DougCoH_20.com

Introduction

Douglas County's water professionals like to carry rocks in their pockets, chunks of the hard sandstones and conglomerates that daily haunt them. On the occasion that somebody asks about the water supply challenges faced by the South Metro suburbs of Denver, these utility managers and policy gurus sigh and produce pieces of the Dawson or Denver or Arapahoe or Laramie Fox-Hills formations to show the inquirer exactly what they're working with. Sometimes they'll even hold up a plastic straw as well. "Draw water from this stone," they say, often with just a glance. "It's what I do every day."

Dam Tower over a slowly filling Rueter-Hess Reservoir in Parker, Colorado. June 2012. (Photo by author.)

The charade is actually quite instructive. For one thing, the subsurface is still a place of mystery to the masses. More people think aquifers are made of underground rivers and streams than you'd believe, a consequence of primary school teachers leaving groundwater out of their water cycle lessons and the still-robust market for water dowsers in the West. Waving rocks around serves as a visual and visceral corrective, a hand-held wake-up to the fact that the Parker Water and Sanitation District, like its neighbors, draws the vast majority of its water supply from betwixt the tiny pore spaces of the hard sedimentary layers that compose the Denver Basin's aquifers – tiny voids that filled with water over millions of years, as ice melted, mountains uplifted, rivers arose, geology happened.

Their rock waving also highlights the resource's indifference. "We are not important to water. It's the other way around," Barbara Kingsolver has written. And she is right. As the water-bearing formations below Douglas County cease to cooperate with municipalities' industrial-grade pumps, and new wells must be sunk to steady the yield, we are reminded that the commons doesn't care about us. We must care about the

commons. Doing so requires thinking differently – another thing that rocks silently encourage. Understanding groundwater requires us to stretch our minds further back than usual, along geologic timescales. Fathoming our use of it requires us to contemplate the distant future just as carefully.

If you are a city on Colorado's Front Range, you hope to be blessed in four ways. You hope that you are located near the mouth of an alpine watershed – Clear Creek Canyon, say, or Boulder Canyon or St. Vrain. You then hope that you're an "old" city, that your founders had the foresight to apply for rights to vast quantities of this mountain front surface water in the mid-to-late nineteenth century, and that your current population is small and stable. No Front Range city enjoys all four of these blessings (if they aren't left wanting on one of the geographic or temporal counts, then they're certainly stymied by the population bit). Douglas County's municipalities have struck out on every single one of them. All they have is groundwater, for the most part – nonrenewable groundwater that is being drained quickly by one of the fastest growing populations in the country.

The public officials that serve Douglas County's water needs are also cursed by the fact that groundwater is not pretty. It does not conjure images of babbling brooks or majestic rivers, though it often contributes much of their volume. It is not something to sink a fly fishing line into, though it is critical to many aquatic habitats. It is not usually the subject of watershed rallies or community cleanup events, though it connects the hydrologic bodies we care about and works as their natural filter. It is rarely the focus of interstate water compacts, until somebody's stream water goes missing. . It isn't literary either; it carries no ready-made narratives of journey and renewal. Most of groundwater's work goes unseen and unappreciated until late in the game, when it is almost gone, or has turned saline, or is polluted or threatened in some way. Then we begin to recognize its import.

One way of understanding groundwater's significance is to pay close attention to the responses generated by the threat of its shortage. In Douglas County, those responses range from the crazy (you want to build a pipeline to where in Wyoming?) to the mysterious (why *is* that big new reservoir empty, anyway?) to the extraordinarily astute (why didn't Aurora Water and Denver Water team up to share infrastructure and pass on the savings sooner?). In the series that follows here, I explore these responses, plus the

many questions that Douglas County raises about Western water and its limits. How do we use science to try to understand limits to water supply? How do we attempt to build or negotiate our way out of those limits? How do we relate to critical resources that are out of sight in the subsurface?

This series originally appeared as a sequence of six blog posts in the fall of 2012. I have endeavored to present it here in a similar format – hyperlinks and all – so as to continue telling these stories using the tools of our time. Creative nonfiction is increasingly Web-based, to the delight of some and the despair of others. The digital form does allow some advantages – the inclusion of lots of pictures, for example, as well as the instant gratification of chasing a citation electronically and the ability to combine six related, but disparate pieces into a whole over the course of four months. In the following pages, you'll find Douglas County hydrogeology explained, hydrographs questioned, and hydrologic balances forecasted, but you'll also meet a diverse cast of characters whose fates are bound up in the data, mine included.

For a title, I have retained only the series' web address, DougCo$H_2$0.com, though I have put the blog to bed temporarily for the sake of anonymity (you'll be free to chase the sources, click the hyperlinks, and see the images in color as soon as the Thompsons are over). As titles go, DougCo$H_2$0.com is modest, unassuming, and mostly meaningless, I realize – a far cry from the declensionism of most water headings, which either inspire fear with words like "dry," "desert," and "disappearing," or stoke resentment with allusions to Cadillacs and other symbols of power and resource politics. (I must admit that I came quite close to playing off Marc Reisner's famous work and calling the series Minivan Prairie, however.) I avoided these tropes so as to allow the articles to speak for themselves individually, uninfluenced by a master dictum, and perhaps so that readers could come up with titles of their own. I look forward to hearing yours.

A Sterling Example

The sod truck was almost cinematic in its timing as it barreled south on I-25, surrendering blades of grass to the turbidity of highway travel as it went. It appeared alongside our busload of water policy conference goers just as the chief of the Douglas County Water Resources Authority, his back to traffic, took to the microphone to praise Castle Rock – our next stop – for being the most water savvy town in the region. As he spoke, the load of lawns moved purposefully in the same direction, eliciting a nervous laugh from several dozen water resources devotees and delivering, with its thirsty green rolls, a reminder of water-strapped Douglas County's current dilemma.

Douglas County
(Image: maps.google.com)

It appeared that the market for new sod was still strong in Douglas County on that day this June, but there are good reasons to wonder whether it will be in the future. The population of this ambitious, but arid county – which sits in between Denver and Colorado Springs along the increasingly metropolitan Front Range – has shot up so quickly over the past two decades that onlookers and residents alike wonder whether it has enough water to sustain more development. Some ask if the county has enough water to reliably supply the suburban enclaves already built.

Douglas County's zealous rise earned it the title of fastest growing county in the nation from 1990-2000, when it gained 115,000 people, many of them drawn to the southeastern suburbs from near and far by Denver-based tech jobs and a strong school district. The county lost its national growth ranking in the past decade, but only because other counties managed to grow even faster. From 2000-2010, its population grew by another 110,000 (a change of 62%). All told, the supermajority of its current 285,000 residents arrived sometime in the past 20 years. Collectively, they had the eighth highest county-ranked median income in the nation in 2008.

The young county relies almost entirely on groundwater from Denver Basin aquifers for its water supply, and its residents have drawn so heavily on the resource that hydrogeologists are increasingly worried about its future. State officials project sizeable

water shortages in the area by 2050, and regional water providers are moving to build a new reservoir and acquire surface water rights wherever possible. The county's inveterate pro-growth bent persists, however – at least it did until last month, when a district court judge abruptly deposited county officials at a crossroads they had long been nearing.

A Ranch By Any Other Name

Harold Smethills had hoped to break ground on his 12,000-unit mixed-use development in the Chatfield Basin in northwest Douglas County by now. Smethills and his partners – wife, Diane, and brother-in-law, Jack Hoagland – spent the last ten years drawing up a plan for the 2,400 acres they own in the still-quite-pastoral stretch of valley nestled against the foothills south of Chatfield Reservoir. The team envisions condos, acreage properties, and patio homes built according to a village concept that prizes density in order to maximize open space. The $4.3 billion endeavor would provide housing for so many people – 31,000 by 2026 – that Smethills and his partners are also planning for five elementary schools, a middle school, and a high school, among other public facilities. They call the place Sterling Ranch.

Sterling Ranch Team (Photo: Denver Business Journal.com)

Sterling Ranch was heading toward a 2012 launch until last August, when Douglas County District Court Judge Paul King halted the outsize new residential development because of its undersized water rights portfolio. In so doing, King put teeth on a 2008 state law that came to terms with Colorado's headlong growth and ever-present aridity by attempting to integrate land use and water use planning. The law requires that county commissioners reject zoning applications for subdivisions unless the developer can "definitely" prove that they can provide a sufficient water supply for the subdivision "in terms of quantity, dependability, and quality" (C.R.S. §30-28-133). It was drafted, at least in part, to grapple with the reality that developers in areas like Douglas County were coming to planners and county commissioners with groundwater permits that

looked good on paper but didn't truly guarantee a dependable and clean water supply over the long term.

It's a good thing, then, that Smethills is no stranger to drumming up scarce Colorado surface water supplies: he spent much of his career handling water negotiations for Coors Brewing Co. But he doesn't have the roughly 9,000 acre-feet, or 29 billion gallons, that 12,000 homes would need in Sterling Ranch. He has 230 acre-feet from the South Platte River, which is enough for the first phase of construction, plus plans to secure more as the project unfolds, and a progressive philosophy on water conservation built on the belief that Douglas County residents can get by with about half as much water as they currently use. He likes to argue that developers can be more accurate and frugal in their water planning if they do it in phases rather than making an enormous upfront capital investment in water rights. He wants this to be enough.

It was enough for the Douglas County Board of County Commissioners. After months of hearings and deliberation, the board decided in 2011 that Sterling Ranch's water plan was satisfactory – at least for now – and voted unanimously to approve Smethills' zoning application. In doing so, they granted Smethills' appeals that the county reduce its per-house water minimum to 0.4 acre-feet per year from 0.75 acre-feet per year and allow Sterling Ranch to bring its proof of sufficient water rights to the county in phases. The commissioners asked Sterling Ranch to provide its water plans at every stage of plat filing, and to guarantee that the new community wouldn't overdraw Denver Basin groundwater and impinge upon its existing neighbors' groundwater use.

Appeals by Sterling Ranch's neighbors – one-to-five acre ranchette owners who don't want a densely populated mixed-use development in their midst – brought the county commissioners' decision to district court almost immediately. Their challenge focused on the county's water decisions. In the words of on Chatfield area resident, the county commissioners had simply dismissed their own rules, deciding that "many of the zoning regulations they are bound to follow don't need to be followed." But Douglas County's Board of Commissioners believed their decision fell well within the zone of legality. The difference between the county and some of its residents hung not on *if* a developer should have to prove their water supply, but *when*.

King erred on the safe side of the 2008 land and water use law when he ruled against the county in August of 2012. In doing so, he immediately stoked grumbling by real estate interests and state legislators that the law could be and should be changed. Douglas County appealed the court's decision right away, arguing that King's reading of the law limits the county's ability to make its own long-term development decisions. The *Denver Post* highlighted the irony that water concerns had stymied one of "the most water-conscious developments ever planned in Colorado – one intended to sip, rather than guzzle." Sterling ranch was being "punished for foresight," according to the newspaper's opinion editors.

The Would-be Sterling Ranch
(Photo: DenverPost.com)

Smethills and his team say they are determined to move forward with their plans, one way or another. Sterling Ranch recently shored up another few hundred acre-feet of water in transfer deals with neighboring suburbs, and Smethills asked the court to reconsider its decision in September. The developers say they will also keep up their efforts to develop water-wise landscaping techniques at their test garden in Roxborough, and that they'll keep experimenting with the state-supported rainwater-harvesting project they are piloting there.

Douglas County at a Crossroads?

At it stands, the fate of Sterling Ranch, the 2008 land use law, and the region's development decisions hang in the balance of the judicial appeals process, which may ultimately decide whether Douglas County has actually reached a crossroads or not – and, if it has, which direction it will proceed. Sterling Ranch has presented Douglas County with a more clearly defined intersection of land and water use claims than perhaps any development before it, one that will force the county to grapple with a question that has long stymied water policy scholars: whether a limited water supply can actually put the breaks on development in the West. Some argue that it does; others claim that it doesn't. Sterling Ranch puts us squarely into the territory of wondering whether the answer is quite so simple.

The Plight of Pumping

Douglas County is operating on borrowed time. Each year, it joins its Front Range neighbors in draining an estimated 350,000 acre-feet of nonrenewable water from the major aquifers of the Denver Basin, steadily depleting a groundwater supply deposited over millions of years. Recent studies suggest that the current rate of pumping will cease to be sustainable within the next half century, putting Douglas County in a particularly precarious position, since it relies on Denver Basin subsurface storage for nearly three-quarters of its water supply.

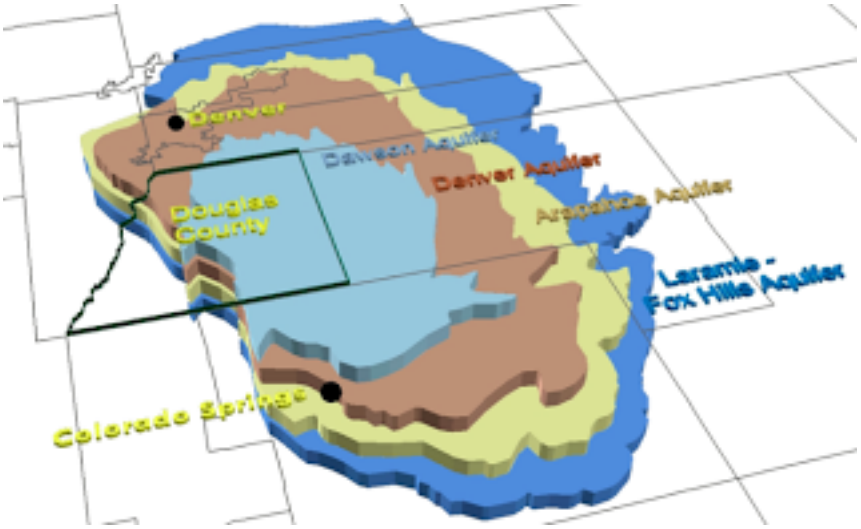


Image courtesy of Douglas County 2030 Master Plan
http://www.douglas.co.us/CMP2030/Water.html

Exactly how long Douglas County has been in the time-borrowing business depends on when you start your clock on the Denver Basin. If you keep time on geologic scales, then the clock started ticking roughly 70 million years ago, when the Western Interior Seaway retreated to the east and left the Basin's basement aquifer – the Fox Hills Sandstone – behind it. If you operate on a more human scale, then a stopwatch has been running on the Denver Basin since 1884, when residents of Denver successfully sunk their first artesian well. If you operate by legislated timescales, then the Denver Basin has been in countdown mode since 1973, when the state of Colorado started a 100-year clock on the resource with the adoption of Senate Bill 213.

The 1973 law sought to protect the Denver Bain groundwater supply from the Front Range's rocketing postwar population, but only for the medium-term. It set up a pumping regime that allowed landowners to extract 1% of the available volume of groundwater beneath them per year. State lawmakers accepted that artesian pressures would fall and that aquifer storage would be depleted over time, setting the Front Range out on the course it is on today – with Douglas County perhaps its most committed member. By the best guess of the time period, the water would last for a century. That was 40 years ago.

Official Time

Exactly how much time Douglas County has before its groundwater debts come due depends, at least in part, on our scientific understanding of a complicated subsurface system. The Denver Basin's future also hangs upon how seriously we take that scientific understanding, and whether we're capable of thinking in longer units of time than the annual hydrograph. Groundwater systems challenge us to think further into the past and the future than we're accustomed to, and the Denver Basin is no exception.

Stretching roughly 7,000 square miles along Colorado's Front Range – from Greeley to Colorado Springs on its north-south axis, and from the foothills to Limon on its east-to-west axis – the Denver Basin is made up of multiple aquifers stacked one on top of the next, each with its own characteristics. The Laramie-Fox Hills aquifer is the oldest and deepest of the Denver Basin aquifers, which is why it's known regionally as the aquifer of last resort for well drillers. A total of 490 high-capacity wells currently withdraw 52,000 acre-feet per year of water from the Laramie-Fox Hills. Most Front Range wells draw from the Laramie Fox-Hills's younger siblings, all of which owe their origins to wild rivers that ran off the ancestral Rocky Mountains as they uplifted. The sediment and debris that tumbled off the mountain front laid, in sequence, the Arapahoe, Denver, and Dawson formations.

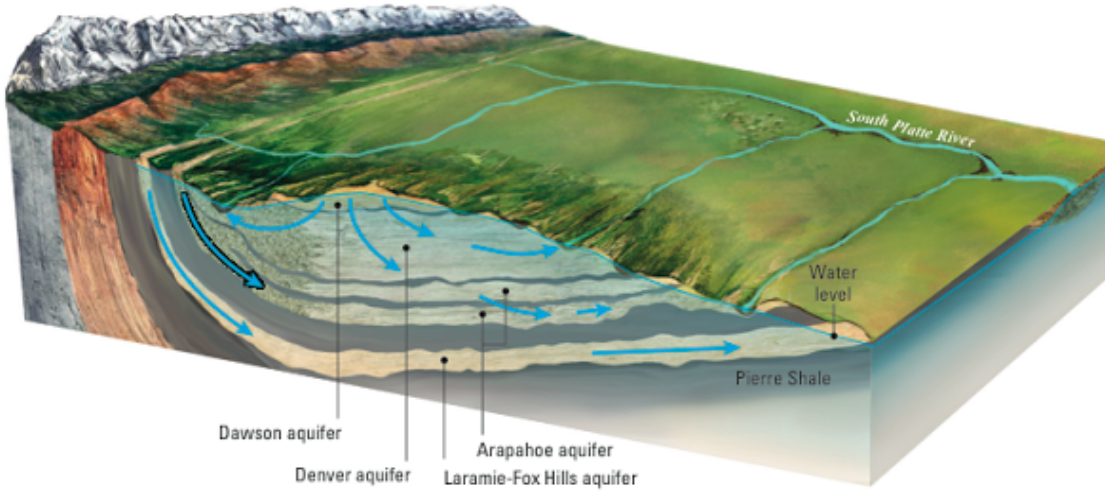


Figure A2. Conceptual block diagram of the Denver Basin aquifer system for predevelopment conditions.

Image courtesy of USGS Professional Paper 1771

http://pubs.usgs.gov/pp/1770/

The Arapahoe Formation is the oldest of the three layers and holds the most gravel from the Rockies' early uplift, making it the most productive aquifer of the system. Front Range cities rely heavily on the 800 gallon-per-minute (gpm) flows of deep municipal wells sunk into the Arapahoe. More than 1,000 high-capacity wells withdraw 170,000 acre-feet per year from the Arapahoe formation along the I-25 corridor. The Denver and Dawson formations overlie the Arapahoe, making them the shallowest, uppermost aquifers in the Denver Basin – aside from the alluvial aquifers of the South Platte River, that is. The two formations intermingle with each other and yield 50-300 gpm. A total of 2,700 high-capacity wells withdraw 110,000 acre-feet per year between them.

Modeling the Future

As environmental systems go, groundwater might be the most forgotten and misunderstood by policymakers and laymen alike, which is why we're lucky that a cadre of credentialed state and federal hydrogeologists have been working to demystify the Denver Basin's inner workings since the 1970s. The U.S. Geological Survey (USGS) constructed the first numerical groundwater flow model of the region in 1987. Built in four layers and written in code that predated MODFLOW, it served as the basis for all Colorado groundwater decisions until the mid-1990s. It also over-predicted the amount

of groundwater available to the Front Range by a third. Initial estimates that the Denver Basin held 270 million acre-feet of available water shrunk to 200 million acre-feet as modeling improved over the years.

Scientists began to understand the miscalculations of early groundwater models in the late 1990s, when a Denver Museum of Nature and Science field campaign dug to the very heart of the matter. In 1999, a core sample drilled to 2,256 feet below ground surface in Kiowa provided hydrogeologists with the first full stratigraphic cross-section from the middle of the Denver Basin. The core sample suggested that wells wouldn't be able to drain as much water as previously anticipated. It also revealed that aquifer yields varied significantly by location.

The USGS updated their models in 1996, again in 2002, and most recently in 2011, when it published the results of a seven-year project. The 2011 model represents the state of the art. It captures each Denver Basin bedrock aquifer and confining unit, as well as the alluvial aquifers that sit on top of them, in grid cells of one square mile. It is capable of simulating inputs from precipitation and return flows, as well as water withdrawals in the form of evapotranspiration, discharge to surface water systems, pumping by wells, and flows between aquifers. It also simulates changes in aquifer storage. The model runs all the way back to the steady-state conditions of 1880 and forward to 2003, producing modern-day outputs that are a decade behind our current groundwater extraction rates, which makes its already worrisome results even more concerning.

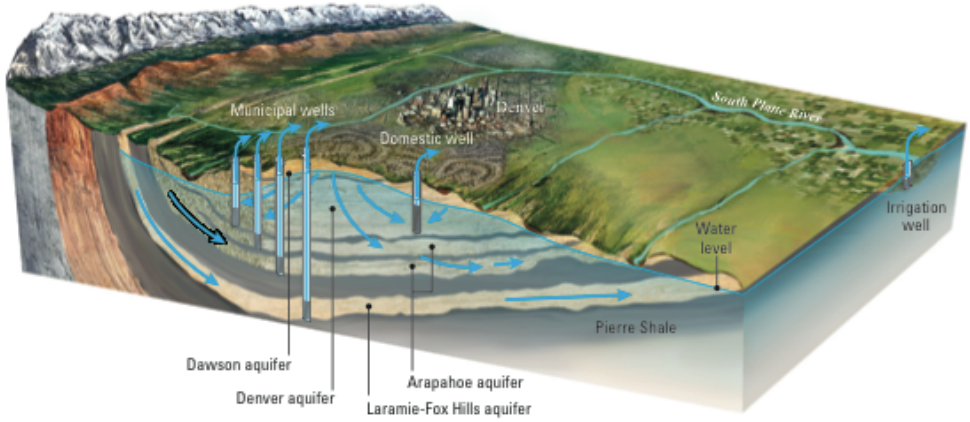


Figure B21. Conceptual block diagram of the Denver Basin aquifer system for developed conditions.

Image courtesy of USGS Professional Paper 1771

According to the USGS and others, we have greatly reduced the artesian pressures that early Denverites found in the Denver Basin aquifers in 1884. Groundwater extraction has lowered hydraulic heads across the region, altering groundwater flow directions in some places and recharge patterns in others. In heavily pumped areas like Douglas County, the artesian pressures are declining 30 feet per year on average. Municipal supply aquifers – the Arapahoe and Laramie-Fox Hills – are in particularly bad shape. In Douglas County, the confined Arapahoe aquifer declined 100-300 feet from 1990-2000; it is on a trajectory to lose its hydraulic pressures altogether by 2020, becoming "unconfined" in Douglas County. When the Arapahoe Formation reaches an "unconfined" state it will begin to compact as water is drawn off and it succumbs to the pressures of the overburden above it. The aquifer will yield water faster and receive even less recharge, sealed in its nonrenewable fate.

A Groundwater Gambit?

How much water has already been pumped from the Denver Basin? By USGS's count, the aquifer system has seen an exponential loss in storage from bedrock aquifers since 1999, due to drought conditions and increased pumping spurred by population growth. Between 1880 and 2003, Douglas County and its neighbors removed about 690,000 acre-feet of groundwater in total – the equivalent of 3.5 Dillon Reservoirs. The basin's bedrock aquifers surrendered 41,300 acre-feet of water in 2003 alone, with Douglas County and the southern metro region accounting for half of those losses. The decline is but a fraction of the 200 million acre-feet of water estimated in storage, but hydrogeologists caution that storage estimates are still uncertain and that the impacts of depletion will be felt on a local scale. Well-to-well interference is expected to reduce aquifer productivity by as much as 85% in the next few decades.

While nobody knows exactly when Denver Basin groundwater will run dry, hydrogeologists agree that the day will come. Which is to say that the future of Douglas County hangs in the balance of regional water conservation tactics and bids to develop surface water supplies (called "renewable water" in Southern Metro water utility parlance). Regional policymakers hope that the populace will be willing to pay for those surface water supplies, and that they'll be politically, socially, economically, and environmentally feasible to develop.

Betting on the Hydrologic House

If dams and reservoirs are built at all in the modern West, they are not built quietly. No, dam and reservoir projects are the opposite of low-profile events. They are knockdown, drag-out affairs – fiscal, cultural, and political flashpoints nearly unmatched in their ability to launch and sustain conflict. And yet right now the 72,000 acre-foot Rueter-Hess Reservoir is filling up behind the Frank Jaeger Dam in Douglas County without much ado from anyone. Even the residents of Parker, the reservoir's hometown, hardly know that a 196-foot earthen dam now plugs a 7,675-foot gap in the rolling mesas to the west of town, and that the future of the region is largely tied up in how much water it will ultimately hold in place.

Rueter-Hess Reservoir in 2011.
Photo credits: PWSD.org and Jackie Shumaker

The Rueter-Hess Reservoir is anomalous for this reason and more. It happens to be the first major dam and reservoir project West of the Mississippi River to receive federal approval for construction in the past 30 years, according to its advocates. This alone is a striking departure from the anti-dam water norms of the modern West, but it is made even more remarkable by the fact that the Rueter-Hess Reservoir sits within 25 miles of Denver Water's abandoned Two Forks Dam site. Two Forks drew an environmental veto

from the Environmental Protection Agency in 1990 that water scholars now characterize as a major anti-dam, anti-reservoir turning point in Colorado water history – one that appeared to be permanent until Rueter-Hess came along.

Rueter-Hess Reservoir is also odd for its optimistic operational plan. The Parker Water and Sanitation Department (PWSD) built the $165 million* reservoir to store Cherry Creek surface flows based on water rights so junior that they date only to Colorado's John Elway era. According to the water utility's calculations**, roughly 45 percent of Rueter-Hess's future volume hinges on the availability of 1985 flows on a river that has been appropriated all the way back to 1903. As plans go, this seems like a risky bet, one that wagers too heavily on an increasingly fickle hydrologic cycle that scientists and water managers no longer believe they can predict. It also sounds somewhat familiar.

In its idealism and self-assurance, the Rueter-Hess project might find a philosophical home in the discredited climatological theory and Manifest Destiny mantra of the 1860s and 1870s that the "rain would follow the plow." Politicians and scientists of that era – Denver booster William Gilpin among them – truly believed that homesteading and agriculture would alter the Plains' precipitation patterns in yeoman farmers' favor, and they had reasons to. What they didn't, and couldn't, know at the time was that they'd moved to Colorado's Front Range during a wet period that wouldn't last forever. In Rueter-Hess's case, the water-short communities of Douglas County seem to be betting that the snowmelt will follow the bulldozer. Future hydrologic cycles have yet to weigh in on whether their strategy will pan out.

Putting these trends together, it appears that Rueter-Hess Reservoir is uniquely bucking the anti-dam orientation of the modern West while simultaneously synching up with failed historical beliefs in its climatological rationale. For both of these improbabilities the Rueter-Hess Reservoir begs a closer look. After all, how did a large, reservoir gain federal approval in the Two Forks neighborhood in the year 2003? And is it fair to say that the development of major water projects on junior water rights is a 21st century replay of 19th century homesteading beliefs? These questions are far too big to tackle in a single go, but let's take a quick peek at them anyway.

A Different Fork

If one clear difference stands out in a comparison between Rueter-Hess and Two Forks, it is the fact that the potential ecological impacts of all proposed reservoirs are not equal. When the EPA vetoed the construction of the Two Forks Dam in 1990, it was because, in the agency's words, the dam would have wrought "unacceptable environmental damage." The Two Forks Dam would have sat at the confluence of the South Platte River's main stem and the river's North Fork, in the foothills of the Rocky Mountains, where, by the U.S. Army Corps of Engineer's assessment, it would have leveled the local bighorn sheep population, eliminated up to a third of the endangered Pawnee Montana Skipper population, backed up over 20 miles of Gold Medal and Wild Trout fishing waters, and inundated geological landmarks, historic buildings, and an undetermined number of prehistoric Native American sites.

Highlands Ranch, a large Douglas County subdivision, from the air.
(Photo: Wall Street Journal)

According to the same agency, the Rueter-Hess Reservoir will preserve as many, or more, environmental and cultural resources than it will ruin. That is in no small part because the reservoir sits off the main channel of Cherry Creek, where it will inundate nearby prairie instead of the ecologically sensitive waterway. It's also notable that PWSD made no secret of its intention to sell its land to Douglas County's industrious housing developers if the Corps denied them the reservoir, which left the agency to decide which would be the lesser of the two ecological evils in its environmental impact analysis. The Corps found further silver lining in the argument that Rueter-Hess would aid in weaning Douglas County off Denver Basin groundwater – at least partially – and extend the life of that critical nonrenewable aquifer system a bit longer.

Rueter-Hess won't back up Gold Medal fishing waters, nor will it impact bighorn sheep or endangered fish species (though it could impact a threatened jumping mouse). It did inundate two prehistoric campsites and the 1,000-year-old burial site of a Northern

Cheyenne woman and child, but it will also create bald eagle habitat and provide a positive scenic feature, according to the Corps. All told, the agency found about as many cultural and environmental positives in the project as they did negatives and gave PWSD the green light to build its dam – once in 2003, and again in 2007, after the water utility asked to significantly increase its size.

Will the Snowmelt Follow the Bulldozer?

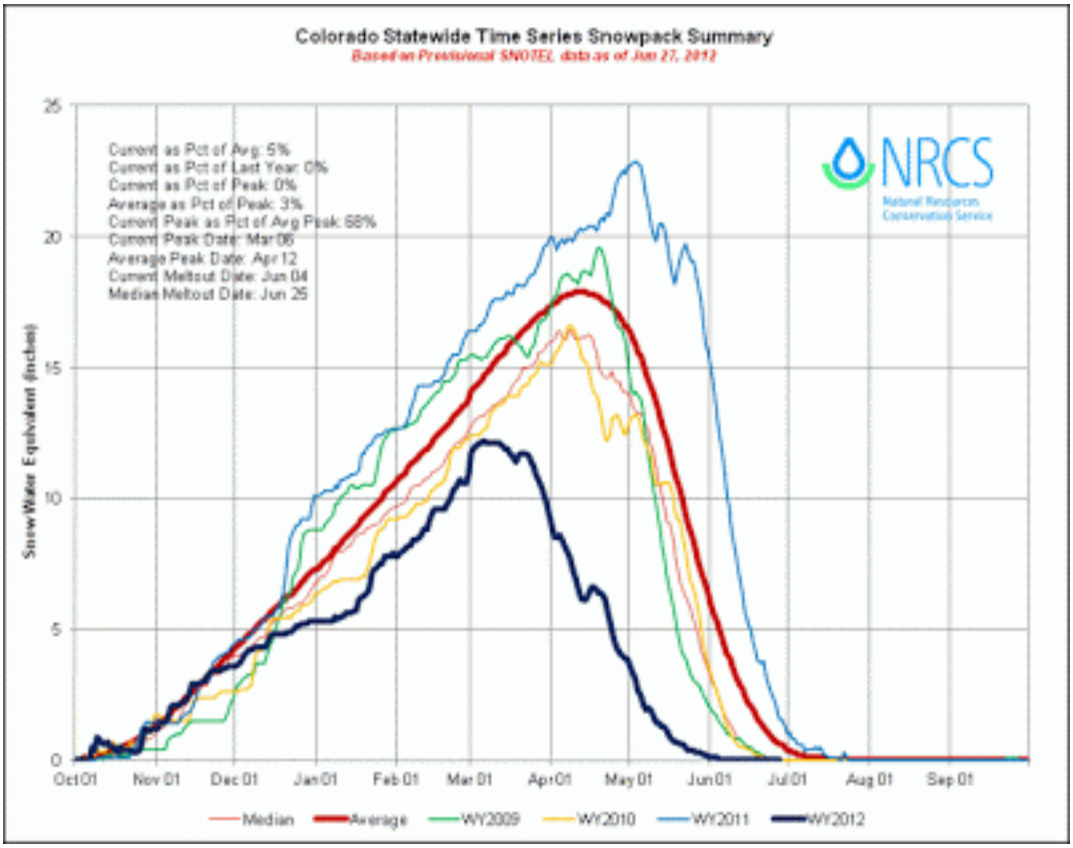
In assessing the merit of Rueter-Hess, the Army Corps seems to have overlooked one key sentence in the project proposal, however. A line on page 21 reads: "Any operational plan… will be contingent upon the availability of water from each of the water source components described herein." What the report doesn't add to this disclaimer is that water availability is never certain in the West – particularly not for junior water rights holders on the Front Range. It also fails to mention that climate change is making the West's already unreliable hydrologic cycle even less predictable, and that, climate change aside, tree ring studies indicate that several droughts within the last 400 years were much worse than the modern droughts we've experienced since the 1950s. Other Front Range water utilities are working these vulnerabilities into their long-range planning.

PWSD, on the other hand, is doubling down on its already vulnerable junior rights. With a 1985 appropriation, the reservoir can only capture water during periods of open river, which typically occur in the winter and during spring snowmelt, according to PWSD. To make this strategy work, the Rueter-Hess project included construction of a small, inflatable dam that lies in the bed of Cherry Creek and rises when PWSD is allowed to draw water, temporarily boosting the level of the stream so it can reach an adjacent pumping station that lifts water from the creek to the reservoir. PWSD estimates that they can deposit an annual 2,845 acre-feet of Cherry Creek water into the reservoir this way. Another annual 3,350 acre-feet of water per will come from wastewater effluent and return flows from lawn irrigation, according to the water utility.

Rueter-Hess Reservoir in 2011. (Photo: PWSD.org)

Sounds solid enough. But how did PWSD go about calculating all of these numbers? And how much climatological contingency is built in to their estimates? Turns out, not much. In making their pitch to the Army Corps, PWSD based their water availability analysis on 50 years of U.S. Geological Survey stream flow data from a Cherry Creek gaging station near Franktown, just south of Parker. They then used that data to calculate three-year averages representing dry, wet, and average flow conditions, which served as the basis of reservoir filling and 50-year long-term water yield simulations for start periods under each set of conditions. According to PWSD's calculations, Rueter-Hess would fill in approximately six years with an average condition start period (based on the initial size proposed in 2003).

According to the PWSD's 50-year model, the reservoir would draw 6,195 acre-feet of water annually, with outlier wet years providing as much as 25,587 acre-feet. PWSD determined that the reservoir would draw so much water that over the course of 50 years the water utility would be able to inject 46,743 acre-feet of excess water into the Denver Basin to improve groundwater conditions. Drought would strike once a decade or so, and only for 2-3 years at a time, during which the reservoir couldn't pull any water from Cherry Creek or its other sources. Over the course of 50 years, a maximum of 10 years would provide no water at all – assuming, of course, that the last 50 years will accurately predict the next.



Hydrologic outliers: 2011 in light blue (high) and 2012 in dark blue (low). Graph: NRCS.gov

Rueter-Hess started filling up in 2010, gradually. Since then, Colorado has been on a hydrologic seesaw. The state experienced two wild swings in water supply with back-to-back hydrologic outlier years – an extraordinarily wet period in 2011 and a bone-dry period in 2012. Turns out, those weren't the only erratic events in the Rueter-Hess picture. In May, angry residents of Parker voted for a complete leadership shake-up on the board of the Parker Water and Sanitation District. Frustrated that their water currently costs 28 percent more than Denver's and unaware of the hydrologic and historical realities that dictate why, Parker's voters elected an entirely new water board and succeeded in pushing out longtime PWSD general manager Frank Jaeger with allegations of wasteful spending. It could be said, at least for now, that there are still forces at work in Colorado that make its snowpack look predictable by comparison.

* The reservoir as initially planned would have spanned 16,000 acre-feet and cost less than $165 million. After PWSD received Army Corps approval to construct the dam, neighboring communities joined the project to expand the reservoir to 72,000 and pay an additional $56 million to make it possible. The calculations and statistics that I report here are based on PWSD's initial proposal, approved in 2003.

** The Rueter-Hess Environmental Impact Statement is no longer posted online by URS, but it is available by CD. The U.S. Army Corps kindly mailed me the 2003 version of the EIS (covering the reservoir as initially proposed) for this article. They did not provide the 2007 edition by press time.

Writing about Home

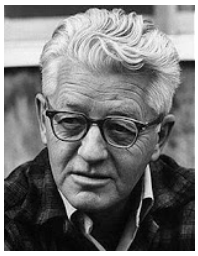
I've been keeping something from this blog, leaving something out, and that is the fact that I grew up in the place that I've been writing about. Parker, to be exact. In fact, my parents still live there, in my childhood home no less. It sits within a short radius of all the places I've brought up thus far – 10 miles from the improbable Rueter-Hess Reservoir, 20 miles from the controversial and water-short Sterling Ranch site, and directly atop the rapidly draining Denver Basin aquifer system. I lived there from age eight, when we moved to Parker from northern England, to age seventeen, when I left for college in faraway upstate New York. Now that I reside in Boulder, I go back once month or so, and while I've lived all over since I graduated from high school, it's the place that feels like home.

And that means I am a co-conspirator. That means that I am literally a product of the fossil groundwater whose demise I've been lamenting. That means I am a participant in Douglas County's rapacious population growth over the past three decades. That means I must implicate myself in the stories I've been telling. Yet thus far I haven't mentioned my own stake in Douglas County's water past and future. I cannot produce a good reason why, except to say that it isn't always easy to slot the first person into discussions of hydrology and water policy. It's a practice that we academics are explicitly trained against. But I would argue that we omit these details to the detriment of discussion and debate, not just disclosure. So I've been mulling how to proceed.

Should I approach Douglas County's water woes as a supposedly disinterested third party, as an utterly subjective participant, or as something (someone) in between? Which of these perspectives allows me to study my hometown in the most thorough and thoughtful manner possible? How shall I balance critique with empathy, despair with hope? When it comes to the careful examination of one's home, questions seem to outnumber answers.

In search of some methodological ground to stand on, I turned to the category of people that wrestles with these questions for a living: Western writers. Specifically, I checked in with their dean, Wallace Stegner, master of Western fiction and non. I also queried one of his contemporaries in both genres, a sage who writes as trenchantly as Stegner

about Western environments and our complicated ties to them: John Steinbeck. I leavened both of these with the perspective of a slightly more recent contributor in William Kittredge, Oregon-born author of *Owning it All* (1987), among other works. They are pictured below, and here's what they said.

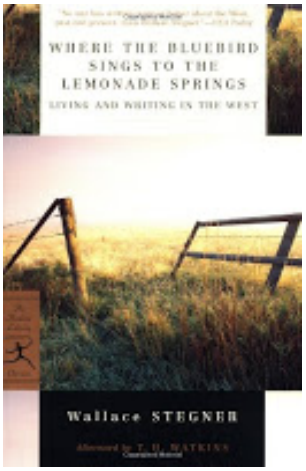


Stegner

Steinbeck

Kittredge

When it comes to questioning one's roots and the environmental impacts of those roots, I've found good company. Western writers have a long history of writing about their hometowns and homelands – both critically and lovingly. It is a practice that defines them, as thinkers and as citizens of the world, and often they cannot hope to extract themselves from the narrative. Stegner sums it up this way in *Where the Bluebird Sings to the Lemonade Springs: Living and Writing in the West* (2002):



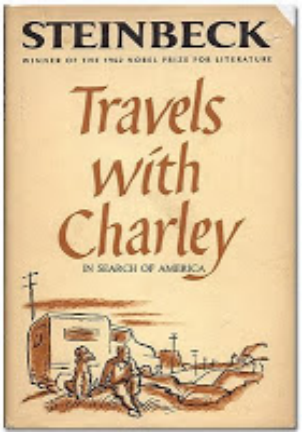
If there is such a thing as being conditioned by climate and geography, and I think there is, it is the West that has conditioned me. It has the forms and lights and colors that I respond to in nature and in art. If there is a western speech, I speak it; if there is a western character or personality, I am some variant of it; if there is a western culture in the small-c, anthropological sense, I have not escaped it. It has to have shaped me. I may even have contributed it in minor ways, for culture is a pyramid to which each of us brings a stone. Therefore I ask your indulgence if I sometimes speak in terms of my personal experience, feelings, and values, and put the anecdotal and normative ahead of the statistical, and emphasize personal judgments and trial syntheses rather than the analysis that necessarily preceded them. In doing so, I shall be trying to define myself as well as my native region.

To the work of regional and self-understanding, Stegner applies a specific method: leaving home and then coming back. "That is essentially the whole story" of his career, he tells us. "I grew up western, and the very first time I moved out of the West I realized what it meant to me. The rest is documentation, detail." Stegner isn't alone in this approach, though his fellow writers bring their own variations to the practice of departures and arrivals. Steinbeck left Salinas, California for New York and returned for a high-impact visit when he wrote *Travels with Charley in Search of America* (1962), though at a much later stage in life than Stegner's brief early-career sojourns to Iowa City and Boston. Kittredge, on the other hand, didn't leave his farm in the Warner Valley of southeastern Oregon until after his writing career took off, and then he didn't go further than Montana. Stegner writes of the pattern this way:

It is not an unusual life-curve for Westerners – to live in and be shaped by the bigness, sparseness, space, clarity, and hopefulness of the West, to go away for study and enlargement and the perspective that distance and dissatisfaction can give, and then to return to what pleases the sight and enlists the loyalty and demands the commitment.

In retrospect, my own path fits this "life-curve" quite well. I left Colorado to go to college, came back immediately thereafter to spend time in the mountains, left again to figure out that place known as Washington, D.C. and what happens there, and returned home to study hydrology at C.U. in an effort give back to the place I care about – compelled, fittingly, by Stegner's biography of John Wesley Powell, which united my interests in geography, science policy, and Western resource issues under a single meridian. I know first-hand what Stegner means when he says that distance brought him perspective. I also understand the way that perspective demands re-commitment to the West as home.

In applying both perspective and re-commitment to the task of making sense of his homeland, Stegner and his colleagues write primarily about change. But they do so with different results. Each author writes in a different style and tone about the rapidly developing post-war West. All three embody the lived-in complexity and dissonance that crop up when we face our places of origin and consider their fates.

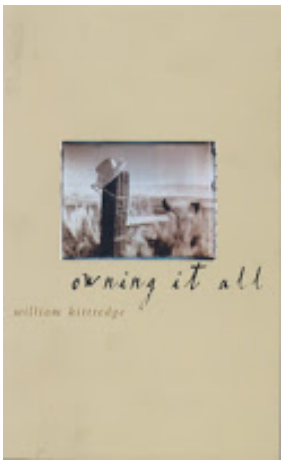


Change jerks Steinbeck from his moorings and throws him for a wistful loop in *Travels with Charley*. When he reaches his hometown of Salinas for the first time in years, he despairs that he hardly recognizes the place for all the new houses and suburban sprawl. This isn't entirely surprising. Steinbeck sets out on the trip with Charley, his standard poodle, in the sunset of his long writing career. What results is an uneasy introduction to a 1960s America that he no longer recognizes and a cross-country elegy for a world he has lost. From this perspective, Salinas looks to Steinbeck like a picture of the present drawn over a picture of the past. He cannot help but compare the landscape he finds with that of his childhood, bringing him to the conclusion that "you can't go home again because home has ceased to exist except in the mothballs of memory."

One does not find much promise for clear-eyed investigations of close-to-home change in Steinbeck's reaction. He seems to make the case that all homecomings suffer the blurring effects of nostalgia. Hope for a proper reckoning with the past and the present isn't lost, however. Steinbeck redeems himself elsewhere in the text when he acknowledges the influence that his dissatisfied mental state has on his perceptions of the shifting country. "I discovered long ago in collecting and classifying marine animals that what I found was closely intermeshed with how I felt at the moment," he wrote. "External reality has a way of being not so external after all… This monster of a land, this mightiest of nations, this spawn of the future, turns out to be the macrocosm of microcosm me."

Stegner seems to better fend off nostalgia than Steinbeck, though he isn't immune to its effects. When he wrote *Where the Bluebird Sings* in 2002, Stegner highlighted change's educational value, but he also sounded a cautionary note about damage to Western landscapes. "Sometimes I wonder if Lewis and Clark shouldn't have been made to file an environmental impact study before they started west, and Columbus before he ever sailed. They might never have got their permits," he wrote. To this he added a qualifier: "But then we wouldn't have been here to learn from our mistakes, either. I

really only want to say that we may love a place and still be dangerous to it." In Westerners' sidestepping of aridity, Stegner confirms that we have accomplished both.



Kittredge starts from this point of conflict in *Owning it All*, except he writes from the perspective of a Warner Valley rancher who grew up trying to bring an agrarian order to a place that didn't ask for it. "Aspects of our paradise have been worked to death," he writes of Oregon, and later Montana. But here Kittredge refuses nostalgia, and despair, and anger. "Despair, the music tells me, is a useless way of connecting to the world. Slow down, it tells me, and love what there is," Kittredge tells us. Later, he adds: "Westerners, like everyone, must work to understand that anger looks nowhere but backward, and that this variety is ultimately nostalgic and pretty much useless."

In writing about their hometowns and homelands, Steinbeck, Stegner, and Kittredge attempt to do what we all must when reckoning with our places of origin: they face down a particularly strong breed of nostalgia, with varying degrees of success. The writers also must tangle with the sentiments that often accompany nostalgia – namely, despair over change and anger toward its agents. At its best, this internal struggle sharpens their perceptions and equips them to see our relationships with the world in all their complexity. At its worst, their thinking succumbs, in fits, to Western myths of pre-Euro American Edenic landscapes, as they put the West on a pedestal and take it back off, over and over again. But there is good news to be found in their dissonance: it's still far superior the myth-riddled thinking of outsiders, which created most Western myths in the first place and seem set on forever reviving them.

So I join Stegner in his prediction that "it's the inside Western writers that will help the West realize itself." And who better than the children of the "New West" – those born inside the landscapes and of the change that Steinbeck, Stegner, and Kittredge saw? There are reasons to believe that this generation's commentators will be in the best position yet to reckon with reality. Douglas County was the fastest growing county in the entire country when I was a kid; change came so quickly that we weren't granted the luxury of nostalgia.

If Western creation stories are still stubbornly structured by frontiers, then mine was that of Belmont Way – the last street in our suburban neighborhood. It backed up to a stretch of the Black Forest's pineries that we called, creatively, "The Back Trails." As frontiers go, it didn't last. New houses started to spring up in trails when I was only in middle school. I could rail against the newcomers – at times, I have – but my family was a part of that growth as well. We hadn't moved to Belmont Way too many years earlier. Which means it's my job to confront my own role in the changing West. As a child of Douglas County, I cannot look out from an ideological perch that pretends to be above the fray of Front Range water use and abuse. And this is exactly why I should be writing about home, and exactly why I should do so in a way that clearly states my own stake in the "macrocosm that is microcosm me."

Steppe Bone-fides

Edward Abbey

It is neither polite nor prudent to bring a dead person to an interview, but Edward Abbey wouldn't let me go to the Denver Botanic Gardens without him last week. So when I spent an hour talking with Mike Bone, curator of the steppe collection there, I couldn't help but wonder if the two of them would get along?

Abbey didn't have many male friends. He also wished bricks upon all greenhouses in the pages of *Desert Solitaire*. Both facts make a poor foundation for solidarity with a senior horticulturalist and experienced plant propagator such as Bone, who has been researching and collecting steppe flora for the Denver Botanic Gardens for more than ten years. But still I wonder if, given the chance, the two men might unite under a common appreciation for arid and semi-arid Western landscapes – or, at the very least, mutual respect for each other's pursuit of unexpected dryland-centric career paths and long, distinctive beards.

Mike Bone

Again, I admit that a focus on the affinities of a person more than two decades departed is a morbid starting point for a conversation with a perfectly nice stranger like Bone, who is fascinating for countless of his own reasons. But the fact is, 44 years after the publication of *Desert Solitaire*, Abbey lives on – and lives large – in Westerners' understanding of their relationship to aridity. As self-contradicting and vituperative as Abbey could sometimes be in his desire for Americans to love their dry country but also stay out of it, he is still the "Thoreau of the American West" to many, as well as the West's most famous desert appreciator. I went to the Denver Botanic Gardens to talk with Bone about our ties to dry places. And that's why we couldn't be alone at our potting table.

Specifically, I was there to ask Bone as much as possible about xeriscaping. Reckoning with Abbey didn't mean I intended to privilege Abbey's viewpoint. Rather, I wanted to

highlight a more recent variety of hard-won expertise on Westerners' relationship to their arid and semi-arid environs. Bone's unique vantage point as a researcher and curator of steppe flora promised that and more. I first met him at a water-wise test garden at one of Douglas County's most hydrologically controversial places, the proposed Sterling Ranch development site, where we chatted only briefly. By the time we were through talking in the Botanic Gardens' greenhouses, I had an infinitely more expansive appreciation of the benefits of reconnecting to our Front Range steppe environment through regionally appropriate dry (or xeric) landscaping.

Path to the Garden

If there is an obvious and clear path to a botanic gardens career, Mike Bone did not take it. The horticultural profession has the woes of the manufacturing economy to thank for its appropriation of Bone. If not for a shortage of jobs for apprentice millwrights in the not so distant past, Bone would be repairing industrial machinery somewhere instead of collecting seeds and plant samples from around the world. When the machinist union jobs dried up, Bone, who grew up in Westminster, found work as a "jack of all trades" at a small landscaping company with a small greenhouse and never looked back. "I was there to rebuild fan motors, and to weed whack around the place and lift heavy things, but it was my first connection with the natural world and how man can integrate, manipulate, and expand upon the natural world. That sparked my obsession and I started learning everything I could about horticulture and growing plants," he said.

Bone's burgeoning interests took him to Front Range Community College to study horticulture, and from there, to a job growing plants that fit into one-gallon containers at a local nursery, and ultimately beyond. His involvement with PlantSelect, a partnership between the Denver Botanic Gardens and Colorado State University that strives to put the best regionally appropriate plants in Western gardens, eventually caught the attention of a senior curator at the Botanic Gardens. When he was offered a job, he couldn't believe his luck. "Botanic gardens are sort of the mecca of the horticultural world," he explained. "It's where everything comes together."

For the past decade, Bone has worked to build the Gardens' seed collection and to figure out how to crack the germination codes of

(Photo: Plantselect.org)

countless species of plants so that the Gardens can grow them, among other projects. As a propagator he manages greenhouse and outdoor garden spaces at several Botanic Gardens locations and grows a wide variety of plants there. As a curator he figures out how to translate that research and conservation work into something that people can see and relate to. "We are an accredited museum of plants, and our steppe collection is one of the seven main living collections that makes us a museum," Bone explains. "Part of my job is to try to wrap my head around what the steppe actually is and the important aspects that we need to have on display for the public to understand what the steppe is."

To Bone's credit, ten years of working at a living museum hasn't made him into a stodgy expert type. An extensive network of tattoos peaks out from the cuffs of his shirtsleeves and he uses as many artistic words as he does scientific ones, describing the "ethereal" basis of his interest in the steppe and more than once calling his botanical career "an obsession." And while his career as a millwright is long behind him, he still has the calm and thoughtful air of a person who fixes big things when they're broken and everybody has surrendered hope. In the course of our meeting he assures one colleague that the leak she found on a Botanic Gardens vehicle is just hydraulic fluid from a lift on the back, not brake fluid, and confirms for a volunteer that he'll have no problem caring for the new plant she's delivering. In both cases, he leaves no doubt that everything will be fine.

In fact, you might say that Bone has precisely the kind of professional training necessary for tackling one of Westerners' biggest water resource problems: an abiding commitment to thirsty lawns. He's also in exactly the right geographic location to address Westerners' unnatural fixation with the color green. Denver is the home of xeriscaping, thanks as much to its water utility as its botanical devotees. Denver Water employees coined the term and defined the practice in 1981. "Xeriscaping" stands for seven principles of water-wise landscaping ("xeros" is Greek for "dry"), which include the use of drought-tolerant plants and efficient irrigation. If you're ever in the Denver Botanic Gardens neighborhood, you can see the principles at work in their Dryland Mesa display, which was the world's first xeriscape demonstration garden when it was planted in 1986.

A corner of Dryland Mesa
(Photo: botanicgardens.org)

Steppes Backward and Forward

So how is xeriscape faring on Colorado's Front Range in its 32nd year of life? It's hard to say, and even harder to measure, but if anybody can make a good guess it's Bone. When I ask him, he tells me about his own personal barometer for the popularity of dryland gardening: the Denver Botanic Gardens' annual Mother's Day Plant Sale. The sale has become something of a botanical institution over the 60-plus years it's been held. Last year, the Gardens peddled 85,000 plants of all kinds from all over the world at the event. Bone and his colleagues offer a number of plants from their collections the sale, including "a lot of weird stuff you won't find at the nursery – dryland stuff, a lot of xeric stuff, native plants that you can't find for sale locally," says Bone. Each year, he watches to see who shows up and what they buy. The trends he observes sound promising.

According to Bone, the plant sale's steppe division sees a wide cross-section of visitors, all drawn to xeriscaping for their own vastly different reasons. He sees young 20-somethings who want a vegetable garden and a xeric garden because of their environmental values. He sees retirees who simply can't drag a garden hose around any longer. He also meets young families who want to provide their children with home-based lessons about the natural world, and urban gardeners show up because they want something unique and low-maintenance to grow in their windowsills or on their patio to differentiate their house from their neighbors' houses.

Bone likes to point out that we as humans are children of the steppes, and that these gardeners are, in effect, reconnecting with a lengthy common heritage. "We've evolved in the steppe. That's where agriculture happened. That's where trade routes happened. The steppes are incredibly important to us as a species," he says. All of which makes it even stranger that landscaping and gardening practices have sought for so long to distance residents of the American West from their cultural history and climactic

reality. Talking with Bone makes it apparent that reengaging with the steppe is as good for us socially and culturally as it is for our water resources. The steppe still has a lot to teach us, and some of those lessons come from far away.

Bone in the field in Kazakhstan.
(Photo: botanicgardensblog.com)

When Bone isn't working on local, day-to-day horticultural tasks, he's doing research. Specifically, he pursues answers to paleobotanical questions of how and why plants move around the world. As one might guess, this involves research junkets to faraway steppe environments in search of lost connections between flora. His findings are incredible – linking plants in Colorado to those in the Altai Mountains of Central Asia, some 13,000 miles away, for example. Figuring out why the same plant appears in such distant locations, and only in those locations, requires sifting through everything from seed morphology to ancient plate tectonics and trade routes. In that sense, it's Bone's job to discover forgotten links and unexpected ties, deciphering human and physical relationships expressed in the distribution of plants between steppe environments from South America to North America to Central Asia to South Africa and back.

Each steppe region is home to plant species that somehow relate to other distant steppe regions, and Bone has made it a personal mission to educate people about those connections. "When you start to think about that kind of thing, it takes a giant world, shrinks it down, and crosses cultural and religious boundaries. It makes everything so much more beautiful and interesting." In a sense, Bone takes the long view of steppe environments, one that reaches to the distant past, as well as the wide view, which spans continents and cultures. He'd like to those views expressed in more gardens than his own, through both "native" and "exotic" flora that thrive in Colorado's climate and help us loosen our unnatural grip on European horticultural practices.

Looking out from Bone's steppe, we can also start to understand how change happens. The real measure of xeriscaping's success is to be found institutionally, he says. Xeriscaping gains the most ground, so to speak, when water-wise landscaping shows up as a requirement in city government contracts, homeowners association rules, and housing development projects. Applying xeric pressure from that scale influences what nurseries grow, which shifts the landscaping business from what you might call its root level. "You break the mold with a slight little crack," says Bone. "People come in and demand more xeric plants, so the nursery starts growing them, and then other landscapers pick up the idea when they come in. It starts to slowly build."

Mind the Gap

If you happen to land within earshot of almost any water policy discussion on the Front Range of Colorado these days, you'll likely hear somebody say something about "The Gap." By that I mean you'll probably hear one or more people refer obliquely to "The Gap" many times over in the course of conversation without ever specifying what it is or what it means, as if "The Gap" were an elephant in the room that can be politely mentioned but not engaged in full detail. It sort of is.

To be clear, water policy people are not talking about the American clothing retailer The Gap, even though its popularity soared at the same time that Douglas County's population growth went stratospheric (the 1990s), making it likely that many of that era's Front Range newcomers dressed themselves in the brand name that would later be used to describe their hydrologic consequences. No, when water policy folks talk about "The Gap" they mean "the shortfall," or "the shortage," or "the water we will someday need, but do not currently have," or worse, "the water we will someday need, but do not currently have and do not know where we will find."

As a term and a number, "The Gap" is the product of water supply and demand inventories conducted by state-level water resources experts and river basin-based stakeholder groups across Colorado in various iterations since the 2002 drought. In short, "The Gap" represents the difference between future water supply and demand. It is a numerical portrayal of how much water scarcity Colorado's residents will face in the future, with the year 2050 as a common reference point.

Sounds simple enough, but when people use the term vaguely, it can be somewhat confusing. There is no single "Gap" in Colorado; there are many. And the "Gaps" that are out there will appear in specific places and at specific times for specific political, hydrologic, and economic reasons. All of which is to say that when a water resources person nods toward "The Gap" in general terms, a few follow-up questions are typically in order. First of all, "Whose Gap?" Secondly (and this question is infinitely more difficult to answer): "Whose responsibility is it to fill?"

A Gap By Any Other Name

"The Gap" in the southern Denver metro area, which includes Douglas County, is estimated to run approximately 79,000 acre feet in 2050, according to the most recent calculations by state experts. That's water enough for 200,000 homes, based on a major Douglas County developer's target of 0.4 acre feet of water per home per year in the future. The figure is quite large, and it could turn out to be even bigger. The region's actual new water needs in 2050 will total 120,000 acre feet. The 79,000 acre feet listed as southern metro's "Gap" assumes that water providers will come up with 40,000 acre feet of water by way of existing infrastructure, reuse, regional in-basin transfers, agricultural transfers, and new transbasin projects.

The only part of Colorado that will need more water than the southern metro area by 2050 is the northern Front Range – home to Fort Collins, Loveland, Berthoud, Greeley, as well as Boulder and Longmont. They (ehem, we) will need 150,000 acre feet of new water by 2050, of which 110,000 is considered to be northern metro's "Gap." To be fair, the rest of the Front Range won't be too far behind southern and northern metro in their future water needs. The urban counties of the Arkansas River Basin (that's Pueblo and Colorado Springs) are expected to face comparable water gaps in 2050, as will the Denver metropolitan area itself.

Yikes.

If all of these impending Front Range "Gaps" carry one message, it is that Colorado will soon serve as a large-scale test site for experiments in handling a serious degree of looming water scarcity. In fact, it is already. The headwaters state is, and will continue to be, a place where the questions "Whose Gap?" and "Whose responsibility is it to fill?" will have to be sorted out in one way or another. We'll have to figure out answers to real-world, real-time questions for which history and science provide only mixed precedent and muddled predictions. Prime among these questions is how we, as Coloradoans, will treat each other, statewide, in the face of such incongruent supplies and demands? Will we cooperate and collaborate or will we divide and diverge?

Scarcity Scholarship

Natural resources scholars have yet to fully sort out whether water shortage leads to conflict or cooperation. Most of the research on the topic has been conducted at an international scale by security scholars interested in the circumstances of conflict in trans-boundary river basins. As a result, much of the existing work on water scarcity focuses on international rivers' potential to generate war between two countries. The findings have been mixed.

The precise nature and direction of the relationship between water scarcity and cooperation or conflict has been difficult to determine. Some scholars have found no relationship between water scarcity and conflict. Others argue for the opposite: a positive and linear relationship between the two. Still others think that there is a sweet spot for collaboration at a moderate level of scarcity, with conflict more likely when water scarcity is extremely low or extremely high.

Researchers haven't much considered the effects of water scarcity on collaboration within a single, democratic U.S. state like Colorado. A hundred years from now we'll likely have become a fully-formed case study analyzed in countless journal articles and dissertations, but as it stands now, we're in the early stages of figuring out whether water scarcity will bring us together or tear us apart. In guessing what all of this might mean for Douglas County, I see three potential futures (or a combination of them) on the horizon: a world in which the shortages of southern metro municipalities are everybody's problem, nobody's problem, or some people's problem. It would be impossible to fully investigate these futures in the course of a single article, but for the sake of discussion, let's take an exceedingly quick peek at each.

Water Scarcity is Everybody's Problem

If water scarcity is everybody's problem, then it is no different, in principle, than any other national emergency – drought,

flood, fire, or financial sector collapse. Under an "Everybody's Problem" principle, the southern metro area, including Douglas County, would get "bailed out" of its water scarcity by federal taxpayers. While this sounds somewhat crazy – municipalities and water utilities as the equivalent of failed auto companies? – the West has a long, colorful history of being "bailed out" of its aridity by the rest of the country. In 1996, the Government Accountability Office estimated that the Bureau of Reclamation had spent $21.8 billion on the 133 federally funded Western water projects built in the West since the Bureau was formed in 1902. Of that expense, the Bureau of Reclamation required $16.9 billion to be reimbursed by irrigators, municipalities, and hydroelectric operators (the feds cover costs for flood control and river navigation, since those goals are deemed national in scope). Municipalities and hydroelectric operators have generally done fine in repaying their share, according to GAO's calculations, but irrigators haven't. Over time, irrigators' payments have been reduced to $3.4 billion out of the $7.1 billion owed, due partly to bad policy planning and unstable agricultural markets, but mostly to politics. Which leaves me to wonder: in a water-strapped future world, would we see a reassignment of this political favoritism? Would the water-wise suburbanite one day occupy the national soft spot historically held for the yeoman farmer? I anticipate this being a hard sell to the rest of the country. After all, Douglas County approached its water crossroads deliberately – and so, too, are many other places.

Water Scarcity is Nobody's Problem

"Nobody's Problem" is probably an exaggeration. What I mean to express in this scenario is the possibility that Douglas County's future water "Gap" will become the problem of just a few people – a few people who stand to benefit handsomely from scarcity economics. This scenario also sounds somewhat crazy – how could a handful of people profit privately from the water needs of the public? – but it exists as a real possibility, and that possibility is called the Million Pipeline. A Colorado-based entrepreneur named Aaron Million wants to build a 550 mile pipeline from the Flaming Gorge Reservoir on the Wyoming border to the southern metro area for the purpose of pumping roughly 200,000 acre feet of idling Colorado River allocation to

Denver's suburbs. Million has even pitched the pipeline to two federal agencies for permitting, both of which have thus far denied his applications. By Million's calculation, the pipeline would cost about $3 billion, much of which would be covered by private investors. (Opponents put the figure closer to $9 billion.) Squeamish at the thought of water privatization, the municipalities and water suppliers of the southern metro area have been working on their own version of this massive plan (a publicly funded option) under the banner of the Colorado/Wyoming Coalition. Either scenario sounds extreme – 550 miles is a long way to transport water. Environmental groups such as Western Resource Advocates have come out strongly against the concept. Currently, a state-commissioned independent task force is studying the project's viability.

Water Scarcity is Some People's Problem

Colorado has taken a cooperative turn in dealing with water resources problems over the past six years or so, lending some momentum to a future in which Colorado takes care of its water problems in-house, without major federal or private intervention. State legislators launched the Inter Basin Compact Committee in 2005, establishing a process and a forum for bringing together stakeholders from each of Colorado's seven major river basins to address water issues through consensus-based negotiations. As an experiment in statewide collaboration, the IBCC is both unmatched and unprecedented. On a similar note, Western Slope and Eastern Slope water interests recently signed a historic pact of cooperation on future water supply challenges, easing over a century of animosity between residents of the Colorado River Basin and Denver Water. Closer to Douglas County, a deal between Denver Water, Aurora Water, and the South Metro Water Supply Authority recently paved the way for an innovative water-sharing deal aptly nicknamed the WISE Project. Under WISE, the three entities will redistribute water scarcities and surpluses in ways that benefit all of them. The project will also stretch water resources further by instituting more water reuse on the Front Range than ever before. All together, these achievements echo the idea from the water scarcity literature that there might be a "sweet spot" for collaborative behavior – a point when water scarcity isn't too high or too low, but just right for achieving smart, cooperative outcomes.

A Molecular Model

Which brings me to my egress – that cautious note of optimism on which environmental critiques typically end, an exit strategy both for Douglas County and for myself as a writer. It isn't a broad, far-reaching prescription, but a prompt to inspect the thing that is most central to Douglas County's story: the water molecule itself. For our best teacher in collaboration, we need not look much further. Water gains its best attributes from the fact that it exists in a polarized environment. The H_2O molecule's slightly negative and slightly positive ends encourage it to interact with others on every side. In so doing, water molecules form elaborate networks of hydrogen bonds that are constantly breaking and reforming. Despite perpetual motion and changing circumstances, those bonds are strong enough to create the unique properties of water that make it integral to life – strong cohesion, adhesion, and surface tension, a remarkable ability to absorb heat and a correspondingly high boiling point, as well as an ability to play the role of "universal solvent." Properties, all, that the we might learn from by example.