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**DIVISION OF WATER RESOURCES**  
**Office of the State Engineer**

*People, Water and Stewardship*

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# **Engineering, Technology, and Investigations**

*Jack G. Byers*

*Deputy State Engineer*

2002 Annual Report

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# Engineering, Technology, and Investigations

## ***Forward***

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 at the end of this report. Several staff participated in activities to foster teamwork in the accomplishment of DWR's mission. **I want to take this opportunity to personally thank each member of the staff for their support dedication and teamwork during 2002. With the many retirements several members of the staff have both in the Denver office and division offices have taken on additional workload with only my personal thanks, I am very proud to work with each of them.**

The following report provides only the highlights of 2002, much of the day-to-day routine customer service and program accomplishment is too vast to include in the limited space of an annual report. Coordination with other local, state and federal agencies continues to be a key goal of our organization. In addition the staff is involved as leaders with many state and national professional organizations that reflect favorably on DWR.



# Dam Safety Branch

The Colorado Division of Water Resources' Dam Safety Branch's objective is to prevent property damage and the loss of life, while protecting the loss of water supplies due to the failure of dams in Colorado. The Dam Safety Program includes the enforcement of a comprehensive set of regulations, policies, and procedures for the design, construction, and maintenance of dams; the safe operation of reservoirs; and emergency preparedness planning.

The Dam Safety Program is managed by the State Engineer in accordance with Title 37, Article 87 of C.R.S. (2001 Supp.) and the Livestock Water Tank Act, Title 35, Article 49 of C.R.S. (2001 Supp.), as amended. The program is implemented by the State Engineer through the Dam Safety Branch and the Division Engineer's offices. The Branch currently consists of a branch chief, dam safety engineers, and design review engineers. Currently, the program oversees a total of about 2,900 dams in Colorado with 1,861 dams of jurisdictional size. Of these, about 1,737 are non-federal dams. Of the non-federal dams, approximately 572, or about one-third of the total non-federal dams in Colorado, are classified as dams that, in the event of a failure, would be expected to cause loss of life and/or significant property damage to a significant portion of the state's population.

For FY 01-02, the Dam Safety Program achieved a great number of goals and objectives in the design review and inspection of dams for the determination of safe water storage levels. Although dam safety incidents were reported this year, because of our program, these incidents resulted in reduced consequences with no loss of life or significant property damage. This is attributed to the increased awareness and responsibility of the dam owners for their dams - including emergency preparedness planning - and to the enforcement of the regulations, policies, and procedures by our office. Emergency preparedness for incidents at dams that jeopardize the public safety, including the failure of dams, has become an integral part of dam safety programs across the nation. Colorado has been actively involved in this area since 1981. Approximately 111 new and updated emergency preparedness plans were reviewed during the fiscal year.

During FY 01-02, the State Engineer's Office approved plans for three new dams and thirty-one plans for alteration, modification, or enlargement. Twelve separate hydrology studies were also approved for determination of the inflow design flood for spillway design. The estimated cost of construction for the submitted plans was over \$49 million.

The statutes specify that a safety inspection for the determination of the safe water storage level must include the review of previous inspection reports and drawings, site inspection of the dam, spillways, outlet facilities, seepage control and measurement system, and permanent monument or monitoring installations. During FY 01-02, a total of 639 safety inspections and 128 construction inspections were conducted for a total of 767 inspections. In addition, 158 follow-up inspections were



performed. At the conclusion of the reporting period, there were 193 dams restricted from full storage due to various structural deficiencies such as significant leakage, cracking and sliding of embankments, and inadequate spillways. Total storage restricted was 130,086 acre-feet. The restrictions provide risk reduction for the public and environment until the problems are corrected.

The Dam Safety Branch continues to use risk-based tools to help evaluate and prioritize the jurisdictional dams in Colorado in order to more efficiently and effectively use program resources.

## ***Emergency Incidents***

As is typical, a number of dams experienced serious problems during the period, including:

1. Tarryall Dam, a Class 1 structure, experienced cracking of the concrete dam in the right gravity section. A review of stability analyses under normal and flood loading conditions led to a reservoir restriction and order to repair the dam.
2. Fruita Dam No. 1, a Class 2 structure, experienced a slide on the downstream slope of the dam. Engineering evaluations were performed and temporary repairs have been completed.
3. Mariano Dam, a Class 1 structure, experienced cracking on the downstream slope near the dam crest. Engineering evaluations have recently been completed.
4. Clear Lake Dam, a Class 1 structure, experienced a sinkhole on the upstream slope of the embankment. The sinkhole was discovered during a Federal Energy Regulatory Commission (FERC) inspection. Engineering evaluations are currently underway.
5. May Ranch Dam, a non-jurisdictional dam, experienced serious seepage along the downstream groin. Investigations revealed internal erosion and piping of embankment materials. The reservoir was drawn down to a safe level and repairs are underway.

Although dam safety incidents were reported this year, because of our program, these incidents resulted in reduced consequences with no loss of life or significant property damage. This is attributed to the increased awareness and responsibility of the dam owners for their dams - including emergency preparedness planning - and to the enforcement of the regulations, policies, and procedures by our office.

## ***ASCE Report Card on Dam Safety***

Recently, the American Society of Civil Engineers (ASCE) spearheaded an effort to evaluate or “grade” the condition of the nations aging infrastructure. This has included buildings, highways, bridges, and dams, among other infrastructure features. In Colorado, this effort has been guided under the Colorado Section of ASCE, Government and Public Affairs Committee (GPAC). Within the GPAC, a Dam



Safety Advisory Board was formed in the spring of 2002 to evaluate Colorado's dams. This advisory board consisted of members from federal agencies (U.S. Bureau of Reclamation and Army Corps of Engineers), state agencies (Division of Water Resources and Colorado Water Conservation Board), and representation from private industry. The following general criteria for grading was established by the GPAC for all infrastructure categories:

- (1) condition and performance indices;
- (2) need vs. capacity; and
- (3) funding vs. need.

**Conclusions and Recommendations** - Preliminary conclusions of the study include:

1. At the time of the study, there were 192 dams in all hazard categories, and 32 high hazard dams, on the Colorado Division of Water Resources "restricted list" of dams that are not allowed to operate at full reservoir storage capacity. Seventeen of Colorado's high hazard dams were considered unsatisfactory, meaning that the dam safety inspections indicated definite signs of hydrologic inadequacy or structural distress that could lead to failure of these dams if they are operated at full storage capacity. An additional 92 high hazard dams were categorized as conditionally satisfactory, meaning that the safety inspections revealed symptoms of structural distress such as excessive seepage, evidence of major displacements, etc., that could lead to failure of the dam if conditions worsen.
2. The Colorado Division of Water Resources' Dam Safety Program is recognized as one of the best state dam safety programs in the nation. The state has been able to acquire and maintain a solid group of experienced professionals, and has adequate statutes, regulations, policies, and procedures to implement and carry out the program. However, there remains a number of areas where improvements are needed, including the eventual filling of key personnel vacancies within the program, equipment needs, and the strengthening of a number of existing statutes.
3. Approximately half of the dams on the Colorado Division of Water Resources "restricted list" have been on that list for ten years or longer. This is interpreted to reflect the lack of funding to make repairs or upgrades needed to remove the restrictions. Colorado has no state grant programs for these projects. Loans are available for local government and private projects through the Colorado Water Conservation Board, but these loans are underutilized because dam owners are unwilling or unable to take on even these low interest debts. Another possible funding source for bondable entities is through the bond authority of the Colorado Water and Power Development Authority. With the ongoing, nearly unprecedented drought, Colorado's water supply issues have come into sharp focus. Several 2002 drought-related news reports and articles have highlighted the need to repair and rehabilitate existing dams and reservoirs that cannot be filled to capacity because of structural flaws.

The advisory board is still in the process of drafting their preliminary conclusions and recommendations of the study. A final report is anticipated to be released in early- to mid-2003.



## ***Federal Dam Safety Coordination***

Routine inspections of federal dams by Dam Safety Engineers have been curtailed in accordance with a legislative audit recommendation. The Branch, however, will participate in the evaluation of the safety of some federal dams for special issues and performance problem evaluations, in accordance with the procedure for obtaining approval to participate in these inspections. Less than about 80 hours were spent this fiscal year participating in these safety inspections at a cost of less than \$3,600.

Memorandums of Understanding (MOU) have been executed with the U.S. Bureau of Reclamation, the U.S. Bureau of Land Management, and the Air Force Academy (AFA) relating to dam safety activities in Colorado. They provide for the exchange of safety related information of dams under each agency's jurisdiction. A MOU is also being updated with the U.S. Forest Service, Rocky Mountain Region, to provide coordination of mutual responsibilities for dam safety and their Travel Management Plan for the National Forests. This is necessary to provide access to private dams located within the forests. MOU's are being pursued with the other federal agencies such as the U.S. Army Corps of Engineers and the Federal Energy Regulatory Commission to assure that the dams under their jurisdiction are being maintained in a safe condition and to coordinate activities and exchange of information and data.

The Branch makes safety inspections of dams that are also regulated by the Federal Energy Regulatory Commission (FERC). In accordance with an agreement with them, they notify the Dam Safety Branch of their schedules and invite the Branch to participate in their inspections. They also furnish copies of their reports for Branch records. The FERC is notified of any safety problems that have been identified based on safety inspections, when requested by them. The Branch has curtailed participation in FERC regulated dams in accordance with the audit, but in accordance with the procedures for approval, spent about 12 hours on inspections to evaluate specific performance or maintenance issues, at a cost of less than about \$540.

## ***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. A volunteer committee of meteorologists, hydrologists, engineers, federal and state agencies, and private entities assisted in the preparation of the technical portions of the request for proposal. The Department of Atmospheric Science at CSU was selected to develop a new method of estimating extreme precipitation and to develop concepts of how extreme precipitation varies with elevation in Colorado.

A technical review group is assisting the Dam Safety Branch in reviewing the progress of the research. The draft final report was submitted on July 29, 2002. The technical review group will be meeting in early 2003 to discuss the conclusions and recommendations of the report.

## ***Interagency Personnel Agreement***

The Dam Safety Branch Chief for 20 years, Mr. Alan Pearson, retired in May 2002. However, due to the current funding status and budgetary limitations, it has not been possible to fill this critical leadership position. Therefore, other funding options were



explored to fill this position on a temporary basis. Through some unique resources and abilities, We were able to investigate, request, and obtain approval for an Intergovernmental Personnel Act (IPA) agreement with the Department of the Interior, Bureau of Reclamation, for an individual to provide technical leadership necessary to serve as the Branch Chief. The IPA agreement is valid for up to two years, at the state's discretion, and the Bureau of Reclamation will fund 100 percent of the employee's salary and benefits. The Bureau of Reclamation employee will provide knowledge of the Bureau of Reclamation's efforts to implement risk-based dam safety decision-making processes as attempts are made to implement such processes in the Dam Safety Program.

A highly qualified individual, Mr. Douglas Boyer, was selected in mid-October 2002 and began serving as Branch Chief on November 3, 2002. Mr. Boyer has over 17 years of experience in the investigation, evaluation, analysis, design, and construction of embankment and concrete dams. He has an undergraduate degree in geology and a graduate degree in civil engineering. He has been the principal investigator and/or designer for a number of embankment and concrete dams, including the 275-foot-high Ridges Basin Dam, currently under construction in Colorado. Mr. Boyer has authored or co-authored more than 15 technical papers and has been an invited speaker at university classes, dam safety training courses, and international seminars.

### ***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 through 2002. 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 fifth 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:

1. ASDSO Annual Conference, Dam Safety 2001, Salt Lake City (attended by four dam safety engineers and one design review engineer);
2. ASDSO Regional Technical Seminar, Earthquake Engineering for Small Dams (attended by one dam safety engineer);



3. ASDSO Technical Seminar, Plant and Animal Penetrations of Embankment Dams, Salt Lake City (attended by one dam safety engineer and one design review engineer);
4. Federal Emergency Management Agency, Responding to Dam Safety Emergencies, Emmitsburg, MD (attended by the Deputy State Engineer);
5. HEC-RAS Hydrology modeling seminar by Dr. Arthur Miller, Penn State University, Denver (attended by seven dam safety engineers and one design review engineer);
6. U.S. Society on Dams Annual Meeting, The Future of Dams and Their Reservoirs, Denver (attended by one dam safety engineer and one design review engineer);
7. Federal Emergency Management Agency, HEC-HMS software training, Emmitsburg, MD (attended by one dam safety engineer);
8. Slope stability and seepage software training, GEO-SLOPE International, Calgary, Alberta, Canada (attended by one design review engineer); and
9. Embankment dam presentation by Dr. Ralph Peck, Denver (attended by one dam safety engineer).

## ***Integration of Risk Assessment***

Colorado has relied on an inspection/standards based program for over 20 years to assure the safety of dams in the state. While inspection activities are necessary and provide a basis for dam inventories, evaluation of hazard classifications, and site conditions at dams, too many serious incidents and even failures of dams in Colorado are still occurring. After attending an ASDSO workshop in 1999 on risk assessment, dam safety engineers decided to explore ways to include risk assessment in the Dam Safety Program as a tool for identifying potential failure modes at existing dam and to focus resources at the dams having the greatest risk of failure and significant consequences.

A pilot project was implemented to train staff and evaluate Failure Modes and Consequence Evaluations (FMCE). Simultaneously, an evaluation began of the U. S. Bureau of Reclamation's Risk Based Profiling System (RBPS). It is an indexing method for ranking dams in accordance with weighted failure modes and consequences. RBPS could be used to create a list of dams to do a more detailed FMCE.

A subset of risk analysis, FMCE, is simplified by qualitatively, rather than quantitatively, estimating the likelihood of adverse consequences from loads on dams (static, hydrologic, and seismic). It includes a comprehensive review of the engineering data, operation, performance history, and record of design construction, as well as information related to the consequences of failure and planned emergency procedures, by a team of experts in dam safety. The teams use an "expert elicitation" process to develop an understanding of the most significant failure modes,

consequences, and any risk reductions that can be implemented with respect to a dam. One session was conducted in 2000 and four have been conducted for this fiscal year. The 2000 and 2001 sessions have proven to be very successful and the process shows promise for further implementation in the program.

A review of the RBPS was performed on a number of dams to evaluate the effectiveness of the procedure. In fact, several of the dam safety engineers have ranked many of the dams in their geographic area using this tool. The RBPS results provide a relative ranking of dams that should receive more attention, and in some cases, less attention, in the program.

The Dam Safety Branch continued their efforts in using risk-based tools to help evaluate and rank the jurisdictional dams in Colorado in order to more efficiently and effectively use program resources. One tool that has shown promise is the Risk Based Profiling System (RBPS) as developed by the Bureau of Reclamation. The Bureau of Reclamation has been using this tool for a number of years for similar purposes with much success. Based on understanding of the system and initial reviews, an agreement was executed with the Bureau of Reclamation for adapting this system for the state. An Intergovernmental Agreement with the Bureau of Reclamation was issued to revise their RBPS based on program needs. It is the Branch's goal that, by the end of the next fiscal year, a modified RBPS is in place that is fully functional and effective at focusing resources where they are most needed.



# Modeling Branch

The Modeling Branch exists to provide technical expertise to the DWR and other agencies through review, development, analysis and execution of complex hydrologic computer models. The branch consists of three and one half 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.

## *Rio Grande Decision Support System*

In 2002, the Rio Grande Decision Support System (RGDSS) entered into the final development phase. Future activities are expected to occur within the Modeling Branch as the project moves into the maintenance phase. Major accomplishments in 2002 by the Modeling Branch in coordination with the CWC and RGDSS consultants included Ground Water Model development and Surface Water Model development.

### **RGDSS Ground Water Model Development**

Ground water models continued to be developed for incorporation into the RGDSS and include a steady state, an average monthly, and a monthly (historic) model. All three models are enhanced versions of the model used in the AWDI trial in 1990. The models include five geologic layers and every major water budget component in the valley including recharge, boundary inflows, pumping, stream-ground water interactions, flowing wells, evapotranspiration by native species and subirrigation by irrigated meadow lands. New programming required to simulate flowing wells, evapotranspiration by native species and subirrigation by irrigated meadowlands were adopted by the USGS as a Modflow 2000 enhancement (USGS Open File Report 00-466). Additional coordination with the USGS is anticipated for 2003 that will allow them to adopt State enhancements to Modflow's Stream Package.

The Modeling Branch worked hand in hand with the RGDSS ground water consultant to complete development and calibration of the RGDSS ground water models. Documentation and refinements are expected to continue into 2003 as part of the systems maintenance.

Also, the Modeling Branch will begin development of technical tools required to evaluate rules for new well development in Division 3. It is anticipated that these



enhanced models and technical tools 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.

### **RGDSS Surface Water Model Development**

The Phase 3 RGDSS Surface Water model reached a 95% completion level in 2002. Refinements to the ground water return component are expected to continue in 2003 after the ground water model development is completed.

The RGDSS surface water model is a comprehensive water supply model that simulates every water use and water right in the basin from 1950 to the present. Major enhancements to the State's surface water model, StateMod, that were performed by the Modeling Branch include the ability to simulate the Rio Grande Compact, operate on a daily basis, include ground water use and simulate the variable efficiency of water use.

### ***South Platte Decision Support System***

In 2002, the South Platte Decision Support System (SPDSS) moved from a feasibility study into implementation. The Modeling Branch worked with the CWCB to select experts in the areas of Surface Water, Ground Water, Consumptive Use, Geographic Information Systems, and Systems Engineering (database and software). Contracts were negotiated with each expert that will allow the SPDSS development to begin with a data collection phase in 2003. Modeling branch personnel are expected to provide technical review of all SPDSS deliverables and will be intimately involved in the surface water, ground water, and consumptive use modeling portions of this critical six year, 11 million dollar project.

### ***Kansas v Colorado Litigation Support***

During 2002, final preparations were completed for the final trial segment before the Special Master to determine Compact compliance for 1997-1999. Also, final preparations were made to 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 Use Rules) which were implemented in 1996. Twelve weeks of trial were conducted in Pasadena, CA during the months of June, July, August, September, and December of 2002 and January of 2003.

The tasks accomplished in 2002 in support of this litigation and related activities in Division 2 by the Modeling Branch can generally be classified into the following areas:

- Reviewing and evaluating Kansas expert reports and their deposition testimony concerning proposals for modifications to the Hydrologic Institutional Model (H-I Model) and their evaluation of Colorado's ability to comply with the Arkansas River Compact in the future.



- Monitoring and coordinating the design and modification of two versions of the H-I Model to be used in Colorado's rebuttal case for the years 1997-1999.
- Performing the design and modification of both versions of the H-I Model for use in an analysis of prospective compact compliance for 45 years into the future.
- Performing and documenting an analysis of prospective compact compliance for a period of 45 years of replacement plan operations governed by the "Amended Use Rules" in the Arkansas River Basin.
- Preparing an expert report entitled "Colorado's Response to Kansas Analysis of Colorado Compliance with the Arkansas River Compact 1997-1999 and Prospective Compact Compliance".
- Editing and monitoring completion of all 16 expert reports prepared by Colorado for this trial segment.
- Providing information in depositions and in 5 days of testimony before the Special Master concerning Colorado's efforts to comply with the Arkansas River Compact during 1997-1999 and its ability to comply with the Compact in the future.
- Providing engineering support as part of the litigation team during the conduct of the trial.
- Using the H-I Model to determine operational parameters to be used in the Rules Governing the Arkansas River Water Bank Pilot Program and providing testimony in the rule making hearing conducted by the State Engineer.

The final report by the Special Master to the U.S. Supreme Court is expected to be completed and submitted in 2003.

### ***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 SB96-74 Denver Basin groundwater model to transform the model from a stream depletion impact assessment model to a regional planning model.

It has been rewarding to see the SB96-74 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 existing 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 as has technology, which today enables us to produce better contour maps and build larger refined groundwater models.

While the geology of the basin has not changed, our understanding of the physical elements of the basin such as specific yield has increased. 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 models. While it is not clear at this point whether or how the non-tributary line could be moved, the Modeling Branch is evaluating these and other concerns.

# 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 2002.

## *By the Numbers*

The following is a statistical summary of the branch activities.

• Well construction variance requests reviewed	230
• Geophysical logs evaluated	250
• Geophysical log waivers reviewed	120
• Mined Land Reclamation plans reviewed	12
• Oil and Gas injection well proposals reviewed	17
• Well permit evaluation consultations	700
• Water levels measured	1,200
• Reports written	11
• Phone contacts and evaluations	650

## *General Investigations*

The Branch is involved in a variety of geologic, geohydrologic and geotechnical studies and projects. The following provides a brief description of the key activities in 2002.

- 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. We have been working with Bob Reynolds and assisting in his quest to map sand lobes that extend into the basin. This will help our understanding of the sands particularly in the Arapahoe.
- 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. However, technical issues are still being discussed. Glenn is working with the planning commission and the county commissioners. Any 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.

- State Ground Water Atlas – Glenn Graham and George VanSlyke have been working with the Colorado Geological Survey and the Water Conservation Board to review 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 publication is intended for the general public, but will include technical data and have links to web data.
- 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.
- State Fair – A physical model of the hydrologic cycle and seasonal change was prepared for the state fair exhibit. Chuck Roberts was given the task of designing and constructing the valve system and timing of the water flow within the model. This project took considerable time and energy. Chuck is to be commended for his dedication and skill in the success of this project.
- Meetings have been held with the consultants for the South Platte DSS to insure that geologic and hydrogeologic issues will be addressed.

## ***Ground Water Commission***

The branch continued to assist the Groundwater Commission through the monitoring of groundwater levels and technical support to the Commission and staff. A few of the activities that warrant highlight are presented below.

- 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 gave a presentation to the Commission on the geology of the Denver Basin.
- Chuck Roberts gave a technical presentation to the Southern High Plains ground water management district.
- The entire staff provided technical support to the well permitting staff.

## ***Denver Basin***

The Branch staff are the resident experts in the Denver Basin. Much institutional knowledge is at risk over the next few years. The current efforts of the Branch staff to transfer that knowledge are extremely important. A few key activities associated with the Denver basin are provided below.

- 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 provided detailed information explaining the results of the specific yield testing and the implications to the Denver Basin.

## ***Republican River***

The Branch provided a significant level of support to the Republican River litigation team. A few of the specifics are described below.

- Chuck Roberts, George VanSlyke, Dass, Rich Bell and Michael Schaub spent considerable time entering data from permits into a new database. Information included depth to shale, specific capacity testing and water levels. This was used to assist our consultants.
- Depth to water and water level maps of the basin were prepared.
- 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 WAS 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. The class will be held in Division 1 this year as we gear up for implementation of the South Platte Rules.
- Glenn Graham continues to be the Division representative to the Colorado Ground Water Protection Council.

## ***Board of Examiners***

- Rules and Regulations. Dave McElhaney has spent most of his time working with the Board. We have been getting substantial help from Michael Schaub on enforcement actions.
- Well Completion Monitoring – New procedures for entering the data were developed. Many people have helped to get caught up on entering data since we have been unable to fill the position that Norm Hill vacated.

- Variances – Approximately 230 requests for variance from the well construction rules were processed during the year.
- Dave McElhaney has helped writing proposed legislation for a well inspection program.

### ***Special Note***

- George VanSlyke, Glenn Graham and Chuck Roberts all submitted technical papers to the Geological Society of America and had the papers accepted for presentation at the Society Annual Meeting in Denver in October. George and Glenn had their papers included in a session on the Denver Basin. Chuck's paper dealt with the hydrogeologic assessment of the Southern High Plains.
- Glenn Graham and Dick Wolf prepared and presented technical papers concerning Coal Bed Methane produced water at several technical meetings.
- Chuck Roberts planned and conducted the well testing training. Heidi Frey and Michael Schaub assisted him.
- Chuck Roberts designed the water system for the State Fair project. In addition he spent numerous hours working on the project in addition to his regular work.
- Glenn Graham was a featured speaker at the Fractured Rock Hydrology symposium.
- George VanSlyke was interviewed by personnel from Rams Horn Educational Books (associated with the University of Connecticut) for information to be contained in a ground water textbook.
- Glenn Graham and George VanSlyke have been quite heavily involved in the review of the Ground Water Atlas being prepared by the Colorado Geological Survey.
- George VanSlyke has been involved with the evaluation of ground water resources of the Chatfield East Subdivision for the Homeowners Association.

### ***Geotechnical Branch -Where We Are Going***

Several changes are expected in 2003 many of which will impact the division.

- The Branch will continue cooperation with the USGS and CGS in many areas such as the USGS hydrologic and geologic mapping of the state. A continuation of the Front Range and Denver Basin is currently underway.
- We have been fortunate to have the assistance of Michael Schaub during portions of 2002 and hope to use his geologic ability more fully.
- 2003 may see the retirement of between one and three Branch members. We are trying to get Dave McElhaney and Michael Schaub familiar with all aspects of Branch activity so that they will be able to take over. With two trying to do the work of four, some things may need to be delayed.



# Hydrographic and Satellite Monitoring Branch

## Overview

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 improve the quantity and quality of data used to manage and administer water throughout the State of Colorado.



*Water Safety Training*

The Annual Training Meeting was held in Aspen in late September. Training sessions included a presentation by the USGS on their web information and data tools, non contact flow measurement, using the Aquacalc Meter for streamflow measurements, and equipment training from manufacturers Sutron and Design Analysis. Safety training this year included a cableway safety refresher, a hands on water training safety session, and a recertification of roadway flagging. Also, we had a presentation

and hands on training using HEC-RAS modeling software and field data collected this past summer by the USGS and DWR to extend rating curves at selected sites. Other discussions included program coordination issues with the USGS and CWCB, hydro program highlights and issues, satellite monitoring program highlights, and division reports.

DWR is cooperating with the USGS and CWCB on numerous activities this year:

- We have been working in cooperation with the USGS to analyze our streamgaging network in an effort to ensure our networks are as efficient as possible.
- We have continued to upgrade DWR and USGS gaging sites with monetary assistance from CWCB



*DWR/CWCB/USGS Coordination*



to 'flood harden' areas that may have likely been damaged and unable to report stage during a flood event. Part of this work also includes extending rating curves at 17 gaging sites.

- In cooperation with CWCB, we are developing an ALERT system to warn key staff in the event of low or high flows.

## ***Division Highlights***

### **Division 1**

Extreme low flows on the South Platte and its tributaries required numerous extra measurements, installation of stage-shift tables, gage maintenance trips, and water commissioner assistance. Historic low flows (at times less than 1 cfs) at Bear Creek at Morrison gage were below our inlet pipes. Not only was the gage not reporting, but the water being administered in amounts that were so small --tenths of a cfs--that the flow could not be physically measured with current meters to the accuracy needed. CWCB money was used to construct a concrete control that raised the water level to the gage inlets. The control also incorporated a low-flow section with a sharp-crested rectangular weir for better accuracy. Similar projects were also completed during 2002 to establish new administrative gages with full weir controls at the gages located on the St. Vrain Creek at Longmont, and the Cache La Poudre River at the Greeley wastewater plant. Establishing gages like these has required much extra effort, however the long-term benefit is measured by the gages requiring much less of our time to maintain and are more accurate at low flow.

The tracking the delivery of augmentation water created a significant increased workload in division 1. GASP and Central rely on water delivery that is required to pass numerous headgates. Many of these ditches were called out and dry for the first time, and those ditches in priority were often not receiving their full water right. The administration of water was based on the amount of water in the river, rather than the amounts the ditches took through their measurement flumes. Therefore many more measurements were required just past the headgate.

Special efforts were made this year to track augmentation water relative to the South Platte River compact. Hydrographic contributions included two new satellite installations, extra measurements, and the training of a new deputy water commissioner/hydrographer (Russell Stroud) to work in the Julesburg area. Mr. Stroud performs a wide range of hydrographic work and deserves special recognition for his work.

Division 1 also responded to an added level of activity by working with USGS to jointly apply for CWCB flood monitoring grant to re-establish a USGS satellite gage on the South Platte at Fort Lupton. The CWCB funds were used for the installation of a shelter and instrumentation, Greg O'Neil (USGS) and Bob Cooper (DWR) were able to attract Metro Wastewater as a cooperator to fund the gage operation. Similar collaboration between DWR, USGS, CWCB and water users was successful in establishing a new USGS gage on the South Platte at Fort Morgan.



In addition, division 1 hydrographic operations were affected by added concerns related to the wildfire burn areas. Denver Water initiated significant water management activities for storm runoff and inflow mitigation. The most notable event was the transfer of water into Cheeseman Lake. Many extra measurements and visits to gaging stations were required to keep gages calibrated through a range of abnormally high flows.

## **Division 2**

The Division 2 Hydrographic Program was conducted in 2002 under the overall program leadership of Assistant Division Engineer, Bill Tyner, PE II; supported by Lead Hydrographer, Thomas Ley, PE I; Hydrographic Engineer, Lou Schultz, EIT; and Hydrographic Technicians, Anthony Gutierrez and Adam Adame. Bill Tyner also had specific hydrographic program oversight responsibilities for hydrographic record preparation in Division 5 during the water year.

Division 2 hydrographers have assigned gaging stations/areas for which they have responsibility for station operation and maintenance, as well as the complete development and computation of streamflow records for specific historic record and/or compact gaging stations. Lou Schultz is responsible for gaging stations in WD 11 and provides support in WD's 12 and 13. Tony Gutierrez and Tom Ley are responsible for gages in WD's 12, 13, 10, 14, 15, 16, 79, 18 and 19. Adam Adame is responsible for WD's 17 and 67. Additionally, hydrographers respond to requests of water commissioners for water measurement assistance in their respective districts.

Division 2 hydrographic staff completed 46 streamflow records for WY2002 for publication in the DWR Annual Streamflow report. Seven of these streamflow records are also published by the US Geological Survey in their Annual Water Resources for Colorado Data Report.

During the water year, Division 2 hydrographers completed the following stream gage improvement projects:

### *Flood Hardening:*

- Completed installation of flood hardening equipment and facilities at three gages:
  - Arkansas River below Catlin Dam: flood block and new orifice lines,
  - Purgatoire River at Trinidad, complete rebuild of gage and installation of new shelter on higher ground and satellite monitoring equipment,
  - Cucharas River at Harrison Bridge below La Veta, installation of new shelter on higher ground.
- Initiated installation of flood hardening facilities at Arkansas River near Wellsville (flood block and new orifice lines).
- Assisted USGS staff with cross section surveys at six gages for purposes of rating extensions for flood flows.

### *Stream Gage Refurbishment:*

- Installation of new shelter at Ninemile Canal.

- Installation of new shelter and satellite monitoring equipment at Crooked Arroyo near Swink gage.
- Installation of new shelter and satellite monitoring equipment at Arkansas River near Carlton gage.
- Complete rebuild of South Arkansas River at Mouth at Salida gage with new shelter and well.
- Install new gage at Brett Gray Reservoir outlet flume and connect to DCP at Brett Gray Reservoir at Smith Ranch
- Install SDI Radio Bridges and SDI shaft encoders at Ninemile Canal (linked to Purgatoire River at Ninemile Dam DCP) and Cucharas River below Cucharas Reservoir (linked to Cucharas Reservoir DCP) thereby eliminating two 8004 DCPs.

*High Data Rate Satellite Transmissions:*

- 20 gaging stations in Division 2 were upgraded with high data rate GOES radio transmitters (300 baud rate, hourly transmissions). These gages are now updated hourly on the DWR real-time streamflow web site
- Upgrades in several cases also required installation of SDI shaft encoders and upgraded grounding equipment.

Other activities conducted by Div. 2 hydrographic staff include the inspection of two cableways in Division 2 and one in Division 5 as part of the DWR Hydrographic Program Cableway Safety and Inspection Program.

The 2002 drought required considerable additional work of the Div. 2 hydrographic staff:

- Due to extreme low flows there was a need to develop and/or rework the rating tables for several gaging stations. Ratings were either extended down or reworked for at least 10 gaging stations. In most cases, several unscheduled low flow measurements were made to assist the rating extension or development of a new rating.
- Several additional or "special" measurements were made on streams or ditches at the request of water commissioners and other water administration staff. There were a higher number of such measurements than usual.
- Some stream gages required rehabilitation just to maintain contact with the stream and to be able to accurately measure low flow stage. As an example, the Arkansas River above Pueblo gage experienced the lowest flows in its history when the gates at Pueblo Reservoir were closed in August 2002. At flows below about 80 cfs the well becomes isolated. Div.2 hydrographers installed a new low flow primary reference gage and an accububble for accurate measurement of these low flow gage heights. The datum of the gage was decreased and a new rating developed based on several low flow measurements in the range from 1.5 to 80 cfs.

Division 2 hydrographic staff expended considerable effort in 2002 to coordinate stream and reservoir gaging activities with the USGS Pueblo Subdistrict office, the US Bureau of Reclamation, and the US Army Corps of Engineers.



### *Hydrography in Support of Water Administration:*

The severe drought conditions in 2002 created situations within the Arkansas River Basin that had not previously been experienced and in particular the areas of substantial population growth, including Colorado Springs and Pueblo, found that their normally reliable water supplies were tenuous. This situation created many unique challenges for Division of Water Resources Hydrographers, Water Commissioners and Reservoir Operations Staff, but also forged some very good working relationships with affected water users in the process of maximizing the dwindling water resources focus involving a relatively small amount of water that required an inordinate amount of administrative and measurement activity.

Division of Water Resources staff, including Charlie DiDomenico, Monique Morey, Tony Gutierrez, and Tom Ley worked carefully with all of the entities involved to try to maximize the limited water supply by identifying the daily minimum needs of each of the power plants and the fish hatchery, reviewing changes to inflow conditions and reservoir release requirements, making stream measurements more frequently and at locations not normally gaged, and calling for the reservoir outlet gates to be set appropriately. Through this extra effort City of Pueblo's critical needs were met, while causing no major disruptions to either of the power plants and maintaining a reasonable flow through the fish hatchery to support operations.

Alan Ward from the Pueblo Board of Water Works, Mark Even with Aquila Corporation, Jim McKissick and Dave Harris with the Pueblo Hatchery and Steve Williams and Roy Vaughn with the U.S. Bureau of Reclamation operations staff at Pueblo Reservoir were also instrumental in communicating effectively to facilitate the coordination necessary to conserve the limited water supply.

## **Division 3**

### *Ramp Flume Installation:*



*Photo 1 Ramp Flume*

The Division 3 Hydrographic Branch installed two new control structures at gaging stations this year. These control structures were a relatively new type of structure called a ramp flume. The ramp flumes were designed and installed by R&M Construction & Services of Montrose, Colorado with assistance from the Division 3 hydrographic staff. The flumes were placed at the Kerber Creek near Villa Grove gage and the North Clear Creek below Continental Reservoir gage.



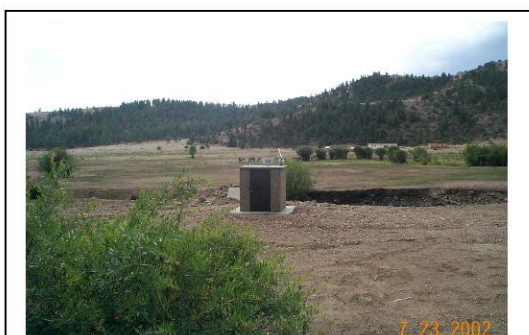
The ramp flume is supposed to be even more accurate than a Parshall Flume, and it is hoped that these installations will provide better data for these sites. This year, the new flumes proved themselves in allowing us increased accuracy for the very low flows experienced at these sites. (photos # 1, 2)



*Photo 2 Ramp Flume*

### ***Gage Construction:***

This year the Hydrographic Branch in Division 3 worked on two major construction projects. The first project was the



*Photo 3 Kerber Creek near Villa Grove*

relocation of the Kerber Creek near Villa Grove gage. The former location of this gaging station was in a somewhat poor location hydraulically, and high water events over the years had degraded the gage pool, damaged the station, and had at times created alternate channels around the gage. A better location was found downstream, and a new station and ramp flume were installed. The new gage is an exposed aggregate building over a four-foot

diameter concrete well. A new Sutron satellite system was also installed at this site to provide near real-time data. (photo #3)

The second project was the reconstruction of the gaging station at the Rio Grande near Del Norte site. This construction was necessary because the nearly seventy year old wooden shelter and well were beginning to rot, and to also flood harden the gage to protect it better during flood events.



*Photo 4 Rio Grande near Del Norte*



Since this site is a Rio Grande Compact station, it was imperative that the construction cause as little lost data as possible. Therefore, a temporary station was installed across the river from the existing gage to provide the gage height data during construction. The existing wooden shelter and well were removed, new inlets were added, and a new exposed aggregate building with a concrete well was installed. (photos #4-8)



*Photo 5 Rio Grande near Del Norte*



*Photo 6 Rio Grande near Del Norte*



*Photo 7 Rio Grande near Del Norte*



*Photo 8 Rio Grande near Del Norte*



### *Low Flows:*

As with most of the state, Division 3 experienced unprecedented low flows at almost all of its gaging stations this year. This was the driest year ever recorded at virtually all of the gaging stations in this Division. Most of the peak flows for our gages occurred in the fall of the year or in the very early spring, which is very unusual. Many of the streams in the division went dry, even some that had never been known to go dry before. Ute Creek near Fort Garland was dry for a total of 61 days during the summer, and in its 79 year history, it had only gone dry for a short period in one other year. This year we also had to deal with stations becoming isolated from the stream due to the low flows.

Construction work had to be done at several sites to re-connect the stream flow to our gage. The attached photo is of the very low flow at the Rio Grande near Lobatos gaging station. (photo #9)



*Photo 9 Rio Grande near Lobatos*

### *New Rating Tables:*

One of the most time consuming areas this year has been the need to develop and/or rework the rating tables for our gaging stations. We have had at least 13 gaging stations where the flow has fallen below the lowest point on its respective rating table. When this happens there is no easy way to determine the actual flow, and our web site shows an error message for that station. The water commissioners are also 'in the dark' and have to spend extra time trying to estimate the flow. For instance, the rating table for the Conejos River near Mogote only went down to 21 cfs, which had been adequate for the last 90 years, but this year the flows dropped below 10 cfs. In these instances, we have had to make unscheduled measurements and then either develop a new rating table or extend the existing table down to cover the low flows.

### *High Data Rate DCP's:*

Eleven Sutron 8210 DCP units were upgraded with Sutron Satlink High Data Rate satellite transmitters in 2002. These HDR transmitters are equipped with a GPS receiver and antenna that is used to periodically synchronize the time clock on the DCP with Universal Standard Time. This feature eliminates inherent clock drift and combined with the faster transmission rate, allows the DCP to transmit data within a 15 second time window. Therefore the HDR transmitter can be programmed to transmit once every hour instead of every four hours. This greatly enhances the water manager's ability to make decisions based on real time data.

Nine of the DCP units with HDR transmitters have been installed in the field. Since the Satlink transmitter was a completely new design, there were a few bugs to work out. Several visits were required at each of the HDR installations due to failures and



to upgrade DCP and transmitter firmware. On November 1, 2002, Sutron announced that they had finally isolated and solved the problem and released a new version of DCP firmware. Since upgrading to the latest firmware version, there have been no field failures to date. Many more DCP units will be upgraded with High Data Rate transmitters and installed in 2003.

## **Division 4**

Division 4 has had several construction projects in 2002. This included work on two gages on Muddy Creek above and below Paonia reservoir. In addition the gage at the Uncompahgre River near Ridgway was relocated. Through cooperation with the Uncompahgre Water Users Association a new gage on the Selig Canal. The rating and gage went into operation for this past Irrigation season. The division staff assisted the BOR in installing a new Accububble system in a gage that we cooperate with them on, the Gunnison River below the Redlands Diversion Dam. This has become very important to DWR in determining the Redlands call on the Gunnison River drainage and also provided the USGS streamflow information for the transit loss study between the Gunnison River near Grand Junction at Whitewater and below Redlands. And, the indirect project at Surface Creek near (above) Cedaredge.

Lead hydrographer, George Wear also helped with the Montrose Water Festival for fourth grade students in the RE1J school district. Montrose and Olathe students between 400 and 500 participated. He teamed up with the BLM hydrologist.

## **Division 5**

The Division 5 hydrographer has been responsible for and accomplished the following:

- Measuring, recording and publishing the streamflows above Ruedi Reservoir associated with trans-mountain diversions for the Frying Pan-Arkansas Project. There are four manual and four satellite stations.
- Measuring, recording and publishing the streamflows for the Blue River below Breckenridge station for the Colorado Water Conservation Board for minimum streamflow compliance.
- Measuring, recording and publishing the streamflows for the Roaring Fork River below Maroon Creek station for the Aspen Consolidation District for permit compliance.
- Measuring and recording the streamflows for the Snake River at the Keystone Ski Area for the Colorado Water Conservation Board for minimum streamflow compliance.
- Measuring and recording the streamflows for Snowmass Creek below the Snowmass W&S District diversion for the Colorado Water Conservation Board for minimum streamflow compliance. A new compound control was installed at the station this year, requiring rating measurements and the development of new rating tables.



- Measuring, recording and completing the streamflow record for the Government Highline Canal near Cameo.
- Measuring and recording the streamflow records for Bull Creek and Big Creek in District 72 for reservoir release/water administration purposes.
- Measuring diversions and/or bypass flows for water commissioners for administration.
- Providing finished record for approximately three streamflow stations and six reservoir elevation stations, as input to diversion records.
- Responding to data requests from Division 5 staff and the general public.
- Maintaining 27 satellite stations used for administrative purposes and monitoring 43 stations that are operated by other entities.
- Maintaining three satellite monitoring streamflow stations for the Colorado Water Conservation Board.

2002 presented special hydrographic challenges because of drought conditions in Division 5. One of the biggest issues to arise was the estimation and administration of transit losses during winter conditions. Several high-elevation reservoirs and one transmountain tunnel are making releases into stream channels and the accurate estimation of transit, or conveyance, losses for these releases has become critical to proper water administration.

Lower than average streamflows in many streams and rivers in Division 5 in 2002 resulted in instream flow water rights not being satisfied. This required extra diligence in streamflow gaging and water administration. In addition, water rights administration of many tributaries was tighter than ever before experienced, necessitating many extra ditch and/or bypass flow measurements to rate measuring devices or to assist with administrative decision-making.

The Division 5 hydrographer made 53 river measurements (including 33 measurements for the Fry-Ark Project) and 41 ditch/canal measurements during the 2002 hydrographic Water Year.

## **Division 6**

Currently there are 43 active stream gage sites in Division VI. Of these stations 34 are operated by the USGS and 9 are operated by the DWR. Of the nine operated by the Division, seven of them are equipped with satellite monitoring. Of these seven, three of them only transmit reservoir water surface elevation, three only transmit stream flow gage height, and one transmits both parameters. It is anticipated that by the end of the irrigation year 2003 one of the stations without satellite monitoring will be upgraded. This station is Walton Creek, which presently uses a paper recorder as well as a data collection platform (DCP) to record the gage heights.

Though several of the stations at the beginning of the year were experiencing difficulties, all of the problems were resolved within a short period of time. At two of the sites, the problems were solved by replacing the old Sutron SE5600-0530 shaft encoders with new Sutron SE8500 Model shaft encoders.



Division VI installed a new gage station in late April and early May of 2002. The gage station is located on the Michigan River on Jackson County property behind the Town of Walden water collection facility. Thankfully, Jackson County was very cooperative in allowing and supporting the Division of Water Resources installing a gage at this site. The Town of Walden is also very cooperative in allowing us access to this site via their property at the collection facility. The gage consists of a Sutron shaft encoder Model SE8500 connected to a high data rate Sutron 8210 Data Collection Platform with satellite telemetry housed in a structure mounted on top of a 36-inch diameter stilling well. This station has already been and will continue to be used extensively for water administration

The Michigan River near Meadow Creek Reservoir station continues to have reliability issues due to its location. Measurements taken this summer at the site did not correlate well with the existing rating table, as has been the case for several years. A new rating table was developed during the hydrographic record process this year. This new rating table will be used for the water year 2003. Because of the problems at this site, this rating table could also become poor within the next year or two.

The gage on Walton Creek near Steamboat Springs continues to be a critical site due to the streams recent administration. Presently, the site has a paper roll Stevens A-71 recorder and a Sutron 8200A data collection platform and SE8500 Model shaft encoder. Both the data collection platform and shaft encoder were installed at this site in early summer of 2002. It is anticipated that by the end of the 2003 irrigation season the site will be on satellite monitoring. The station is equipped with an a-frame cable way and car used by the USGS several years ago for high flow measurements. After a cableway inspection was conducted by Erin Light in the spring of 2002, the structure was determined to be unsafe and not to be used. As a result, there is presently no means of making high flow measurements at the site.

In addition to maintaining the gage sites, the hydrographic program was unusually busy in making additional measurements at various sites to assist with calls on many streams and the curtailment of water on the Yampa River that occurred in late summer. Some of the additional measurements made were on the Yampa River, Elkhead Creek, Elk River, and several ditches.

## **Division 7**

Streamflow was well below normal for the year. Streamflow records for the 2001 Water Year were completed and delivered to the chief hydrographer for publication. Two records were published by the Colorado office of the USGS and four were published by the New Mexico office of the USGS. Twenty-three records were published in the Colorado Division of Water Resources yearly publication.

The Division 7 hydrographer made 184 river measurements and 33 ditch measurements this year. Other engineers in the Division 7 office made 4 ditch measurements and 3 river measurements. Water commissioners in Division 7 made 41 river measurements and 1 ditch measurement. A large number of the hydrographers measurements were made to calibrate 4 ramp flumes constructed on

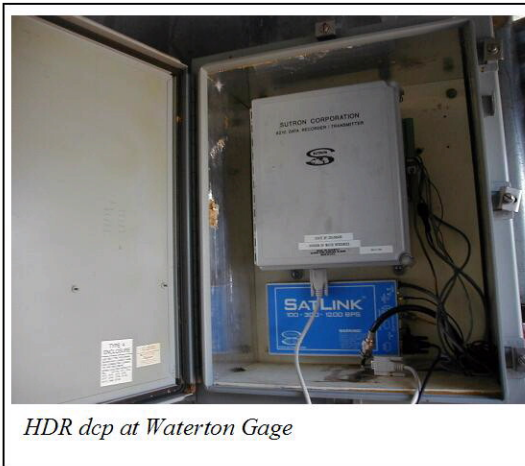


the La Plata River last year. Good low water definition of the rating curves was obtained but the high end must wait for another year.

Division Seven personnel assisted the Florida River Conservancy District in the installation of a ramp flume at the existing State of Colorado gage, Florida River above Lemon Reservoir. It is hoped that this new flume, once calibrated, will provide a much more accurate accounting of the inflows into Lemon Reservoir. Construction of this flume was done by Ted Brooks of R & M Construction & Services, LLC of Montrose, Colorado.

## ***Equipment Maintenance, Repair and Replacement***

Significant progress was accomplished in 2002. Thirtyseven (37) State of Colorado owned Sutron 8210 data collection platforms (dcp) were refurbished from 100bps to



*HDR dcp at Waterton Gage*

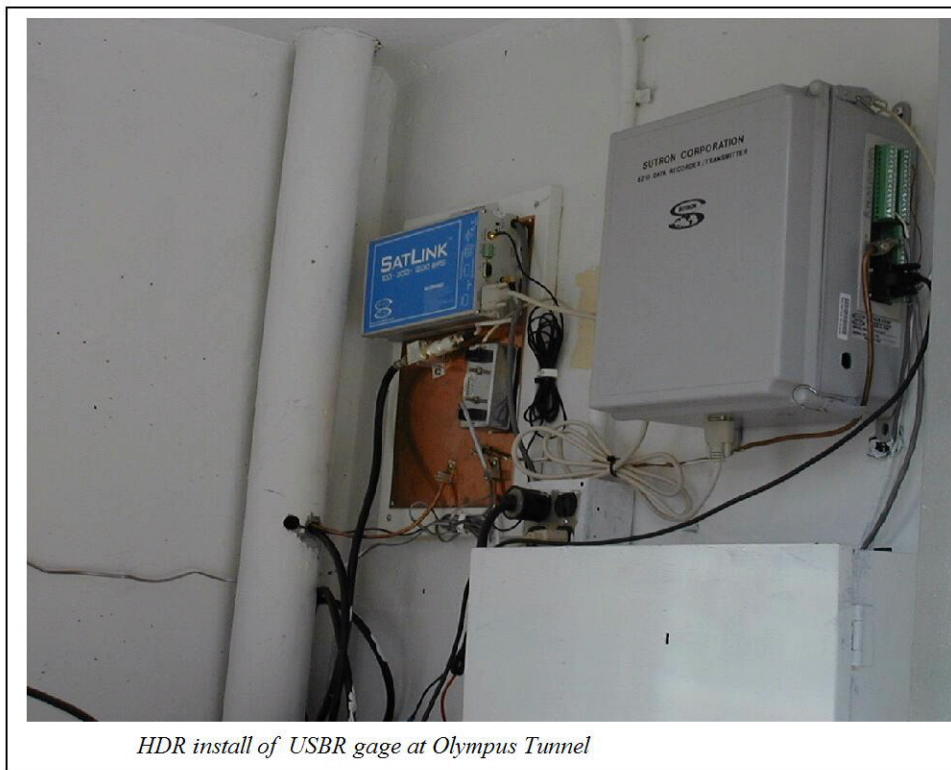
300bps for faster, and more frequent data collection with the help of funds from CWCB. Electronics technician, David Hutchins, provided technical support for the hydrographic branch, and conducted training classes on new and existing equipment. He also repaired and tested numerous dcps and transducers, and installed and setup four USBR owned high data rate dcps at coop stations. David was instrumental in the development of High Data Rate conversion program and assisted Sutron with research and development of a new low cost dcp.

The IPA with USGS, is a cooperative agreement whereby both agencies benefit through coordinated operations and office/shop space at the USGS office at the Federal Center in Lakewood. Approximately ten percent of David's time was spent providing technical support to the USGS Lakewood field office training staff on new and existing equipment, repairing USGS owned dcps, shaft encoders, and water quality equipment, and troubleshooting several USGS streamgaging stations.



*HDR install at HRC194CO*





*HDR install of USBR gage at Olympus Tunnel*

## ***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 streamflow records are published in May of each year for the prior stream flow. In May of 2002, a total of 208 records were published.

## ***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 streamflow 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 SMS allow 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. Out “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 Division of Water Resources 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 \$55,000 for refurbishment and repair of existing dcp's, and \$248,000 for upgrading to high data rate equipment. This year, equipment to upgrade 60 dcp's to high data rate was purchased, and 30 were installed. CWCB also provided \$100,000 for flood hardening work. A list of the gages to be hardened, and the priority system can be found in the appendix.

## ***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.

# **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, up to four 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 and, due to budget constraints and a hiring freeze, the position has not been formally filled. To accomplish the recording of data from the various work reports submitted by drilling and pump installation contractors, assistance has been provided by several individuals who volunteered to enter data in addition to their normally assigned duties. Much of the input was done by Rhona Jackson during her brief tenure as receptionist and by Richard Bell prior to his retirement. Arlene Stewart, Michael Schaub, Dave McElhaney, and Sandy Johnson have also devoted a portion of their time to entering data. The work is currently being accomplished by Jessie Dunbar on assignment from the Records Section. Data entry of well construction information is being kept current by Mr. Dunbar's efforts.

## ***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 policies and, during this calendar year, Staff assisted the Board in the development of revisions to Article 91. 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. Much of the credit for successful resolution of issues in the judicial arena goes to Linda Bassi, Susan Schneider, and Shana Smilovits of the Attorney General's office.

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.....	66
Complaint Type: Construction violation.....	15
Permit violation.....	33
Unlicensed contractor.....	15
No Work Report Filed.....	1
Order to Fix or Plug .....	2
Complaints Resolved.....	92
Initiated prior to 2001.....	4
2001 complaints resolved in 2002.....	47
2002 complaints resolved .....	41
Resolution/Action: Dismissed, withdrawn, discontinued, or otherwise resolved.....	21
Complied with Order.....	47
Court action (fines and fees).....	0
Letter of admonition/reprimand.....	10
Suspension/probation.....	3
Warning letters.....	10
Referred to State/Division Engineer.....	1

In addition, the staff prepared one policy statement, and processed 229 requests for variance and infiltration gallery plans. The staff reviewed 7374 completion reports, 4074 pump installation reports, 1050 abandonment reports, and over 2500 well owner completion notices.

## ***Licensing***

The Board licensed a total of 325 contractors in 2002, including 7 new contractors. The Board conducted oral examinations for new licenses. Gina DeArcos 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 7374 wells during calendar year 2002. Seventy two observations suggests that approximately 1% of the wells constructed are being observed during or after construction. The low percentage of well observations was not surprising in light of the budget situation and an increase of time spent on water administration by water commissioners during another year of drought.

The well observation program summary is provided in Exhibit E.



## Miscellaneous Activities

### *Division of Water Resources Safety Activities*

Snake bite kits and fire extinguishers were distributed to all state vehicles, and all vehicles that are used for state business by field personnel. Both of these items were requested by field personnel based on hazards they frequently encounter, and the fact that they are typically in remote areas and need to react without immediate help from emergency services.

Hard Hats were ordered and distributed to personnel and offices for use when inspecting or observing well drilling. The hats have DWR displayed on them to aid in personnel identification.

The West Nile Virus was a big scare this past summer, and will again be an issue this year. To ease fear and promote awareness, a pamphlet was developed with facts, statistics, and safety precautions.

A Flagger Certification review and exam was given at the fall 2002 Hydro meeting. This is a state certified program that legally allows our hydrographers to flag road areas in the event they are blocking the road when measuring streamflow.

Also at the Hydro meeting this past fall, a hands on water safety training was given. This allowed our hydrographers the opportunity to experience different floatation devices, and what it was like to be submerged completely clothed. There was also a pail of ice water for people to try to unlock a padlock to experience the lack of mobility when in very cold water.

A non- smoking eating area was also acquired on the outside patio at the Centennial Building so employees would not be exposed to dangerous second hand smoke.

### *Emergency Management*

As the DWR emergency coordinator and assistant DNR emergency coordinator I was involved in several activities during 2002.

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



Well observations performed by Division personnel during 2002. The program was implemented in March of 1999. Observations are shown by Division and month the inspection occurred.

### **WELL INSPECTIONS – 2001**

<b><u>Div.</u></b>	<b><u>Jan.</u></b>	<b><u>Feb.</u></b>	<b><u>Mar.</u></b>	<b><u>Apr.</u></b>	<b><u>May</u></b>	<b><u>June</u></b>	<b><u>July</u></b>	<b><u>Aug.</u></b>	<b><u>Sept.</u></b>	<b><u>Oct.</u></b>	<b><u>Nov.</u></b>	<b><u>Dec.</u></b>	<b><u>TOTAL</u></b>
<b>1</b>	6	0	0	0	0	4	0	1	3	0	0	0	<b>14</b>
<b>2</b>	1	0	1	1	0	0	1	2	0	1	0	0	<b>7</b>
<b>3</b>	1	3	4	0	0	1	0	0	0	0	0	0	<b>9</b>
<b>4</b>	1	0	3	2	4	1	3	2	4	0	0	0	<b>20</b>
<b>5</b>	0	0	1	1	0	0	2	2	0	0	0	0	<b>6</b>
<b>6</b>	0	0	0	1	0	2	0	1	0	1	0	0	<b>5</b>
<b>7</b>	0	0	0	0	2	4	1	1	1	1	1	0	<b>11</b>
<b>TOTAL</b>	<b>9</b>	<b>3</b>	<b>9</b>	<b>5</b>	<b>6</b>	<b>12</b>	<b>7</b>	<b>9</b>	<b>8</b>	<b>3</b>	<b>1</b>	<b>0</b>	<b>72</b>

7374 Construction Reports were received in 2002, 72 inspections results in approximately 1% of the wells constructed were inspected

# ENGINEERING, TECHNOLOGY AND INVESTIGATIONS

**Jack Byers**

**Deputy State Engineer**

264

DWR Emergency Management Coordinator  
DNR Deputy Emergency Response Coordinator

Gina DeArcos -  
Assistant

## Hydro & Satellite Monitoring Branch

**Vacant**

Professional Engineer III (191)

Dave Dzurovchin, Eng/Phys Sci Tech II (283)  
David Hutchens, Telecom/Elec Spec III (429)  
Jana Riedesel, EIT II (2460)

## Modeling Branch

**Brian Ahrens**

Professional Engineer III (370)

Dale Straw, Professional Engineer III (259)  
Jana Riedesel, EIT II (2460)  
Vacant, DSS Applications PE1

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-  
DSS Projects

**Ray Bennett**

Professional Engineer III (446)

## Dam Safety Branch

**Doug Boyer (IPA)**

Vacant, 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)

## Board of Examiners

**Jack Byers**

Administrator