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History of Ground Water Regulation from a Technical Perspective

Matt Freeman

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status as a headwater state with many binding compacts. Arizona, Colorado, and Washington are the only states in the West without comprehensive water plans. Through an executive order in May 2013 Governor John Hickenlooper directed the CWCB to commence work on the Colorado Water Plan, which Eklund is currently working on.

The CWCB's comprehensive water plan will be a dynamic document amended every two to five years. Eklund stated that the CWCB's goals include addressing the gap between supply and demand, incentivizing quicker regulatory processes for businesses wanting to establish in Colorado, and devising a statewide comprehensive water plan. Eklund also called for the need to formulate alternatives to "buy and dry," which refers to users (typically municipalities) in one location buying water rights from other users (typically farmers) and drying up vast swaths of land completely. Eklund concluded by reminding the audience that Mother Nature and hydrology require that we move quickly.

The E2 conference served as a platform to begin an informed conversation between entities that value a strong economy built on responsible water use and conservation. A predictable and secure water future for the West is in the best interest of the community and the economy, so E2's effort to engage a wide array of participants in the discussion is a step in the right direction.

Emily Dowd

COLORADO BAR ASSOCIATION AND CONTINUING LEGAL EDUCATION IN COLORADO INC. PRESENTS: GROUND WATER REGULATION– HISTORY AND FOCUS ON DIVISION 1, 2, AND 3

Denver, Colorado October 30, 2013

HISTORY OF GROUND WATER REGULATION FROM A TECHNICAL PERSPECTIVE

James Slattery, a professional engineer who serves as Water Engineer for the Republican River Water Conservation District, presented on the topic of the changing ways engineers and hydrologists evaluate the effect of ground water withdrawals on nearby surface streams. Slattery has provided expert testimony for the State of Colorado in two arbitration hearings and is also an engineering representative on a team that is designing a $21 million pipeline system to collect and deliver well field water to the North Fork of the Republican River.

The current techniques for determining the relationship between the amount of pumped water from underground aquifers and the decrease in surface water is the result of more than a century of evolving ground water measuring techniques. In 1856, Henry Darcy, when experimenting with water flow as it traveled through porous mediums, discovered a rule to predict groundwater flow in any situation, later becoming "Darcy's Law." This rule was rudimentary in its practicality because it did not include any unit of time, which made it unruly in application. However, Darcy's Law laid the foundation for future inventions that sought to predict with greater precision the measure-

ment of ground water flow and the effects groundwater pumping would have on surface sources. Darcy's Law was the prevailing measuring technique during the implementation of the majority of Colorado's wells.

Nearly a century later, after analyzing the similarities between water traveling through a porous medium and heat's dispersal through metal, Robert Glover, from Colorado State University, predicted the magnitude of depletion pumping a well had on a nearby river. The test, later known as the Glover Equation, became the standard measuring unit for groundwater extraction on surface water in Colorado and across the U.S. This test proved more applicable than its predecessors despite the need to rely on certain assumptions during any study. These assumptions included: the tapped aquifer is isotropic and homogeneous, the surface stream having no meanders, water table is flat, and the well pumping is consistent.

Upon its creation in 1976, Stream Depletion Factor ("SDF"), an alternative to the Glover Equation, quickly became the industry standard. The approach relies on the premise that, from the time a well is pumping continuously, the affected stream's volume decreases by twenty-eight percent of the pumped volume. However, the SDF technique had many of the same assumptions implicit in the Glover Equation, and it was not until hydrologists recalibrated the equation in 1974, naming it the "Jenkins and Taylor SDF Approach," that a truly reliable technique existed to address recharge and depletion values on streams from ground water pumping. The Jenkins and Taylor SDF Approach incorporated irregular aquifer boundaries and stream meanders into the formula, enabling assessors to realize that drawing ground water has a lagging effect on the surface stream. Steadily pumping a well for a month will create a depletion in the surface water that month, and, if the surface water is not recharged, for many months into the future.

After more than a century of evolving techniques, surveying groundwater has now become digital, in the form of the U.S. Geological Survey MODFLOW code. The 3-dimensional, public-domain software solves the groundwater equation in a finite-difference framework. Hydrologists are able to simulate coupled groundwater and surface water systems with the assurance of peer review processes. There is still debate in the water law community and among hydrologists as to just how accurate and reliable MODFLOW is, given the varied situations to which it is applied. However, with the current technology available, it is impossible to determine with certainty the exact impact on surface waters by ground water wells.

MODFLOW has proven itself to be extremely valuable. With the aid of MODFLOW, hydrologists and engineers working on water rights issues in Colorado, specifically in Districts 1, 2, and 3, are addressing water systems with levels of certainty that would have been impossible before. In District 1, the 2002 droughts forced many senior claimants to seek redress from those with groundwater rights. MODFLOW played an integral role in the subsequent replacement plans in the South Platte River Basin, which also required the cessation of hundreds of wells. In District 2, the court in the landmark case *Kansas v. Colorado* relied heavily on various MODFLOW models to determine that Colorado's groundwater wells were depriving Kansas of state-line flow of the Arkansas River required by compact. In District 3, the Rio Grande

Decision Support System is using MODFLOW along with additional geohydrological data to improve regional knowledge of groundwater impacts on surface water.

Matt Freemann

LEGAL HISTORY OF GROUND WATER REGULATION

Veronica A. Sperling, Esq. of Buchanan and Sperling, P.C. gave a presentation on the Legal History of Ground Water Regulation in Colorado. Although her presentation covered all ground water regulation, Veronica primarily focused on the type of wells that generated most of the legal history- high capacity irrigation wells that pump tributary ground water.

Most high capacity irrigation wells were drilled between 1930 and 1970, when there were few ground water regulations. The irrigation wells pumped large quantities of tributary ground water that would have otherwise ended up in a stream, thus affecting the amount of surface water available to surface water right holders. Conflict between surface water users and groundwater users began as early as the 1950's. Ground water regulation's most pressing legal issue was how to belatedly integrate ground water users with the surface water prior appropriation system.

The first instances of a legislative attempt to reconcile ground water and surface water uses were the 1953 Act and the 1957 Act. The 1953 Act required well drillers to obtain a license, give notice before drilling, and submit well logs after drilling. The 1957 Act repealed the 1953 Act and required the State Engineer to issue permits to drill water wells. The 1957 Act expressly stated that the well permit did not confer a water right, and the legislature obligated the State Engineer to issue all permits, provided all the fees were paid.

Ground water regulation's next evolution came in 1965 with House Bill 1066 and the Colorado Ground Water Management Act. HB 1066 defined the State Engineer's duty to administer tributary ground water within the surface water prior appropriation system. The Ground Water Management Act allowed the State Engineer to deny a ground water well permit for the first time.

The 1965 Act was challenged in *Fellhaur v. People*. The State Engineer tried to curtail ground water use in the Lower Arkansas Valley. The Colorado Supreme Court ruled that the State Engineer violated the Colorado Constitution's due process and equal protection clauses. Furthermore, any ground water curtailment must be supported by reasonable written rules and regulations, reasonably lessen a material injury to a senior surface water rights, and allow wells to operate as long as senior water users were protected. The court also opined the need for "maximum utilization" of Colorado's water resources. Maximum utilization is now integrated into statute and called "optimum utilization." Optimum utilization does not advocate using every available drop of water, as maximum utilization did.

In 1967, partially in response to *Fellhaur v. People*, Colorado passed Senate Bill 407. SB407, among other things, called for ground water studies. The 407 studies concluded that pumping ground water had infringed senior surface water rights. These results, coupled with increasingly depleted surface