

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

*People, Water and Stewardship*

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# **Engineering, Technology, and Investigations**

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*Deputy State Engineer*

2003 Annual Report

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Organization Chart



# 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 2003. 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. This annual report was compiled with tremendous assistance from the staff.

## 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. (2002 Supp.) and the Livestock Water Tank Act, Title 35, Article 49 of C.R.S. (2002 Supp.), as amended. The program is implemented by the State Engineer through the Dam Safety Branch and the Division field 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.

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 again 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.

The State Engineer's Office approved plans for four new dams and thirty-nine 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 \$95 million. The increased reservoir storage resulting from the approved new dams and enlargements is approximately 13,500 acre-feet.

A total of 573 dam safety inspections and 233 construction inspections were conducted for a total of 806 inspections. In addition, 178 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 144,437 acre-feet.

The restrictions provide risk reduction for the public and environment until the problems are corrected. Although many dams were repaired and removed from the restricted list within the last year, a number of dams were also added to the list during the same time period. The change in the restriction from the same time last year resulted in the same number of dams on the restricted list, however, the volume of the restrictions increased approximately 15,000 acre-feet. The increase in the volume of storage restriction can be related, at least in part, due to the increased aging of the dam infrastructure within the state. Approximately half of the dams on the Colorado Division of Water Resources restricted list have been on that list for ten years or longer.

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. A recommendation of the recently published "Report Card on Dam Safety in Colorado" by the American Society of Civil Engineers was to "support Colorado's presently successful state dam safety program with increased funding levels."

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.

The Dam Safety Program is executed 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. The dam safety engineers are responsible for the program in their geographic area. The dam safety review engineers and branch chief are located in Denver.

After many years of stability within the branch personnel, the past year brought about a number of personnel changes. Some of these changes were due to retirements and some due to reorganization within the branch to better utilize the resources.

- John R. Blair was hired as new dam safety engineer in Division 6 after the retirement of Sally Lewis.
- Dennis Miller transferred from Division 1 to Division 7 as the Division 7/3 dam safety engineer after the departure of Brett Nordby.
- Garrett Jackson transferred from Division 2 to Division 5 (Grand Junction) as a Division 4/5 dam safety engineer.
- Douglas Boyer was brought on as the Chief, Dam Safety Branch, through an Intergovernmental Personnel Act (IPA) with the U.S. Bureau of Reclamation after the retirement of Alan Pearson.
- Hired a new dam safety engineer, Bill McCormick, in Division 2 to replace Garrett Jackson who transferred to Division 5. (This hire was completed as of October 27, 2003).

Interagency coordination occurs as necessary. A Memorandum of Understanding has been executed with the Division of Wildlife (DOW) regarding the responsibilities of each agency in carrying out the safety inspection of DOW dams. The DOW is making safety inspections of their Class 3 (low hazard) dams.

The Colorado Water Conservation Board (CWCB) makes its construction fund available to assist owners with the repair of their dams. We closely coordinate the review and approval and final acceptance of these dams with the CWCB.

## *Emergency Incidents*

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

- Fisher Canyon Dam, a Class 3 structure, experienced rapid reservoir seepage losses of approximately one vertical foot per day and significantly increased flows from a previously documented spring approximately 500 feet from the dam. The reservoir was drawn down and investigations were conducted to determine the cause of the seepage losses.
- Warren Lake Dam, a Class 3 structure, experienced excessive seepage at the toe of the dam.
- Anderson Dam, a Class 3 structure, experienced excessive seepage along outlet works conduit.
- Haunted Spring Dam, a Class 3 structure, experienced excessive seepage at the toe.
- Ivanhoe Dam, a Class 3 structure, experienced piping of embankment materials at downstream toe. The reservoir was drawn down and an upstream geomembrane liner was installed on the upstream slope of the dam.
- Grimes-Brooks Dam, a Class 1 structure, experienced increased abutment seepage. The reservoir was drawn down to a safe level and monitored on a daily basis.
- Sellers & McClane Dam, a Class 3 structure, experienced excessive seepage through the dam due to extensive muskrat burrows in the dam.
- Western Hillside Dam, a Class 1 structure, experienced snow slide damage to the spillway structure. The reservoir was lowered to a safe level, the spillway repaired, and a ramp constructed to divert future snow slides away from the spillway area.
- Rist-Benson Dam, a Class 3 structure, experienced excessive seepage at downstream toe due to plugging of toe drains. The toe drains were cleaned and repaired.
- Sylvan Park Dam, a non-jurisdictional dam, experienced excessive seepage along outlet works conduit. The reservoir was drawn down and a new outlet conduit was installed.
- Turner Dam, a non-jurisdictional dam, experienced near overtopping failure of the dam due to rapid snowmelt runoff and blocked spillway conduit. The blockage at the spillway conduit was removed by the Water Commissioner and Dam Safety Engineer

that prevented the dam from overtopping. The actions prevented the dam from overtopping and possible failure of the dam.

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 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 2004 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.

During the later part of 2003 Mr. Boyer was appointed to a high level job within the Bureau of Reclamation. However he continues to provide limited assistance to the division on several key projects including the extreme precipitation study. Mr Boyer's leadership and management skills will be missed, however we do wish him well in his future challenges.

### ***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. 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 sixth 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, (attended by one dam safety engineer and the Deputy State Engineer);
2. U.S. Bureau of Reclamation, Safety Evaluation of Existing Dams Seminar, Denver (attended by one dam safety engineer);
3. ASDSO Western Regional Conference and Technical Seminar, Plan Review and Construction Inspection of Dams, Salt Lake City (attended by one dam safety engineer);
4. Federal Emergency Management Agency, Risk Assessments in Dam Safety Emergencies, Emmitsburg, MD (attended by two dam safety engineers);
5. Federal Emergency Management Agency, HEC-HMS software training, Emmitsburg, MD (attended by one dam safety engineer);
6. Slope stability and seepage software training, GEO-SLOPE International, Calgary, Alberta, Canada (attended by one dam safety engineer); and
7. U.S. Bureau of Reclamation, Risk-Based Profiling Training, Denver (attended by all dam safety engineers).

### ***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

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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 professional engineers that independently or as a team conduct investigations 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 Ash. Jana actually splits her work time 50% for the Modeling Branch and 50% for the Hydrographic Branch.

## *Litigation Support*

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

During 2003, the final week of trial in Pasadena, CA was completed in January. Following the trial, closing briefs were prepared and submitted. Work was started to plan for and initiate tasks that were anticipated to be required as part of the probable findings that the Special Master would make in his fourth report which was to be completed and submitted later in 2003. The tasks that were accomplished in 2003 are:

- Prior to receiving the first draft of the Special Master's Fourth Report, a project was initiated to collect input data and run a preliminary update of the Hydrologic – Institutional (H-I) Model for 2000, 2001, and 2002. The best estimate of information that would be dependent on the Special Master's findings in his Fourth Report was made for use in the preliminary update.

A review of the first draft of the Special Master's Fourth Report, which was received in August, was conducted and changes that would be required to the H-I Model and additional data requirements were determined. Planning was started for projects that will be required to obtain additional data to be used in the H-I Model. These include construction of large lysimeters at the CSU Agricultural Experiment Station at Rocky Ford, CO, construction of weather stations to be added in the Arkansas Valley to the state-wide CoAgMet network operated by the Colorado Climate Center, and the conduct of studies of the impact of salinity and irrigation management practices in the Arkansas Valley.

- Review of the Special Master's Fourth Report was started after it was received in November. A budget request was initiated for the projects that will be required to obtain

additional data and to provide for review of changes made by DWR to the H-I Model. Planning was started for the construction of the large lysimeters at Rocky Ford. Changes were made to the H-I Model based on the Special Master's findings and an updated run was performed to determine the performance of the model for 2000, 2001, and 2002. Input data collection was started to enable running the H-I Model for 2003. The budget request to support the projects discussed above was approved by the Colorado Water Conservation Board on March 16, 2004 using \$750,000 from the CWCB Litigation Fund.

- A plan was prepared for the conduct of studies and preparation of reports to be provided to Kansas during 2004 and 2005 to summarize the implementation of the findings in the Special Master's Fourth Report.

### **Republican River Compact Litigation Support**

During 2003, the Modeling Branch participated in activities to prepare to assume more responsibilities in the running of the model used to support the settlement agreement in *Kansas v Nebraska* and Colorado concerning the Republican River Compact.

## ***Rio Grande Decision Support System***

In 2003, the Rio Grande Decision Support System (RGDSS) entered into the fifth and final development phase. Future activities are expected to occur within the Modeling Branch as the project moves into the maintenance phase. Major accomplishments in 2003 by the Modeling Branch in coordination with the CWCB and RGDSS consultants included Surface Water and Ground Water Model development and Peer Review enhancements.

### **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. 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 of meadow and alfalfa lands. New programming required to simulate flowing wells, evapotranspiration by native species and subirrigation by irrigated meadowlands were adopted by the USGS as Modflow 2000 enhancements (USGS Open File Report 00-466). Additional coordination with the USGS is anticipated for 2004 that will allow them to adopt State enhancements to Modflow's Stream Package.

The Modeling Branch worked vigorously to complete development and calibration of the RGDSS ground water models. Documentation and refinements are expected to continue into 2004 as part of the Decision Support System (DSS) maintenance.

Also, the Modeling Branch has started transition of the RGDSS ground water model to an administrative tool required to develop rules and regulations for new well development from the confined aquifer in Division 3. It is anticipated that this administrative tool will be used in the promulgation of Rules and Regulations for new wells located in the confined aquifer in the Valley scheduled to be in place on July 1, 2004.

## **RGDSS Surface Water Model Development**

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.

The Phase 3 RGDSS Surface Water model was completed in 2003. Refinements to the ground water return component are expected to continue in 2004 after the ground water model development is completed.

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

In 2003, the South Platte Decision Support System (SPDSS) moved into the first of six phases of implementation. The Modeling Branch worked with the CWCB to allow the SPDSS development to begin with a data collection phases in 2003 and 2004. Modeling branch personnel are providing technical review of all SPDSS deliverables and will be intimately involved in the surface water, ground water, and consumptive use modeling portions of this six year, 11 million dollar project.

## ***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

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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 2003.

## *By the Numbers*

The following is a statistical summary of the branch activities.

- Well construction variance requests reviewed 190
- Geophysical logs evaluated 185
- Geophysical log waivers reviewed 95
- Mined Land Reclamation plans reviewed 12
- Oil and Gas injection well proposals reviewed 18
- Well permit evaluation consultations 930
- Water levels measured 1,200
- Reports written 11
- Phone contacts and evaluations 900

## *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.

- Jefferson County Mountain Ground Water Study - Glenn Graham worked with the county and the USGS on this project. The final report has been submitted to the county with the USGS' recommendations. Glenn continues to participate in discussions regarding acceptance and implementation of the recommendations.
- Coal Bed Methane – Glenn Graham continues to be the branch's lead geologist in questions related to the development of coal bed methane and potential impacts to ground water.
- State Fair – A physical model of the hydrologic cycle and seasonal change was prepared for the state fair exhibit. Chuck Roberts continues to maintain the model and ensure that it operates properly. He spent many hours working on the project in addition to his regular work.



- Additional 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.
- The entire staff provided technical support to the well permitting staff.

### ***Denver Basin***

- Denver Basin – The Geotechnical Services Section, and Glenn Graham in particular, remain involved with the Museum of Nature and Science concerning the depositional history of the Denver Basin and its relationship to the bedrock aquifers. Much of the recent interest in the basin has been generated since drilling of the Kiowa core hole and testing of the core. We have been working with Bob Raynolds and assisting in his quest to map sand lobes that extend into the basin. This will enhance our understanding of the sands, particularly in the Arapahoe aquifer.
- The Geotechnical Services Branch is monitoring, and will be providing geophysical and water level information for, several modeling efforts proposed for the Denver Basin. Glenn Graham and Dave McElhaney have attended scoping meetings for coordination of modeling efforts with the USGS, Museum of Nature and Science, and the participants in the South Platte DSS effort.

### ***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. Chuck is involved in the on-going training of personnel in the use of GPS.
- Well Permitting and Subdivision Review Assistance - work continues on a daily basis with these activities. The Geotechnical Services Branch routinely assists the permitting staff by reviewing the geology along the margins of the Denver Basin to determine aquifer boundaries.
- Chuck Roberts has prepared Michael Schaub and Heidi Frey for teaching the class for Well Tester Certification. The class was taught under Chuck's supervision in 2003.
- Glenn Graham continues to be the Division representative to the Colorado Ground Water Protection Council.

## *Board of Examiners*

- Complaint Investigations for Rules Enforcement - Dave McElhaney has spent most of his time receiving complaints and performing investigations to resolve complaints before the Board.
- Variances – Approximately 190 requests for variance from the well construction rules were processed during the year.
- Dave McElhaney helped in formulating proposed revisions of Article 91 of Title 37 which were included in Senate Bill-45. Among other changes to the statutes, the bill directs that a well inspection program be implemented and provides for funding the program.

## *Special Note*

George VanSlyke retired at the end of December 2003 after serving the Division of Water Resources for 30 years. In 1973, George began work as a geologist in the Division's Engineering Section working on subdivision reviews. In 1980, the Geotechnical Services Branch was formed, under George's supervision, and combined all of the geological functions within the Division. We will miss George's geologic and hydrogeologic expertise, particularly in the Denver Basin. We wish him the very best in his retirement.

# 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.

The Annual Training Meeting was held in Frisco in late September. Training sessions included AquaCalc Meter use training, Parshall Flume information, and equipment information from manufacturers Sutron and Design Analysis. Safety training this year included a presentation by the Colorado State Patrol regarding driving safely and avoiding road hazards. 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 continued to upgrade DWR and USGS gaging sites with monetary assistance from CWCB to 'flood harden' areas that may have likely been damaged and unable to report stage during a flood event. Part of this work also included extending rating curves at 17 gaging sites. In cooperation with CWCB, we launched an Alert, or notification system to notify key staff in the event of low flows, high flow, or rate of change of stage.

## *Operations*

Assistant Division Engineer, Bill Tyner, PE II, provided overall program leadership of the Division 2 Hydrographic Program WY2003. He was 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 oversight responsibilities for hydrographic streamflow record preparation in Division 5 during the water year, and provided overall coordination of the records preparation and review schedule for DWR.

Each of the Division Two hydrographers continued their assigned work with specific gaging stations and geographic areas. Routine work includes responsibility for regular streamflow measurements, gaging station operation and maintenance, satellite monitoring equipment operation and maintenance and the complete development and computation of streamflow

records for specific gaging stations. Additionally, hydrographers respond to requests of water commissioners for water measurement assistance in their respective districts.

Currently the State operates 12 active stream gage sites in the Yampa, White, and North Platte River basins. Of the twelve operated by Division Six, eight of them are equipped with satellite monitoring. Of these eight, two of them transmit reservoir water surface elevation, four transmit stream flow gage height, and two transmits both parameters. Of the remaining four, Bear Lake, Morrison Creek near Fly Ranch below Silver Creek, and Pot Creek at Stateline, are equipped with a paper recorder; and Walton Creek is equipped with a paper recorder as well as a data collection platform (DCP) to record gage heights.

The Pearl Lake gage station (PEARLACO), which records reservoir storage elevation only, experienced equipment problems throughout the entire record period. Both replacement of the AccuBar and installation of a new nitrogen tank were completed with hopes of remedying the problem but with no success. More work will be done in the spring of 2004 with hopes of remedying the problem.

### ***New Stations/Rehabilitations/Modifications***

Along with the flood hardening projects, we must also continue to refurbish and maintain our existing gaging sites that are not designated as critical flood sites, but are extremely important for our primary purpose of Water Administration. The CWCB in 2003 granted us \$55,000.00 for this purpose, along with General Fund Appropriations necessary to carry out this work. These dollars were used to allow us to do channel work at our Stateline Station near Julesburg in Division One, as well as several locations in Division Two, Cottonwood Creek near Buena Vista, Purgatorie River at Ninemile, Arkansas River at La Junta. Division Three had work done at Carnero Creek near La Garita, Rio Grande River at Thirtymile Bridge, Terrace Reservoir, Big Spring Creek at Medano Ranch, along with a few projects still pending. Division Four had refurbishment done at Vouga Reservoir, Roubideau/Cummings Gulch, and Razor Creek. Division Six finished a site at Lake Catamount. Here again we continue working when we can to maintain and refurbish stations as necessary.

Division Two refurbished the concrete control at the Lake Fork Creek below Sugarloaf Dam gage by adding a 6-inch thick concrete apron (5 ft x 38 ft) on the upstream side of the control with a 1 ft x 1 ft x 38 ft monolith key way poured at the upstream end of the apron. They also added a new coat of paint to several stream gage shelters.

Division Three replaced the cableway at the Rio Grande at Wagon Wheel Gap gage this year. The previous cableway, constructed by the USGS approximately 10 years ago, did not meet our criteria for safety and had been condemned. Nearly the entire cableway, with the

exception of the mass anchors, was replaced, making cabling at this site much safer. The left mass anchor at our Rio Grande at 30-Mile Bridge cableway was also replaced this year. This mass anchor had been buried by improvements made to the nearby county road, and it was impossible to determine the condition of the anchor and associated hardware. A construction company was hired to dig up the old anchor and construct a new, much larger mass anchor that will dramatically improve safety.

An additional cableway was also rehabilitated this year. This cableway was located at our Saguache Creek near Saguache gage. The existing cableway was in need of significant repairs, but instead of repairing the old cableway, a new bank operated cableway was installed. Although we have several bank-operated cableways in use in Division 3, this cableway, a 'Tacoma' bank operated cableway system, was the first of its kind that we had installed. It appears to be a very good system and we are looking to install several others in the next few years.

The concrete control at Carnero Creek near La Garita was also rehabilitated this year. The concrete weir had developed some small cracks in it over the last several years. During the very low flow periods this year, the entire flow of the stream was simply running through these small cracks, causing the gage to be isolated from the stream. Repair was made to the entire control. This repair should allow the control to operate properly for many years to come.

Division Four worked with the private Overland Ditch Company to install and operate their privately purchased Sutron 8210 DCP. DWR charged the ditch company \$1,200 for the installation the first year and will be charging \$100 per month after that. Division Four hydro staff completed these field installations and supported the operation using their operating budget.

We encouraged the BOR to replace the sensor at Taylor Park Reservoir. Our Division Four staff with the help of our electronic support staff from Division Three installed the new SDI-12 unit. We cooperated with the Uncompahgre Valley Water Users Association in setting and calibrating the sensor with four water surface surveys. The new sensor was installed on May 22, 2003.

A new concrete ramp flume is done at Roubideau. The inlets have been repaired and replaced, and the A 35 strip chart recorder has been refurbished. The site is on line and transmitting using an 8200 DCP and a used antenna mast from the project at Surface Creek nr. Cedaredge. The final survey and theoretical rating will be received soon and we are in the process of confirming these with actual measurements.

A new concrete ramp flume is also done at Muddy Creek below Paonia Reservoir. All the invoices have been received. The electronic equipment supplied from the US Bureau of Reclamation was installed, and a new Satlink Logger and a new SDI-12 shaft encoder are in

place, but not transmitting due to a communication error. We are in the process of confirming the theoretical rating with measurements.

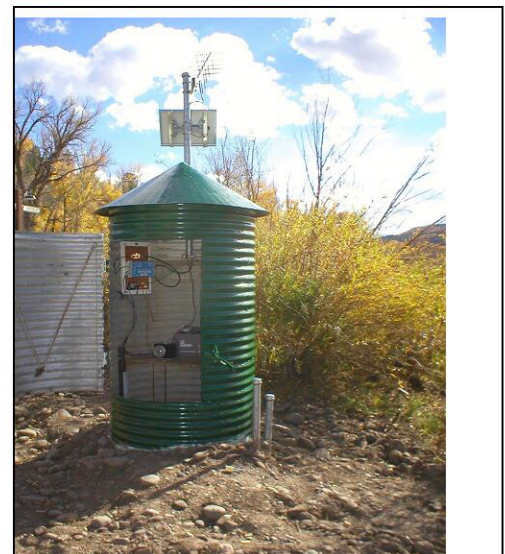
Another concrete ramp flume has been completed at Surface Creek near Cedaredge. The new shelter has been installed and conduit has been buried for the orifice tubing. The new material for the antenna mast or the new DCP (8210) and Accubar have not been installed. We still need nitrogen bottles and various connecting hoses and fittings.

The Surface Creek at Cedaredge gage is scheduled to get a new/retro fitted 8210 DCP freed up from the Muddy Creek below Paonia project. This is the best, most efficient use of this equipment because it can act in concert with the flood hardening project seven miles upstream.

The old shelter donated by the USGS from Surface Creek near Cedaredge has been installed with a refurbished A 35 Strip Chart Recorder at Cummings Gulch near Delta. We are in the process of developing a rating by making discharge measurements.

Vouga Reservoir/Razor Creek is actually two new stations. Vouga Reservoir elevation and outflow is the first station. We have fabricated and installed a shelter at the outflow on an existing 9X4 ft rectangular cutthroat flume. We have trenched and buried about 300 ft. of schedule 80 3/4 inch conduit between the valve house on the crest of the dam and the outflow structure. We have the data cable and material for the antenna mast, the new SDI-12 shaft encoder, and the Accububble for the elevation on the dam. We still need to pull the data cable through the conduit and construct plywood shelves for the structure. We have purchased the plywood and most of the pipe and fittings, and we still need the Satlink Logger and shaft encoder float. The inflow on Razor Creek has had a shelter fabricated and installed at an existing 8 FPF. We have trenched and buried about 100 ft. of 3/4-inch schedule 80 conduit for data cable to connect the Tommy Ditch, and the shelter for the shaft encoder on the Tommy ditch has been fabricated and installed. We have two SDI-12 shaft encoders for these two stilling wells. We still need to put the wood shelves in the two structures and pull the data cable between them. The antenna mast needs to be assembled and installed, and the grounding plates and electronic components still need to be installed. We also still need a Satlink Logger and two shaft encoder floats for the second station.

Division Five improved a few gages. First, a new water administration satellite monitoring station was installed at a parshall flume for a trans-

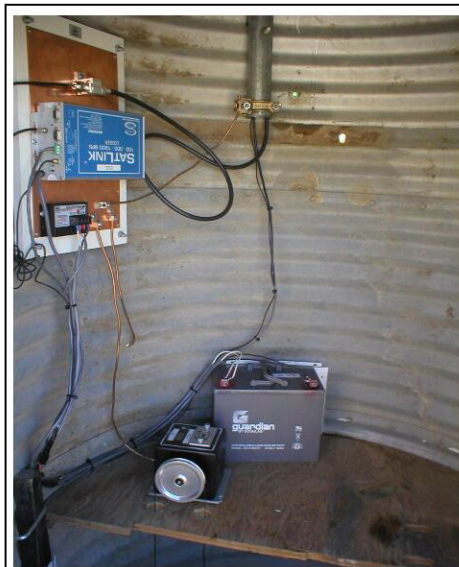


Shelter/Stilling well for new gage on the Yampa River above Lake Catamount

District ditch which diverts water from District 38 and transports to District 45. Permanent NEMA boxes and masts were installed at two water administration satellite monitoring stations in order to facilitate faster setups for the brief diversion seasons at these stations, and trees in the vicinity of the cableway at the Roaring Fork River below Maroon Creek station were removed as recommended by an inspection maintenance item.

Planning was completed for a new gaging station on the Government Highline Canal in District 72, necessitated by the installation of a fish screen in the canal. When constructed by the spring of 2004, it will be operated in tandem with the old station for WY2004 in order to confirm the rating at the new station. We also coordinated with multiple agencies in the planning of an electric power installation to the Blue River at the Highway 9 Bridge gaging station.

In the summer of 2003, a water commissioner in Division Six discovered an old gage site on Morrison Creek consisting of a shelter and stilling well with a paper recorder in it that appeared to have not been used for years. After some investigation, the owner/operator of the gage could not be determined. DWR set the paper recorder to start recording in the middle of July. Because an operating gage station at this site could prove very beneficial, the DWR hopes to start maintaining this gage. Needed at this site to begin full operation is the installation of a staff gage or setting of a reference point for use with a drop down tape so that a gage height can be determined; and the development of a rating table once several measurements are made.



Equipment Installed at new gage on Yampa River above Lake Catamount

Division Six installed a new gage station in late September and early October of 2003. The gage station is located on the Yampa River just upstream of Lake Catamount (YAMABVCO) at the Routt County Road bridge 18C. Thanks to the cooperation, support, and assistance of Catamount Development Inc., the gage station was successfully installed. The gage consists of a Sutron shaft encoder Model SE8500 connected to a high data rate Sutron SatLink Logger with satellite telemetry housed in a 42-inch diameter stilling well. This station has already been and will continue to be used by Catamount Development Inc. for reservoir operations and by the DWR for water administration.

Since 1991, the Division of Water Resources has maintained hydrographic records at the Lake Catamount dam. These records have included continuous recording (using a data collection platform) of the lake level and thus the amount of water spilling over the spillway and spot readings of a rated staff gage near the outlet of the reservoir. In the summer of 2003, another parameter

was added to the data collection platform (DCP) record that allowed an observer of the outlet staff to manually enter the outlet staff gage reading into the DCP. This allows those using our transmitted data

to not only see the lake level and the amount of flow spilling, but also, the total flow in the Yampa River below Lake Catamount (spillway plus outlet).

## *High Data Rate*

We are continuing our High Data Rate upgrading this year, with CWCB once again contributing \$248,000.00 toward this end. Included in this value was the purchase of twenty AquaCalc electronic measurement recording devices along with 20 magnetic head pygmy meters, to enhance and speed up stream flow measurements. When fully utilized, this new equipment will help our hydro section do their jobs more quickly and efficiently.



High Data Rate Installation at Smith Ranch

Sixteen gaging stations in Division Two were upgraded with SatLink DCPs and 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 at fourteen of these sites required installation of SDI shaft encoders and upgraded grounding equipment. SatLink DCPs were installed at two sites to replace SDI Radio Bridges which have proven to have operational reliability issues.



High Data Rate Installation at Michigan Ditch

Thirteen stations were fitted with high data rate DCP's this year in Division Three. Eleven of those stations originally had regular DCP's and were upgraded to high data rate. The other two stations did not previously have any type of DCP. Since eleven other stations were upgraded to HDR DCPs last year, Division Three is approaching the halfway mark for all of their stations to be upgraded. These HDR DCPs transmit every hour instead of the traditional rate of every four hours, which enhances our ability to make real-time decisions about water management.

Three gaging stations in Division Five were upgraded with SatLink DCP's and high data rate GOES radio transmitters, and Division Six has two

gaging stations equipped with High Data Rate (HDR) equipment with no plans for additional upgrades to HDR.



## *Flood Hardening*

Our Flood Hardening projects continue to be one of our top priorities. The CWCB gave us an additional \$100,000.00 this year for the continuation of this extremely important phase of our overall mission. We either finished or are working on several projects in Division Four. These include the installation of two new ramp flumes, one each at Surface Creek near Cedaredge and Muddy Creek below Paonia Reservoir. Also, equipment has been upgraded in cooperation with USGS at 3 locations on the Colorado River. They are Colorado River near Dotsero, Colorado River Near Cameo, and Colorado River near Grand Junction. St. Vrain Creek at Lyons was also finished this year in our Division 1, Greeley Office. A new building was installed on the Rio Grande at Trinchera location out of our Alamosa, Division Three Office. There was a continuation of upgrading of gaging sites at the Hayman Burn Site, in Douglas County, and we have several ongoing project sites that we hope to have finished in the next few months.

Division Two completed installation of flood hardening equipment and facilities at five gages: The Arkansas River near Wellsville, and the Purgatoire River below Highland Dam near Las Animas, a flood block and new orifice lines were installed. At the Arkansas River near Rocky Ford, a flood block, new orifice lines, and a new wire weight gage were installed. At the Arkansas River at Nepesta Bridge near Nepesta, installation and armoring of new conduit and orifice lines to a high water orifice located in flood block below shelter was completed. They also installed a new gaging station for flood warning and monitoring, at Raton Creek above Starkville

One of the larger Division Three construction projects undertaken this year was the replacement of our Rio Grande above the mouth of Trinchera Creek gaging station. This station was replaced due to the extreme deterioration of the old wooden shelter and well, and the fact that the gage was very near to the river. There was a concern that the gage may be washed away in very high flow conditions. As a replacement, an exposed aggregate shelter and concrete well were installed. The new gage was also placed at a higher elevation and farther from the river to minimize flood damage potential.

DWR had two contracts for extending rating curves at locations where the curve did not exist for high flows. A rating curve contract with E&H, Inc. developed and/or extended ratings for high flows at the new Raton Creek above Starkville gage, the Cucharas River at Harrison Bridge near La Veta gage, and the Arkansas River below Catlin Dam near Fowler gage. The extended ratings have been reviewed and implemented. The USGS, with cooperation from DWR employees, was contracted to extend ratings on twelve other gage sites. The final ratings have not yet been released.

## *Alert*

In cooperation with CWCB, DWR has set up an Alert notification program that provides automated alerting by email, phone (pager or fax) of specific individuals when threshold

high and/or low stage conditions or threshold rate of change conditions occur at a stream or reservoir gage. The DCPs at each of the alert system gages were programmed in the field for the specific alert thresholds desired. We are looking into the feasibility of adding USGS gages to the system in the future. We currently have 59 Alerts in our system; 45 upper limit alarms, 8 lower limit alarms, and 6 rising rate alarms.

## *Measuring/Records*

The DWR published 214 sites in our annual Streamflow publication this year. In Division Two, the hydrographic staff completed 43 streamflow records, and made 592 discharge measurements at stream gages and 121 discharge measurements on canals and diversion structures. Seven of these streamflow records are also published by the US Geological Survey in their Annual Water Resources for Colorado Data Report. The Division Three hydrographers measured and/or developed meter notes for stream and ditch measurements over 1,090 times. These measurements were used to develop fifty-eight yearly records of flow, which were published in the annual publication. In addition, several stations were operated as administrative stations with their flow records not being published. Division Four made about 50 administrative measurements in the Grand Mesa and North Fork areas, with five of these on a trans district diversion. Division Five made 68 river discharge measurements (including 41 measurements for the Fry-Ark Project) and 14 ditch/canal discharge measurements in WY2003. Ten streamflow records for WY2003 were completed for publication in the annual report, including 8 records for streamflow stations in the Fry-Ark Project.

The Gunnison River below Redlands Diversion was seen to have a historic low flow on April 10, 2003. Two measurements were made to confirm about 13 cfs below the Redlands Diversion Dam, which was during a time before the BOR contracted to deliver water below Redlands from the Aspinall Unit, kicked in on June first. Eight measurements were made of the Redlands Canal and the Gunnison River below Redlands Diversion Dam combined during the last week of March and the first two weeks of April to assure that the low water conditions were captured and that an accurate V Shift table was in place during a critical administrative situation.

A new Aqua Calc Pro was acquired in the first part of May in Division Four. They have converted all of their measurements to this new tool. It has proved to be more accurate in that it can be programmed to use the meter formula. It is faster because it can calculate a velocity after 40 seconds. A Price AA meter has been converted to a magnetic head, which reduces resistance of the cat whisker contact and saves time in adjusting the contact. A new HIF rated Pygmy meter has really helped the accuracy of measurements in



AquaCalc Pro

concert with the AquaCalc Pro. The shallow depth and fast velocity of many flumes can be more accurately measured, as the really fast velocities couldn't be counted using a conventional cat's whisker contact. The drought situation and a call by the Gunnison Tunnel meant that we were measuring the South Canal on a much more frequent schedule to account for aquatic growth. We, also, cooperated with the USGS in alternating with their measurements of the Gunnison River below the Gunnison Tunnel in the Black Canyon of the Gunnison River. The hydro section of Div4 also participated in checking USGS published records worked in Div7 for WY2002.

In Division Six, forty-two measurements were taken at gage sites in addition to many other measurements taken in ditches and other streams at the request of water commissioners. Hydrographic records will be published for four of the twelve sites: Walton Creek near Steamboat Springs, Michigan River near Walden, Michigan River near Meadow Creek Reservoir, and Illinois River near Rand.

In water year 2003, Division Six acquired bridge-measuring equipment to facilitate the ability to take high flow measurements. For the first time ever in Division Six, high flow measurements were taken in the Spring of 2003 - two measurements were taken on the Yampa River above Lake Catamount, three measurements were taken on the Michigan River near Meadow Creek Reservoir, and three measurements were taken on the Illinois River near Rand.

Division Six also acquired an AquaCalc in the spring of 2003. Because the AquaCalc has difficulties functioning with flow meters equipped with a cat-whisker, a magnetic head pygmy was also acquired. Both these pieces of equipment have proved to be very beneficial.

The Division 7 hydrographer made 169 river measurements and 22 ditch measurements, and water commissioners in Division 7 made 34 river measurements and 4 ditch measurements. A large number of the hydrographers measurements were made to calibrate the ramp flume constructed on the Florida River above Lemon Reservoir last year. A good definition of the rating curve was obtained. They published six hydrographic records, and met the publication deadline. Three of these were used as diversion records for the Irrigation Year. They worked an additional record that wasn't published or used for diversion records, but had high significance for the Endangered Fish Recovery Program and subsequent contractual obligations of the BOR and significant importance of being below the lowest calling structure on the Gunnison.

## *Miscellaneous*

We are looking at having to upgrade our computers for our hydro branch also, as the new equipment will not work with old laptops. Also, some new bridge measuring equipment needs to be purchased.

Division Two had numerous miscellaneous activities:

- intensive measurement and monitoring of the Fountain Creek at the Mouth stream gage and comparison with Fountain Creek at Pueblo stream gage;
- inspection of two cableways in Division 2 as part of the DWR Hydrographic Program Cableway Safety and Inspection Program;
- inspection and flow measurement checks on several augmentation stations in Water Districts 11, 17 and 67;
- design and implementation of a transit loss estimation study on Trout Creek Ditch in WD 11 involving a total of 33 measurements at ten locations along the Ditch over a two day period;
- inventory and analysis of Arkansas River Basin stream gages in cooperation with the USGS and presentation of results at the 2003 Streamgaging Symposium;
- receipt of and training in the use of AquaCalc stream flow computers and magnetic head Pygmy current meters;
- preparation and delivery of a report describing the results of analyses of 67 historical releases and deliveries of water from John Martin Reservoir to the Colorado-Kansas Stateline, the purpose of which was to evaluate transit losses occurring during delivery of water to Kansas;
- preparation and delivery of a presentation on the DWR satellite monitoring system and hydrographic program to the NOAA GOES user group meeting hosted by CO DWR in June in Frisco;
- led the development of two new standard operating procedures and equipment use policies for DWR Hydrographers regarding the use of AquaCalc Streamflow Computers and magnetic head Pygmy current meters;
- routine coordination of stream and reservoir gaging activities with the USGS Pueblo Subdistrict office, the US Bureau of Reclamation, and the US Army Corps of Engineers and other State and federal agencies during WY2003.

For the second year in a row, Division 3 experienced severe low flow conditions in most of its rivers and streams. Although not as dry as 2002, this year was again a struggle to ensure that our stations collected reliable low flow data. Ironically, we also experienced floods at a few locations because of indirect effects of the drought. The very dry conditions last year led to a major forest fire in the area above our South Fork of the Rio Grande gage. The loss of vegetation in this area, combined with hydrophobic soils created by the intense heat, in turn led to several flash floods on the South Fork and the mainstem of the Rio Grande below the confluence.

Division Four cooperated with and helped the USBR install a new Accububble at the Gunnison River below Redlands Diversion Dam on February 21, 2002. This was the result

of a good working relationship with the local Grand Junction Projects Office and the fact that we encouraged them to purchase the unit.

We cooperated with the Gunnison River Transit Loss Study conducted by the USGS and funded by the USBR, CWCB, Fish and Wildlife Service.

We cooperated in a transit loss study of the Ruby Anthracite and North Fork of the Gunnison conducted by Wright Water Engineers. This was to establish values for augmentation water released from Lost Lake Slough. The increased coal mining activity on the North Fork precipitated the need for better accounting of the needed augmentation water. Division Four hydro staff check measured the USGS gage, the North Fork of the Gunnison near Somerset during two days of the study. We also check measured the Parshall flume below Lost Lake Slough on the first day of the study.

DWR participated in the Children's Water Festival conducted by Montrose School District for fourth graders, and participated in the Montrose County Useful Community Service program. Eight people worked 355 hours from November 22, 2002 to January 14, 2004 which allowed needed maintenance at gages to be performed. Five gages were brought up to standards for grounding utilizing this program.

During the low water of the summer of 2002 the reach below Dallas Creek near Ridgway and Ridgway Reservoir was searched for a shelter that washed away in 1999. The local landowners were contacted and asked to keep an eye out, and this season we were contacted about a possible lead. This was investigated and turned out to be the missing shelter. It was barely visible and wedged under an under cut bank. The Colorado State Park Service administers the area about 0.96 miles below the gage site, so they were going to help excavate it with one of their rubber-tired tractors. This has not happened even after several follow up inquires. We will not be sure if the Sutron 8200 DCP is inside till we can get into the inside

In addition to maintaining the gage sites, Division Six made many field trips with water commissioners to conduct flow measurements on ditches, reservoir releases, and streams. On the horizon, the Division Six hydrographic program foresees the potential of re-establishing a gage station on the Williams Fork River of the Yampa River once operated and maintained by the USGS and on Service Creek of the Yampa River also once operated and maintained by the USGS. The potential need for these is the result of the Fish and Wildlife Service Endangered Species Program on the Yampa River and the recently applied for recreational in-channel diversion by the City of Steamboat Springs, respectively.

As a result of the satellite monitoring system a high water measurement was made on September 9, 2003 at the La Plata River at the Colorado/New Mexico Stateline. The 1200 cfs measurement was the highest measurement since July 25, 1977.

## ***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 funds for refurbishment and repair of existing dcp’s, and for upgrading to high data rate equipment. CWCB also provided funds for flood hardening work

## ***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. Until near the end of the fiscal year, there was 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.

Entry of data from well construction reports, pump installation reports, and well abandonment reports required by the Board is currently being accomplished by Jessie Dunbar who also shares his time supporting the permitting section. Data entry of well construction, pump installation, and well abandonment information is being kept fairly 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 proposed revisions to Article 91. Implementation of the enacted revisions is explained in more detail below. 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.

A revision of Article 91 of Title 37 occupied a substantial amount of staff time and effort during the 2003 legislative session. Although the Board and its support staff had been contemplating revisions to the article for several months before the legislative session began, the effort was accelerated by the introduction of Senate Bill 03-045 (SB-45) in response to a well construction situation in the San Luis Valley. The Board's support staff worked diligently to ensure that proposed changes in the article would compliment and assist the Board in its efforts to protect the ground water resources of the state and the public





Complied with Order.....	3
Court action (fines and fees).....	5
Letter of admonition/reprimand/fine.....	10
Suspension/probation/fine.....	3
Warning letters.....	4

In addition, the staff prepared one bulletin, and processed 193 requests for variance and infiltration gallery plans. The staff reviewed 7638 completion reports, 3958 pump installation reports, 878 abandonment reports, and more than 2000 well owner completion notices.

### ***Licensing***

The Board licensed a total of 332 contractors in 2003, including 6 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 by individual outreach through mailings, CWWCA newsletter articles and examination preparation workshops.

### ***Well Inspection Program***

The *Well Observation Program* reported in years past is being replaced with a *Well Inspection Program* authorized by the legislature in SB-45 and funded by an increase in well permit application fees. Presently, it is envisioned that the program will consist of a Chief Well Inspector headquartered in Denver and up to seven well inspectors distributed throughout the state. The Chief Well Inspector will coordinate the activities of the program and provide additional support to the Board. The primary objective of the program is to assist the Board with the enforcement of its rules and regulations for well construction and pump installation. The personnel of the Well Inspection Program will be a welcome addition to the State Engineer's support staff for the activities of the Board of Examiners.