States that are moving towards improved safety of non-federal dams. Colorado applied for and received grants for federal fiscal years 1998, 1999, 2000 and 2001 in the amount of \$25,162, \$49,230, \$85,000 and \$85,000 respectfully. The grants are to provide the dam safety engineering staff advanced training in dam safety engineering subjects, and to acquire computer hardware and software for the analysis of dam performance. Many other general benefits have accrued to DWR through the purchase of computer equipment, safety supplies, and miscellaneous support.

In the fourth year of our assistance grants, we continued the training of our dam safety staff, and upgrading our computer capabilities to enable the use of comprehensive software programs. This is in accordance with a training plan that was developed by surveying the staff on their needs for training in relation to our goals, and scheduling their attendance at appropriate training events. The general dam safety training acquired at ASDSO Conferences is considered to be an important area for all of our staff to take part in and learn about the state of the art of dam safety. Following is a list of the training/meetings that were attended during the period:

May 2001 – One engineer from the Dam Safety Branch attended the FEMA training on HEC-RAS presented by Dr. Arthur Miller, PSU, at the Emergency Management Institute.

May 2001 – Two engineers attended the ASDSO Western Region Conference and Technical Seminar on Dam Failure Analysis in Anchorage, AK.

July 2001 – Two engineers attended the USSD Annual Meeting in Denver, CO.

September 2001 – Five engineers from the Dam Safety Branch attended the ASDSO Annual Conference in Snowbird, UT. Two of the engineers also attended the Technical Seminar on *Plant and Animal Penetrations of Embankment Dams*. We also purchased ten of the seminar manuals for distribution to the staff.

November 2001 – One engineer attended the FEMA training on HEC-HMS presented by Dr. Arthur Miller, PSU, at the Emergency management Institute.

January 2002 – All of the members of the Dam Safety Branch, and invited personnel from our Division of Water Resources and the Division of Wildlife, attended a three-day training session on HEC-RAS presented by Dr. Arthur Miller, PSU, in Denver, CO.

We began our Pilot Program on Failure Mode and Consequence Analysis (FMCA) in June 2001. We organized and conducted failure mode analysis on four dams in our

Division 1 office, two dams in our Division 2 office and two dams in our Division 4 office. The training and findings from the pilot have been very successful. A plan for implementing FMCA in our program has been prepared by our staff members, and FMCA sessions are scheduled for 2002, one in our Division 1 region, and another in our Division 5 region. To date we have expended about \$19,000 on the pilot.

We also have made revisions to the Bureau of Reclamation's *Risk Based Profiling System* (RBPS) for use in our program. We are negotiating with the Bureau to make revisions to their Access Program for our use. Once it is revised, the staff will use it to rank their dams for developing inspection plans, and to identify dams for conducting FMCA

Integration of Risk Assessment

The mission of the State of Colorado Dam Safety Program (DSP) is to protect the State's water supplies and to prevent loss of life and property damage resulting from the failure of dams. The integration of a risk assessment procedure provides an additional tool to evaluate dams and to direct limited resources toward activities that result in a higher level of public safety. The information provided herein will provide an overview of how risk assessment will be integrated into the Colorado DSP to improve our ability to accomplish the DSP mission.

The Colorado DSP has evolved from a response program to a preventative program, which includes assessing the potential for dam failure through physical inspection, spillway capacity evaluations, and emergency action plans. The technical expertise, efficiency and effectiveness of the State's Dam Safety Engineers have steadily improved through experience and training. This improvement, coupled with low staff turnover, has resulted in a skilled and knowledgeable staff. Integration of risk assessment, is a logical next step toward improving the effectiveness and efficiency of the DSP mission.

The integration of a risk assessment component into the Colorado's current DSP consists of a Risk Based Profiling System (RBPS) designed specifically for Colorado's DSP and a failure modes and consequences evaluation (FMCE) that can be accomplished in about the time required for a dam inspection, relying primarily on existing information. The process includes staff training, pilot projects, customization of risk assessment tools and eventually revision of rules to meet Colorado's DSP responsibilities. The outcome will be an improved, comprehensive dam safety program that includes field inspections, risk assessment, monitoring and surveillance, emergency action plans, staff and dam owner training, and facility operation and maintenance plans. Risk assessment as part of the DSP is both an additional tool for the improvement of Colorado's dam safety program as well as a tool for utilizing limited staff resources on the highest priority activities to protect the public and water resource. Additional information on risk assessment is provided in Exhibit C.

Modeling Branch

The Modeling Branch provides technical expertise to the DWR and other agencies through review, development, analysis and execution of complex hydrologic computer models. The branch consists of four highly skilled engineers that independently or as a team conduct investigation and analysis of computer models designed to simulate surface and ground water systems. The investigations and analysis are conducted to forecast streamflow, determine stream depletions due to pumping ground water, determine diversion requirements, transmission losses, evaporation losses, determine historic consumptive use, and general characteristics of stream regime. The staff provides expert advice to other agencies, provides expert testimony in water court, and recommends plans for water use and development within Colorado through the use of computer modeling.

The Modeling Branch engineers include Brian Ahrens, Ray Bennett, Dale Straw and Jana Riedesel. Jana actually splits her work time 50% for the Modeling Branch and 50% for the Hydrographic Branch.

HI Model Upgrading and Updating

During 2001, work continued in preparation for a trial segment before the Special Master which will determine Compact compliance for 1997-1999 and determine the ability of Colorado to comply with the Arkansas River Compact in the future using the “Amended Rules and Regulations Governing the Diversion and Use of Tributary Ground Water in the Arkansas River Basin” (Amended Rules) which were implemented in 1996. This work can generally be classified into the following areas.

Developing and testing improvements to the Hydrologic Institutional Model (HIM) which is being used in this litigation.

Evaluating the most recent report produced by the Kansas experts which evaluates the performance of the replacement plans provided for by the Amended Rules during the period 1997-1999 and estimates the effectiveness of the Amended Rules in the future.

Deposing the Kansas experts concerning their most recent report and analysis.

Preparing a rebuttal report to address the information presented in the most recent report by the Kansas experts.

The next segment of the trial is scheduled to take place in the summer of 2002.

South Park Conjunctive Use Project

The Modeling Branch was heavily involved with the ground water model associated with the application for water rights of Park County Sportsmen's Ranch, Case No. 96CW14 in Division 1 Water court. The application was for the right to divert surface waters from the headwaters west and north of Boreas Pass and west of Kenosha Pass. The surface waters would have been delivered by ditch and pipeline to recharge areas located on and near Sportsmen's Ranch. The recharged water would then have been pumped from the South Park aquifers through a series of wells to meet the raw water demands of the City of Aurora.

The application raised a number of concerns including: 1) the fact that Colorado has not historically recognized the ability of an applicant to claim salvage credits derived from drying up preexisting natural vegetative cover on land not owned or controlled by the applicant; 2) the quantification of the amount of surface waters legally available to the applicant; 3) the ground water model developed to support the application is inaccurate and unreliable; and 4) the application will be impossible to administer as currently proposed.

Brian Ahrens spent 3 to 4 months reviewing and analyzing the ground water model and found that the model had insufficient data for conceptualization, aquifer parameter inputs, and more importantly, insufficient data to verify the results of the model. Brian was successful in producing exhibits, with the help of Jana that clearly showed the model was continuously "calibrated" during the predictive runs. Brian, along with Glenn Graham and our Attorney Generals, Jennifer Gimbal, David Hayes, and Steve Simms, spent the bulk of July and August in 2000 in Fairplay listening to 6 weeks of testimony by the ground water model developer as the applicant endeavored to build and continually resurrect it's case. The applicant was unsuccessful in completing the case in chief.

Briefs and oral arguments to dismiss the application were presented to the court in January and February 2001. On June 1, 2001, the court ordered the application dismissed based on three conclusions, one of which was that "The results produced by the MODFLOW groundwater model are insufficiently reliable as a basis to determine the timing, amount, and location of stream depletions, or to determine the rate of aquifer recharge resulting from the PCSR recharge facilities".

South Metro Water Supply Study

This study is intended to provide water supply strategies to meet near- and long-term water needs for Douglas County Water Resource Authority participants that would delay and minimize the need to import water from the Colorado River Basin. The Douglas County Water Resource Authority, the Colorado River Water Conservation District, and the Denver Water Board cooperatively developed the scope of work for the study.

The Study Board decided to use the MODFLOW groundwater model of the Denver Basin aquifers developed by Dewayne Schroeder and Brian Ahrens for the SB96-74 study as a starting point for one of the components of this study. Hydrosphere Resource Consultants from Socorro, New Mexico were selected to perform a series of

investigations and modifications to the SEO Denver Basin groundwater model to transform the model from a stream depletion impact assessment model to a regional planning model.

Brian Ahrens is actively involved in the Technical Peer Review process and has spent numerous hours providing the SB96-74 groundwater model and supporting data to Hydrosphere. Brian has worked closely with Hydrosphere regarding key assumptions made during development of the SEO Denver Basin groundwater model and helping them to understand limitations of the model for the purposes of this study.

It has been rewarding to see the SEO Denver Basin groundwater model recognized, and defended by others, as the most complete representation of the Denver Basin groundwater system developed to date. In addition, it has been recognized as the most complete integration of hydrogeologic data and information of the Denver Basin aquifers.

Tamarack Recharge Project

The Tamarack Recharge Project (Project) is located on the Colorado Division of Wildlife (CDOW) Tamarack Ranch State Wildlife Area (SWA). Current Project facilities include 10 pumping wells located along the South Platte River and three recharge ponds located on the Sand Hills several thousand feet south of the river. The Project at the end of Phase 1 could have 17 wells and 11 recharge ponds. The primary function of the Project is to pump wells near the river in the winter or when there is water legally available and then discharge the pumped water to the recharge ponds. The recharge water would then percolate into and become part of the groundwater system slowly traveling back to the river providing accretions in the summer and late fall when additional flows are needed.

The Colorado Division of Wildlife, Northern Colorado Water Conservancy District (NCWCD), and Colorado State University (CSU) are working together to create a groundwater model for the Project. The primary objectives of the modeling effort are to evaluate operational scenarios to determine:

Any onsite effects of the Project operation on the SWA,

Any adverse effects and necessary protective measures to features traversing the SWA,

The timing, amount, and location of return flows and water accounting procedures,

The overall efficiency of the Project operation,

Proper administration of the Project through a groundwater model that will support water right applications in water court,

River accretions for different recharge operational scenarios,

The Colorado component of the Platte River Cooperative Agreement

As directed by Greg Walcher, director of the Department of Natural Resources, Brian Ahrens and Ray Bennett were assigned to the Tamarack Modeling Team and have provided technical input and guidance to the primary model developers.

Denver Basin Rules

An investigation is currently underway for a “Proposal for Revision of the Denver Basin Rules”. The current rules were developed and instituted in the mid-1980’s with no further revisions to date. Over this period of time, our knowledge of the geology and physical characteristics of the basin has greatly increased. In addition, today’s technology enables us to produce better products such as computer generated contour maps rather than hand contoured maps. Also, computers today allow us to build larger groundwater models with better resolution with less (inexpensive) computer time to ‘crunch’ the numbers.

While the geology of the basin has not changed, our understanding of the physical elements of the basin has increased such as specific yield. Recent investigations provide evidence that the specific yield values in the current rules are too high and that they vary across the basin from the west to the east. This new evidence could significantly move the non-tributary line derived through application of the SB-5 groundwater model. While it is not clear at this point whether or how the non-tributary could be moved, Brian Ahrens is evaluating these and other concerns.

Cline Ranch

Centennial Water & Sanitation District in Case No. 99CW199 proposed to transfer 90% of the Cline Ranch irrigation water rights to municipal use to supplement the water supply of the District and included an augmentation plan to offset downstream stream depletions.

Brian Ahrens evaluated the MODFLOW groundwater model and analytical solutions submitted by HRS Water Consultants. Brian provided concerns regarding the collection of raw data and testing of the aquifers under unsaturated conditions leading to highly uncertain derived values. In addition, Brian provided arguments that MODFLOW and the Glover analytical method are not well suited to the conditions found on the Cline Ranch because of the lack of a hydraulic connection between the stream and wells or recharge facilities, a fundamental violation of both methods.

A stipulation was achieved whereby the District agreed to verify or refine the estimated aquifer parameters used in the Glover and MODFLOW analysis by monitoring field operations and collecting raw data for 7 years. The monitoring will include measurement of groundwater levels in the existing wells and accurately measuring the amount of water diverted into the recharge ditch and remaining in the ditch at 1500-foot intervals every two weeks during operation of the project.

Rio Grande Decision Support System Groundwater Model

Brian Ahrens spent the bulk of the year residing in the office of HRS Water Consultants, Inc. actively participating in the development and calibration of a steady state and an average monthly groundwater model of the San Luis Valley. These

models along with a monthly (historic) model are being developed for incorporation into the Rio Grande Decision Support System (RGDSS). All three of the models are enhanced versions of the model used in the AWDI trial in 1990. It is anticipated that these enhanced models of the San Luis Valley groundwater system will be used in the promulgation of Rules and Regulations for new wells in the Valley currently scheduled to be in place on July 1, 2003.

Decision Support Systems

DWR's modeling branch, in cooperation with the Colorado Water Conservation Board, is involved in the management, development and maintenance of three decisions support systems; the South Platte Decision Support System (SPDSS), the Rio Grande Decision Support System (RGDSS) and the Colorado River Decision Support System (CRDSS).

SPDSS Progress in 2001

In October 2001 a feasibility study was completed to determine the users, components, cost and schedule for developing a decision support system for the South Platte River Basin (SPDSS). Following are key results of that feasibility study:

A DSS system is necessary to allow state agencies, water providers and water users to evaluate management decisions in response to increases in population, demand, droughts, endangered species issues and reductions in federal water program funding.

Development of a DSS for the South Platte is feasible. It will cost of approximately 15 million dollars and take approximately 6 years to complete.

The feasibility study reflects the needs identified by water users, the CWCB, and DWR that resulted from 3 public meetings and 71 interviews with the water community. A core advisory group was formed and met twice to guide the project formulation.

The anticipated funding source is the Colorado Water Conservation Board's construction fund. The Board voted to include SPDSS in next years Bill at their November 2001 board meeting.

The SPDSS will include new data collection, enhanced administrative tools, planning models, user involvement and training. These products will provide State of Colorado agencies and water users a comprehensive system for organizing, accessing, sharing and evaluating water resource data.

RGDSS Progress in 2001

Calendar year 2001 was the third year of development for the Rio Grande Decision Support System (RGDSS). Following are key accomplishments:

Ground Water

Major accomplishments by the Ground Water Component in 2001 that are being performed by HRS Water Consultants with State assistance include:

The ground water data collection program for the confined aquifer was completed. Total well construction and geophysical testing for the project now includes 15 monitoring wells. A cooperative agreement was executed with the Rio Grande Water Conservation District to observe and publish daily water level measurements at each site.

Ground water model development continued. Draft steady state and average monthly ground water models were developed and calibrated. Developing a monthly groundwater model and finishing the steady state and average monthly models are expected to be done in 2002.

Surface Water

Major accomplishments by the Surface Water Component in 2001 that are being performed by Hydrosphere Resource Consultants with the State assistance include:

The State's surface water model, StateMod, was enhanced to include variable efficiency, soil moisture accounting and the Rio Grande compact.

Development and calibration of StateMod on a monthly basis from 1950 to 1997 was completed. The model now includes 100% of the basin's consumptive use by explicitly modeling over 400 diversions, 2,500 wells, 12 reservoirs and 28 instream flows.

Development of a daily model was initiated and expected to be completed late in 2002.

Consumptive Use and Water Budget

Major accomplishments by the Consumptive Use and Water Budget Component in 2001 that are being performed for the State by Leonard Rice and AGRO Engineering include:

A water budget model, StateWB, was completed and documented. Applications were performed that include the entire Rio Grande Basin as well as the ground water model (valley floor) area.

Relational System Integration

Major accomplishments by the Relational System Integration Component in 2001 that are being performed for the State by Riverside Technology include:

The ability to package and distribute data via a CD was completed.

A database refresh that includes all year 2000 data was performed in cooperation with DWR's Information Technology Section.

The database viewing tool, StateView was enhanced to include daily capabilities and a map based query and viewing capability.

Software enhancements to the data management interfaces (DMI's) that allow well and daily data to be accessed from Hydrobase and used by the systems models were completed.

Spatial System Integration

Major accomplishments by the Spatial System Integration Component being performed for the State by HDR Engineering include:

River call data was obtained and digitized for Division 3. The inclusion of this data into HydroBase is expected to be completed in 2002.

CRDSS Progress in 2001

The Colorado River Decision Support System development was completed in 2000. Major maintenance activities conducted in 2001 include the following:

The CWCB and DWR completed their third year of maintenance on CDSS. Activities included hardware upgrades, a database refresh, enhanced product delivery using the Internet and data distribution via CD. Major accomplishments include:

The surface water model, StateMod, was enhanced to allow daily simulation and variable efficiency of water use.

The irrigated acreage database for year 2000 refresh was initiated.

Geotechnical Services Branch

The Geotechnical Services Branch provides expertise in the disciplines of geology, hydrogeology, engineering geology, geophysics, well construction and satellite assisted surveying. The Branch includes three professional geologists, one professional engineer and one well drilling inspector. The branch primarily responds to requests by internal or external customers assisting in general investigations, ground water litigation, ground water data collection and reporting and technical assistance to the Board of Examiners and Groundwater Commission. The following is a summary of work done by the Geotechnical Services Branch in 2000.

By the Numbers

General Investigations

Denver Basin Deep Core Hole – The Geotechnical Services Section and Glenn Graham in particular remain involved with the Museum of Science and Nature concerning the data developed during the drilling of the core hole and the testing of the core. Results of the study are now beginning to become available. In particular the results of the specific yield testing have been submitted. The testing shows that approximately a 30% reduction in the amount of water stored in the Denver Basin may be necessary due to the characteristics in the finer sediments of the eastern part of the basin.

Jefferson County Mountain Ground Water Study - Glenn Graham has worked with the county and the USGS on this project. The final report has been submitted. Currently the county and interested parties are reviewing the results. Final decisions are still probably a year away.

Coal Bed Methane – Work has been done in cooperation with the Oil and Gas Conservation Commission and the Department of Health to understand the hydrology of coal bed methane development and the implications to ground water production and availability. Glenn has been actively involved and has been a presenter at several symposia this year.

State Ground Water Atlas – Glenn Graham and George VanSlyke have been working with the Colorado Geological Survey and the Water Conservation Board to begin work on a state-wide ground water atlas that will not only describe the ground water of the state, but also link the descriptive material to actual ground water conditions such as water levels, geology and aquifer properties. The first draft was prepared by the CGS and has been reviewed. It appears to be a most comprehensive study.

Southern High Plains Study – Chuck Roberts worked closely with the Southern High Plains Ground Water Management District, the Water Conservation Board and McLaughlin Water Engineers to manage and develop the ground water study of the Southern High Plains basin. The report has been completed and the district is discussing Rule changes.

Ground Water Commission

Monitoring of water levels in over 1500 wells covering almost 3/4 of the state are done annually and published by the Branch in a series 10 annual reports.

George VanSlyke and Chuck Roberts gave technical presentations to the Plains-East Cheyenne and the Southern High Plains ground water management districts.

Denver Basin

A committee has been formed to investigate possible revision to the Denver Basin Rules. George VanSlyke is chair of the committee. Three meetings have been held to explore legal issues, physical aquifer characteristics and to make recommendations as to how the rules should be revised and the procedures to accomplish this. Money was contributed to a graduate student to investigate the age of the water in the aquifers. If this project is successful, we may be able to figure out a recharge rate for the aquifers. Glenn and George prepared a memo to Hal explaining the results of the specific yield testing and the implications to the Denver Basin.

Republican River

- Chuck Roberts and George VanSlyke conducted training sessions and field trips for the consultants who have been hired to work on the Republican River litigation.
- Chuck Roberts spent numerous hours traveling across the country reviewing documents for the Republican River Litigation.

Division Support

- Court actions were limited to review of findings.
- GPS - Chuck Roberts continues as the in-house GPS expert answering questions of the field users and obtaining state-of-the-art equipment and software. Acquisition of personal mapping software for the division offices, Denver office, and all water commissioners was a major project for the year. Another is the on-going training of personnel in the use of GPS. He has also evaluated the new WAAS availability for GPS.
- Well Permitting and Subdivision Review Assistance - work continues on a daily basis with these activities. The Geotechnical Services Branch reviewing the work of the permitting section along the margins of the Denver Basin.
- Chuck Roberts is again preparing to teach the class for the Well Tester Certification in the Arkansas Valley. This class takes considerable time and effort. Since Chuck plans to retire in the near future, he is training Heidi and Michael to take over the teaching of the class.
- George VanSlyke provided training for the Denver staff in what we know about the Denver Basin, how we got there and where we are going.
- Chuck Roberts provided training to the Denver Staff and the Division well commissioners on Fluid Mechanics, Water Well Testing and Water Meters.
- Glenn Graham continues to be the Division representative to the Colorado Ground Water Protection Council.

Special Note

- George VanSlyke was a major contributor to a front-page article in the Denver Post concerning the Denver Basin.
- George VanSlyke was invited to speak to the Tri-County Health Department on the Denver Basin.
- George VanSlyke provided a training session for Tri-County Environmental Health on the Denver Basin, Water Law and Well Permitting.
- George VanSlyke was one of four featured Technical Speakers at the “Troubled Waters Symposium” sponsored by Parker and the Ground Water Association.
- Glenn Graham and Dave McElhaney attended a three-day training symposium in Durango concerning Coal Bed Methane.
- Glenn Graham has been called upon several times to speak at workshops concerning the Denver Basin Kiowa Core Hole.
- Glenn Graham was a presenter at the Coal Bed Methane Symposium.
- Chuck Roberts and George VanSlyke conducted training sessions and field trips for the consultants who have been hired to work on the Republican River litigation.
- Chuck Roberts spent numerous hours traveling across the country reviewing documents for the Republican River Litigation.

Hydrographic and Satellite Monitoring Branch

The Hydrographic and Satellite Monitoring Branch strives to provide accurate, high quality 'real time' stream flow data. The Branch also develops historic stream records in coordination with other state and federal entities and the water user community. Key staff record and check measurements, maintain equipment and develop procedures in order to improve the quantity and quality of data used to manage and administer water throughout the State of Colorado. An organizational plan was developed and approved in 1998 that improved long-term employee development, enhanced the QA/QC program and improved coordination throughout DWR.

David Hutchens joined the Hydrographic Branch as a telecommunications/electronics technician in 2001. David is highly skilled and provides a balanced mix of technical capability and interpersonal communication skills to the branch. Through a unique working agreement with USGS David is located at the USGS subdistrict office at the Denver Federal Center. There he assists both agencies in hydrographic coordination and program accomplishment. DWR is fortunate to have David on board.

The Annual Training Meeting was held at Winter Park September. Key discussion on the Hydrographic Program Review, budget, CWCB coordination, high data rate transmission transition, and USGS coordination were accomplished. In addition, several guest speakers provided timely information on stream flow measurement techniques, instrumentation, and research.

Satellite-Linked Monitoring System

The satellite-linked monitoring system (SMS) provides the Division of Water Resources, other state and federal entities, and the water user community with access to real-time and historic stream-flow data from gaging stations across the State of Colorado. These data and software systems provide for more effective water rights administration, water resource management, computerized hydrologic record development, and flood warning.

The Satellite Monitoring System (SMS) allows the Division of Water Resources to collect, process, store, and distribute any kind of environmental data transmitted from remote locations. The data set of interest to the Division is the water level at rivers, streams, diversion structures, and reservoirs. The SMS converts these raw water level values into several "products" of use to various "clients". The "products" range from raw data passed on to other computer systems to the official Hydrographic Records of mean daily stream flows. Our "clients" include Division of Water Resources personnel and other water users wanting real-time administrative data, computer

systems performing other analyses, and the varied user community of state and federal agencies, municipalities, canal companies, attorneys, and consulting engineers needing access to real-time and historic stream flow data.

The State Engineer's Office (SEO) began operating the SMS in 1985. The Colorado Water Resources and Power Development Authority provided initial funding for this project pursuant to Section 37-95-107(5), C.R.S. (1983), by enactment of Senate Joint Resolution No. 20. This system has become one of the most important and integral tools for the administration and management of Colorado's water resources, not only for the Division of Water Resources, but for the entire water user community.

Initially, the State of Colorado operated 150 remote gaging stations linked to the SMS. The Division of Water Resources now operates over 300 satellite gaging stations linked to the SMS. Federal agencies, water conservancy districts, municipalities, and private entities own other stations in Colorado and neighboring states. The Division collects and uses the data from 252 of these stations operated by others. The Colorado Water Conservation Board provided \$298,000 for fifteen HDR DCP's and 65 HDR radios for retrofitting existing DCP's for HDR transmission for a total of 65 satellite installations with new electronic equipment and gaging station renovation. In addition to the important activities associated with the preparation for transition to the high data rate (300 baud) equipment and coordination with Federal partners for implementation we are also involved in flood hardening and low and high flow alarm system development.

Stream Flow Records

The Hydrographic and Satellite Monitoring Branch is also responsible for the development and publishing of annual stream flow records in accordance with USGS standards. The stream flow records are published in May of each year for the prior year stream flow. In May of 2001, a total of 203 stream flow records were published.

Equipment Maintenance, Repair and Replacement

Substantial effort was invested in 2001 to maintain, repair and replace the equipment used to measure and transmit stream flow measurements.

CWCB and USGS Coordination

Information on the flow of rivers is a vital national asset that safeguards lives and property and ensures adequate water resources for a healthy economy. Beginning with the first streamflow gage operated by the State Engineer's Office, now the Division of Water Resources (DWR), in 1881; the number of streamflow gages in Colorado has grown to more than 600 today. Statewide streamgaging programs now are administered by the DWR and the United State Geological Survey (USGS), and have support from more than 60 cooperating organizations. Those programs are closely coordinated between the DWR, the Colorado Water Conservation Board (CWCB) and the USGS to help ensure the data are comparable and easily accessible to every-one, including the provision of real-time data on the World Wide Web.

The DWR State Engineer, the CWCB Director, and the USGS Colorado District Chief meet twice a year to discuss major work issues that concern all entities. Topics include current projects, litigation involving water-quantification issues, and ongoing evaluations of the adequacy of the gage-network operations and coverage. Coordination of equipment purchases to upgrade streamgages also is discussed at these meetings.

Coordination meetings also occur between the DWR Lead Hydrographers, CWCB Gaging Coordinator, and the USGS Data Chiefs not less than three times a year. These meetings enable our agencies to work cohesively and to effectively coordinate our work efforts. Mutual objectives, opportunities, and conflicts are discussed and coordinated to facilitate better operations for all three agencies. Streamflow data coordination is one of the ongoing agenda items at these coordination meetings. Day-to-day coordination occurs between the staff of all three agencies. Contact is made as needed and mutual support routinely is offered among the agencies. Help includes equipment repair and maintenance and streamflow data trouble-shooting. For example, if a hydrographer discovers a problem with another agency's gage while on site, a temporary repair will be made so data are not lost.

The CWCB's programs dealing with compacts, decision support systems, flood warning, and monitoring of low flows for the protection of instream flow water rights are dependent on accurate historic and real-time data from gaging stations operated by the USGS, the DWR, and other stakeholders. As a result, the CWCB works closely with the other agencies to provide input regarding its data needs and also to provide funding and equipment as appropriate. Each year, the CWCB provides funding through its construction fund program to support, upgrade, and refurbish the State's Satellite-linked Monitoring System. In addition, the CWCB coordinates with the USGS purchasing of telemetry and other gaging equipment to upgrade existing stations that are already operated by the USGS. These upgrades are intended to provide the CWCB and the public with accurate real-time data during all seasons when possible. We are also coordinating improvement in the ability to measure high flow information. The CWCB has provided funds to "flood harden" streamgage sites within Colorado to provide the public and emergency responders with timely high flow data.

The coordination between the agencies was institutionalized through a joint fact sheet and MOU. The joint fact sheet is provided as Exhibit C. It is the intent of this Memorandum of Understanding (MOU) to coordinate the use of funds allocated from the Colorado Water Conservation Board's Construction Fund (non-reimbursable project funds) to the Division of Water Resources (DWR) and the Colorado Water Conservation Board (CWCB) staff for the continued operational viability of the Satellite-linked Water Resources Monitoring System (SMS). The roles and responsibilities of DWR and CWCB were also defined, as well as general procedures for the conduct and coordination of the agencies.

Colorado Streamgaging Symposium

On May 3, 2001, eighty people drove through a late spring storm to attend the Colorado Streamgaging Symposium in Breckenridge, Colorado. Given earlier concerns about water supplies for 2001, attendees did not seem to mind driving through the snow and rain to get to the meeting. The symposium was initiated by Assistant State Engineer, Jack Byers; the meeting provided education to the attendees on the past and present streamgaging programs in the state.

The meeting brought together, perhaps for the first time in Colorado, the diverse people and organizations that depend upon accurate stream flow data. Learning of the breadth of water interests in Colorado that regularly use stream flow data, as well as the ways the data are used, was judged to be highly valuable to a number of the attendees.

The symposium was co-sponsored by the Colorado Water Resources Research Institute, the U.S. Geological Survey, the Colorado Water Conservation Board and the State Engineer's Office. In addition, speakers represented organizations such as: Urban Drainage and Flood Control District, Colorado Division of Wildlife, Colorado Water Quality Control Division, Denver Water Board, Colorado River Water Conservation District, Northern Colorado Water Conservation District and others.

Topics discussed included: the history of stream flow data collection in Colorado, the evolving uses and importance of stream flow information, current and future access to stream flow data, and the opportunities for improvement in the gage network coverage and dissemination of information. This last topic was very important to the co-sponsors for planning how to improve the system into the future. Hopefully the dialogue between data providers and users started at this symposium will allow for the development of streamgaging network into the future. An interim streamgaging newsletter is scheduled for the spring of 2002 and second symposium is planned for May of 2003 to continue the progress in stream flow data collection and dissemination to meet the needs of the people of the state.

Hydrographic Program Review

Background

Several issues, inconsistencies, problems and concerns appeared within the hydrographic program during the Satellite Monitoring System conversion over the last few years. Many of these issues have arisen from process and procedural methods that have evolved over several years, some to meet specific objectives. The identification and resolution of hydrographic program issues, inconsistencies, problems and concerns are necessary as DWR refines the tools available with improved technology. Scott Brinton did an excellent job of accomplishing this with issues specific to the records program. Building on Scott's success, in January of 2001 Jack Byers initiated a comprehensive review of the hydrographic program with

the intent to resolve issues that are of greater breath and scope throughout the hydrographic program.

The task at hand was to identify and resolve any and all areas where the hydrographic program has inconsistencies in methodology, procedures, measurement, computation procedures, file management, data use, data analysis and records preparation. The differences may involve individual and style preferences, Division special needs or technology use.

Strategy

The general strategy for identification and resolution of hydrographic program issues is outlined below. Jack Byers provided overall leadership and guidance on task accomplishment, including personal involvement in the understanding and discussion of problems/issues. Tom Ley will lead the technical component in the identification and scope of problems, clarification of perspectives and technical issues. In addition, input on identifying issues was sought from others involved with the collection, analysis and use of hydrographic information. The issues/problems were defined, summarized and evaluated with the input of Hydrographers, Division staff, Information technology staff and others. The intent was to identify issues, coordinate with Division Engineers for the purpose of achieving a consensus on solution/implementation and if a consensus is not possible to achieve, develop a decision document for the State Engineer. The decision document will be a concise statement of the issue with all perspectives presented.

Process and Conclusion

During the period: February-April, 2001, data and information were collected regarding issues, inconsistencies, problems, concerns, and needs within the CO Division of Water Resources Hydrographic Program. A summary of the issues and potential solutions was prepared. The hydrographers, division engineers supported the findings, recommendations and implementation plan. With the concurrence of Hal Simpson, State Engineer the program improvements identified through the review are being implemented. Specifics of the process and reports are available from the Hydrographic Branch.

Board of Examiners for Water Well Construction and Pump Installation Contractors

In Article 91 of Title 37, the Colorado legislature created the State Board of Examiners of Water Well Construction and Pump Installation Contractors "under the division of water resources in the department of natural resources". The Board consists of five members, one of which is the State Engineer who has historically provided staff to support the activities of the Board and to assist the Board in the efficient and effective discharge of its duties and responsibilities. At present, there is one staff member devoted full-time, from three to six other employees of the Office of the State Engineer in the Denver office that contribute part-time to supporting Board activities, and numerous water commissioners and personnel in the Division offices that provide invaluable assistance to the Denver staff to accomplish the Board's objectives.

Norm Hill retired in 2001 after an extended illness. During his disability a number of people volunteered to help process the reports. Of special note are the contributions of Gina Antonio, Dave McElhaney, Michael Schaub, Linda Bassi, and Susan Schneider.

General Support

Primary activities of the support staff are focused in three general areas; complaint/enforcement actions, variances from the requirements of the Water Well Construction Rules, and well construction and pump installation contractor licensing activities. In addition to the primary functions, the Staff provides technical and professional assistance to the Board in the development of its amended well construction rules. The Staff also reviews and presents to the Board new technology developed in the well construction industry, coordinates the activities of the Board with the objectives and requirements of the Division of Water Resources and other agencies, disseminates information to contractors, and provides education and general information concerning the Board's activities in a variety of public forums.

Complaints and Enforcement Actions

Support staff for the Board of Examiners are solely responsible for the investigation of complaints that allege well construction or pump installation that violates the provisions of Article 91 of Title 37, C.R.S., and/or the Water Well Construction Rules. In many instances, the staff in the Denver office enlists the assistance of field personnel to accomplish investigations by providing reports on observations at wells

sites or by determining property ownership. The staff's investigation often results in bringing the issues before the Board of Examiners for resolution, while others are resolved by staff actions authorized by the Board. The staff also conducts all "follow-up" actions to ensure that contractors and well owners are complying with Orders of the Board, including pursuing a judicial remedy if necessary. The staff works closely with the Attorney General's Office to accomplish these tasks.

The following is a summary of complaint/enforcement actions brought before the Board or resolved by the Board or support staff during calendar year 2001.

New Complaints Investigated.....	121
Complaint Type: Construction violation.....	31
Permit violation.....	86
Unlicensed contractor.....	0
No Work Report Filed.....	2
Order to Fix or Plug	2
Complaints Resolved.....	132
Initiated prior to 1999.....	3
1998/1999 complaints resolved in 2000.....	55
2000 complaints resolved in 2000.....	74
Resolution/Action: Dismissed, withdrawn, discontinued, or otherwise resolved.....	28
Complied with Order.....	38
Court action (fines and fees).....	3
Letter of admonition/reprimand.....	11
Suspension/probation.....	4
Warning letters.....	2
Well construction accepted.....	13
Referred to State/Division Engineer.....	33

In addition, the staff prepared two policy statements, and processed 212 requests for variance and infiltration gallery plans. The staff reviewed 4700 completion reports, 3400 pump installation reports, 600 abandonment reports, and over 3000 well owner completion notices.

Licensing

The Board licensed a total of 340 contractors in 2001, including 12 new contractors. The Board conducted 19 oral examinations for new licenses. Gina Antonio now coordinates all of the licensing activity.

Education and Outreach

The staff continues to work with CWWCA to provide information to the licensed contractors. This is accomplished through individual outreach through mailings, CWWCA newsletter articles and examination preparation workshops.

Well Observation Program

Construction Reports were received for 4700 wells during calendar year 2001. One hundred forty observations suggests that approximately 3% of the wells constructed are being observed during or after construction.

The well observation program summary is provided in Exhibit D.

Long Range Plan and Miscellaneous Activities

Safety Activities

Safety and survival kits were purchased and distributed for all state vehicles and those private vehicles use primarily for state business. Fire Extinguishers and Snake Bite kits were ordered for all DWR vehicles and those private vehicles use primarily for state business. Although CPR/First Aid classes were attempted for a low cost certified instruction or no cost non-certified instruction no classes were requested. Individual self-inflating life vests have been distributed to Hydrographers.

Emergency Management

As the DWR emergency coordinator and assistant DNR emergency coordinator I was involved in several activities during 2001.

A simulated flood exercise was executed in division 3 during August. Additional exercises were delayed due to the events following September 11, 2001.

I represent DNR on the Infraguard project and coordinated key facility evaluations for DNR. And provided leadership in the revision of the DNR emergency operations and response plan. As part of that plan I revised the DWR Emergency Response Plan. The plan in part is to support the following mission.

The governor generally calls upon his staff to support local government when an emergency or disaster occurs. Each department will be asked to provide manpower and resources to minimize the effects of the Natural Resources, the Division of Water Resources participates in the planning, exercise, and if necessary the implementation of Emergency Preparedness Plans for dam incidents and failure, responds to flood events, and is a participant in the Colorado Flood and Drought Task Force and infrastructure security workgroups. The Division may be asked to provide the following support to an emergency operation:

- Flooding and dam incident warning and streamflow data
- Operations and incident information support
- Public works and engineering support
- Damage assessment surveys
- Equipment and manpower

DWR Long Range Plan

A summary of ETI activities associated with the LRP is provided in Exhibit E.

ENGINEERING, TECHNOLOGY AND INVESTIGATIONS

ORGANIZATIONAL CHART

February 2002

Jack Byers
Assistant State Engineer 264
DWR Emergency Management Coordinator

Gina Antonio - Assistant

Dam Safety Branch
Alan Pearson
Professional Engineer III (168)
Mark Haynes, Prof. Engineer II (254)
Garrett Jackson, Prof. Engineer II (249)

GeoTechnical Branch
George VanSlyke
PSRS IV (251)
Chuck Roberts, Prof. Engineer III (253)
Glenn Graham, PSRS III (345)
Dave McElhaney, PSRS III (187)
Vacant, Eng/Phys Sci Tech II (288)

Modeling Branch
Brian Ahrens
Professional Engineer III (370)
Dale Straw, Professional Engineer III (259)
Jana Riedesel, EIT II (2460)

DSS Projects
Ray Bennett
Professional Engineer III (446)

Hydro & Satellite Monitoring Branch
Jim McDanold
Professional Engineer III (191)
Dave Dzurovchin, Eng/Phys Sci Tech II (283)
David Hutchens, Telecom/Elec Spec II (429)

Board of Examiners
Jack Byers

Dam Incidents 2001

Seven dams experienced serious problems during the period. Following is a short description of the incidents:

- ◆ Matheson, a Significant Hazard (Class 2) dam near Kremmling in Grand County, has been experiencing significant leakage over the years subsequently developing large sinkholes in the right abutment. The sinkholes are growing in number and progressing towards the dam. The reservoir is restricted to a level below the sinkholes.
- ◆ Martin Cull dam, a Low Hazard (Class 3) structure near Craig in Moffat County had a large slip on the upstream slope which damaged the outlet works. The damage resulted in the reservoir draining and partially filling the outlet conduit with silt.
- ◆ Rifle Gap, a High Hazard (Class 1) dam near Rifle in Garfield County, experienced a sinkhole in the parking lot at the right abutment of the dam. Investigation by the US Bureau of Reclamation found shrinkage cracks in the underlying foundation which the overlying cohesionless material was able to pipe into. The remaining voids were grouted. The reservoir was at a low level at the time of the incident.
- ◆ Wahatoya Lake, a High Hazard (Class 1) dam near LaVeta in Huerfano County, suddenly began leaking in a broad band at the downstream toe near the Northeast corner of the dam. The downstream slope was saturated one-fourth the way up, and a crack appeared on the crest of the dam. The reservoir was spilling at the time. Emergency repairs were done by clearing the extensive brush off of the slope, and installing a weighted filter and drains on the downstream slope.
- ◆ Lake Henry, a Significant Hazard (Class 2) dam near Ordway in Crowley County, suffered severe overtopping of the crest of the East embankment by waves due to high winds. The water saturated the downstream slope causing a slide. Emergency repairs were made to fix the slide.
- ◆ Fruita No.1 dam, a Significant Hazard (Class 2) structure near Glade Park in Mesa County, experienced another significant slide on the downstream slope. Plans have been approved to stabilize the slope and the reservoir is restricted to 20 feet below the crest of the dam.
- ◆ Oasis, a Low Hazard (Class 3) dam near Austin in Delta County, suffered erosion damage due to wave action on the left end of the main dam, which reduced the crest width. The reservoir is being lowered pending repairs.

Risk Assessment

- Additional Tool in the Assessment of the Safe Storage Level and Resource Protection
 - Advanced Practice in Assessment of Dams for Safety and Reduction of Risk
 - Full Spectrum of Analysis and Implementation-Not a One-Size Fits All
 - Improved Public Safety and Resource Use
-
- **Failure Mode and Consequences Evaluation**

A thorough review of the engineering data, operations, performance history and historic record of design and construction as well as the information related to consequences and planned emergency action on a dam by a team of persons in order to develop an understanding of the most significant failure modes /consequences / risk reductions with respect to dam safety.
-
- **Risk - Based Profiling**

A means for ranking the dams in an inventory according to failure likelihood and/or exposure to risk in a consistent manner.

A risk-based tool is consistent with the risk equation (probability of load X probability of adverse response given load X magnitude of consequence). Consequences can be economic, life loss or social / environmental.

 - Patterned on the USBR program – re-work some of worksheets to fit knowledge and experience of State Engineers and simplify some aspects (especially life loss portion).
-
- **Risk Management**

Action and decisions to reduce risk and consequences.

Exhibit D

Well observations performed by Division personnel during 2001. The program was implemented in March of 1999. Observations are shown by Division and month the inspection occurred.

WELL INSPECTIONS – 2001

Div.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	TOTAL
1	0	0	0	0	1	2	0	1	0	0	1	0	5
2	0	0	0	1	4	1	3	4	2	0	1	0	16
3	0	0	1	1	9	4	3	1	2	3	2	1	27
4	0	0	0	1	7	0	4	0	2	3	1	0	18
5	0	1	2	0	0	1	0	3	8	1	0	0	16
6	0	0	0	0	4	0	2	0	0	3	0	0	9
7	0	0	0	0	9	11	11	4	5	6	0	2	48
TOTAL	0	1	3	3	34	19	23	13	19	16	5	3	139

DWR Long Range Plan Tactic Status ASE/ETI

February, 02

1.6; ASE-ETI contributed to overall environment via renovation of 6th floor conference room, and improved employee work conditions through computers, printers, safety and other support equipment and furniture.

1.7.4; Geotechnical Branch planned and initiated technical sessions, Modeling group provided technical sessions on DSS and existing models. Hydro manual development increased institutional knowledge transfer, many dam safety training and coordination meetings including risk assessment. Developed a transition plan November '00 for planned retirements in several technical areas to facilitate transfer of institutional knowledge. The BOE has been updating the Boards policies and documenting the procedures and improving the database.

2.6; The draft document was completed and provided to Steve Witte, Div. 2 on February 29, 2000 for completion of the Water Administration Section. After several reminders there has been no additional work on this tactic. The Draft was also provided to DSE for review and in March 00. Division 2 provided a draft insert February 2002.

3.1.2; complete

3.1.4; complete, litigation ongoing additional work being accomplished as necessary.

3.4.3; This Task is complete as of Jan 99, Republican River Compact support, the alluvium mapping was reviewed and report prepared. Additional information compiled as requested.

3.6.6; Update of RGDSS irrigated acreage, Plan for accomplishment not possible to implement, pilot project implemented Div 5 and IT. **The responsible person for accomplishment of this Tactic should be changed to IT Manager.**

2.2.2; The Hydrographic Branch is in the process of having a senior class at Metro State develop a software program to assist in field operations. Addition cooperative efforts continued in 2001. Chuck Roberts continued to serve on the University of Southern Colorado's Academic/Curriculum Advisory Committee (This program has produced several Engineering Technology students who have become Hydrographers with DWR).

4.3.2; Plan developed 7/19/99, over 35 educational occurrences have been completed to date.

5.1.2; Initial activities completed, updates considered with annual review of the DNR Safety Manual which are to be completed (on or about Mar.1, 2001). This will be accomplished by way of specific references within the DNR Safety Manual to existing DWR Publications specifically addressing safety issues and guidelines for these groups

5.1.3; In addition to the first aid and survival kits, Vehicle Inspection forms were sent to Division Offices and the Denver Office (Nov. 22, 2000). Additionally the Sept. Hydrographer's Conference covered safety inspection forms and procedures for Cableway Measurement systems. Fire extinguishers and snake bit kits ordered.

5.1.4; Initial activities to identify content of safety (first aid) kit accomplished and phase 1 supply purchased either by division or ETI. Continued coordination with the divisions for identification of additional needs and strategy to purchase kits and additional survival gear as necessary for all state vehicles and private vehicles, which are used for state business to accomplish primary job functions. Anticipate completion in 2001. Fire extinguishers and snake bit kits ordered will be distributed in 2002.

Emergency/First Aid Kit distribution (60 distributed in Dec. 2000) and Survival Kit acquisition which will be completed as additional funds become available. Additionally Jana is in the process of coordinating CPR training Division-wide (targeted to be completed within 2001). This training will also accomplish the annual safety meeting requirement of Item **5.1.1**.

5.1.5; Hazard analysis checklists completed as planned. Item **5.1.5** requires that Site Hazard Analysis Checklists be developed for DWR job sites. This Objective/Tactic has technically been completed since August 11, 1999 when drafts of Hazard Checklist for Dam Safety, Field Operations, Hydrographers, and Office Personnel were sent to the Branch Chiefs/ Division Offices for review and feedback. There has been limited response and feedback on the forms from primarily Dam Safety branch and some Division Offices. The actual job site hazard analyses are to be completed by January of 2004. The drafts of the Checklists were forwarded under separate e-mail.

The field staff is supposed to be completing as sites are visited, survey of progress initiated Nov 2000.

5.2.1; The Dam Safety Program Plan is being utilized. Some delay in Rule revision due to workload impact by covering Division 5 and 6 and training for Div3/7 Dam Safety Engineer. In addition, a review of SE authorities and potential program modifications. A meeting was held in the spring of 2000 to discuss potential changes. Additional work is anticipated during 2001. All other activities are proceeding in a timely manner to accomplish the goals and objectives of the DSPP.

5.2.2; Grant and training funds applied for and secured.

5.2.3; Audit recommendations implemented.

5.2.4; See above, Work is progressing on Rule revision and assessment of program activities and statutory authorities. Risk assessment and development of a Risk Profiling procedure will have significant impact on rules revision. Additional work to continue through 2001 estimated completion is now fall 2002. Completion date revised.

5.2.5; The dam observation training is scheduled to be completed in 2001. The Dam owner/operator training is being coordinated with CWCB and Insurance underwriters; four training sessions have been completed. Additional training is scheduled to occur through 2001 and 2002.

5.3.1; Rule revision completed June 2000.

5.3.2; Continuing activities with respect to water well construction and pump installation contractor education of revised Rules. This activity will continue for decades through CWWCA, newsletter articles, letters and seminars. In addition, the development and ongoing implementation of a training program for DWR staff and Water Well Contractors was accomplished in part by the *Introduction Water Well Meter Workshop* that was conducted for the entire staff.

5.3.4; The well observation program was developed, training occurred and the program implemented. The goal of the water commissioners accomplishing well observations on 5% of the constructed wells is not being met. The current annual accomplishment is around 1% and dropping rapidly. To be addressed in division 2001 spring meetings. The 2001 observation rate is about 3%.

5.4.4; Stream gaging program and data access is ongoing coordination with users. Note Stream gaging symposium and coordination with USGS, NRCS and CWCB.

5.4.2; Dependent on completion of SMS conversion. No activity at this time, work scheduled for 2002.

7.2.1 and 2; No activity to date. This goal, objective and tactics are presumed to be related to the development of Hydrobase and will proceed at the appropriate time. The accomplishment date for these Tactics need revision.

7.2.1 and 2; Completed as scheduled.

7.4.3; Completed as scheduled continued accomplishment coordinated with CWCB and DWR division offices.

7.4.4 and 5; Ongoing, evidence of success is the current CWCB Construction Fund Bill and executed MOU.