

Concepts of Ground Water Recharge and Well Augmentation in Northeastern Colorado

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ABSTRACT

In northeastern Colorado, severe drought plus recent state court rulings have caused new and increased pressures on water rights. The current drought has been analyzed and is now thought to be a 300-year event based on proxy data obtained from tree rings. The drought factor, dramatic regional growth, transference of water from agriculture to municipal, and the increasing price of water have all put water rights under new and increased pressures.

Tributary wells in the South Platte River Basin, in particular, have been severely impacted because of recent State Supreme Court rulings. In response, several ditch and canal companies have implemented their own ground water recharge programs and well augmentation plans to replace out of priority depletions to the river caused by well pumping. The approaches that several canal companies have used in developing a long term strategy are described. Interestingly, the dynamics of ground water recharge and well augmentation programs also dovetail nicely with canal modernization strategies and SCADA.

In particular, the efforts of the New Cache la Poudre Irrigating Company and the Union Ditch Company are described to include application for new junior water rights, implementation of ground water recharge programs, and filings of augmentation plans for member wells in their respective service areas.

INTRODUCTION

Contentious issues have never been in short supply in the arena of Colorado water rights. That is particularly true today. In recent years, the authority of the State Engineer to approve substitute water supply plans has been successfully challenged and this put a 30-year-old augmentation plan for approximately 4,000 wells in the South Platte River basin in jeopardy. In fact, the Groundwater Appropriators of the South Platte (GASP) is gradually being dissolved. GASP was heavily reliant on leased water to meet timed well depletion obligations. As a result of GASP's demise, many subgroups of the 4,000 wells have formed, some as individual farm well groups, and some as larger groups, often under the auspices of the mutual irrigation companies.

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Mutual irrigation companies logically get involved in well augmentation plans because they typically hold the decree on behalf of the shareholders under the ditch and because many of those shareholders are well owners, recently well owners needful of a suitable augmentation plan.

Although a rather small group of engineers and attorneys has been involved in well augmentation plans in the past, the current situation has provided both opportunity and necessity for additional technical expertise. Also related, Colorado State University has been actively involved and “in the fray” so to speak in providing useful supporting technical models. These models, described further in a later section, allow the engineers to build timed depletion models on a transparent platform for conformity, better understanding of technical minutia, and most importantly, reduced time in both building (for the applicant) and scrutinizing (for the objectors) depletion models to be used in substitute water supply plans, augmentation plans, and ultimately in water court proceedings.

This paper describes some concepts of ground water recharge and well augmentation and comments on the process and the recent experience.

WATER RIGHTS IN COLORADO

Colorado was the first state to develop a system of water rights and laws based on the prior appropriation system. The core of the system is “first in time, first in right.” So, if you were the first to divert the water from a stream, then you are the first priority on the river, and so forth. Calls on the river are satisfied according to the priority or priorities enjoyed by the water right holder. This approach, started in the mid-1800s, has worked quite well for Colorado and other western states.

In the late 1960’s, a State of Colorado statute legally recognized that tributary ground water is hydrologically connected to surface water⁴. Consequently, both ground water and surface water are administered under Colorado’s prior appropriation system. Colorado’s water supply can come from either surface or tributary ground water sources, both of which are governed in the same way.

WELL AUGMENTATION

When the State of Colorado determined that tributary ground water and surface water should be administered together, they also determined it necessary to develop well augmentation plans. An augmentation plan is a water court approved plan designed to protect senior water rights, while allowing junior water rights to divert water out of priority (CFWE, 2003). These plans insure that the out-of-priority ground water depletions from junior wells are augmented (replaced) at the proper time, location, and quantity so as not to injure more senior water rights.

⁴ When this paper refers to ground water, it is referring to tributary ground water that is hydrologically connected to surface water in streams and rivers. This should not be confused with deep ground water, which is not regulated by the prior appropriation system in Colorado.

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Since the late 1960's, over 4,000 well owners in the South Platte Basin have belonged to the GASP well augmenting entity. This entity provided replacement water for well depletions on a year by year basis by primarily leasing surface water. Over the last 30 years, GASP had operated under a temporary augmentation plan (otherwise referred to as substitute water supply plan), which was approved by the State Engineer annually. Compounded in part by drought and recent legislation in the State Supreme Court, these 4,000 wells are now required to file permanent augmentation plans by the end of 2005.

In general, the process behind a well augmentation plan is to: (1) determine ground water depletions caused by wells, (2) analyze replacement water sources needed to insure senior water rights are not injured by the depletions, and (3) administer and account for the operation of the plan.

Over the last year and a half both the Union Ditch Company (Union) and the New Cache la Poudre Irrigating Company (NCLPIC) have been in the process of refining their augmentation plans, which were filed with the water court in 2003. Figure 1 shows the Union Ditch service area, which is located southeast of Greeley. A major component of an augmentation plan is an engineering analysis used to determine the lagged effects of ground water pumping on the river. These depletions must be analyzed in the context of replacement water sources that are needed to insure injury does not occur. This paper will discuss some of the key components of this engineering analysis, with particular reference to the plans submitted by NCLPIC and Union.

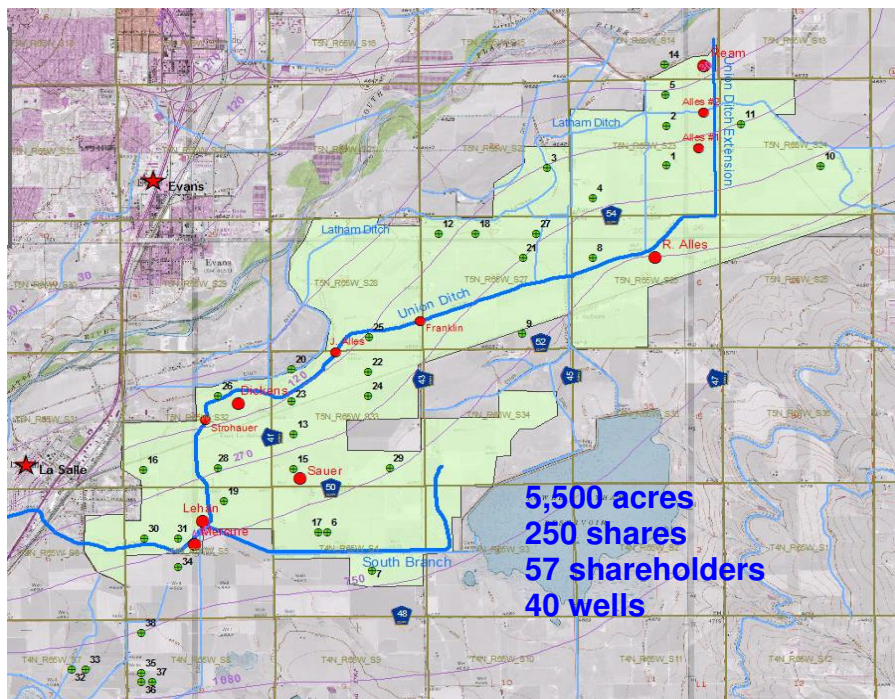


Fig. 1. Union Ditch Company service area.

ENGINEERING TOOLS AND MODELS

The most widely used engineering tools and models used to support augmentation plans in the South Platte Basin have been developed by the Integrated Decision Support (IDS) group at Colorado State University (www.ids.colostate.edu).

The Consumptive Use Model (IDSCU) is used to determine a detailed water budget for farms. Using farm characteristics, surface water supply, and weather data, the model can be used to determine the total water requirement for a farm, the water available from surface water to meet farm water requirements, and the amount of ground water needed to satisfy farm water requirements not met with surface water supplies.

The Stream Depletion Factor Model (SDF View) and the Alluvial Water Accounting System (IDS AWAS) include several methods that can be used to determine the movement of ground water from the river to the well. Conversely, these models can also be used to determine the movement of ground water from recharge ponds to the river.

Simply stated, when a well is pumped there is a depletive effect on the surface water but the impact may not be immediate. Likely the effects of pumping are felt days, weeks, or even years later.

As an example, if the well were very close to the river, even adjacent to the river, the effect would be almost identical to a direct diversion on the river. Colorado law recognizes this in that a well within 100 feet of the river is administered exactly like a headgate. Conversely, if a well is far from the river, the effects of pumping do not reach the river for many days. See Figure 2.

The time delay in Figure 2 is expressed in days and termed the stream depletion factor or SDF. Stream depletion factors are used to determine the lag time from when water is pumped from the aquifer and when the depletion happens in the river -- the larger the SDF, the more delayed the impact on the river (directly proportional to the squared distance from the river).

The USGS completed an extensive mapping of the South Platte in the 1970's and determined SDF values. Maps showing lines of constant SDF were developed and these maps continue to be valid and useful today for those areas mapped at that time. Other areas of the South Platte have never been mapped but additional work is being done by consulting firms in support of their client needs to predict the depletive effects of pumping. The SDF method is one of the most common methods used in these plans to predict stream depletion as well as stream accretion from ground water recharge.

REPLACEMENT WATER SOURCES

Newly formed well augmentation groups are making use of a variety of replacement sources. Because these water sources must replace ground water depletions at the proper time (often throughout the year), location, and quantity, it is necessary for these groups to have a diverse

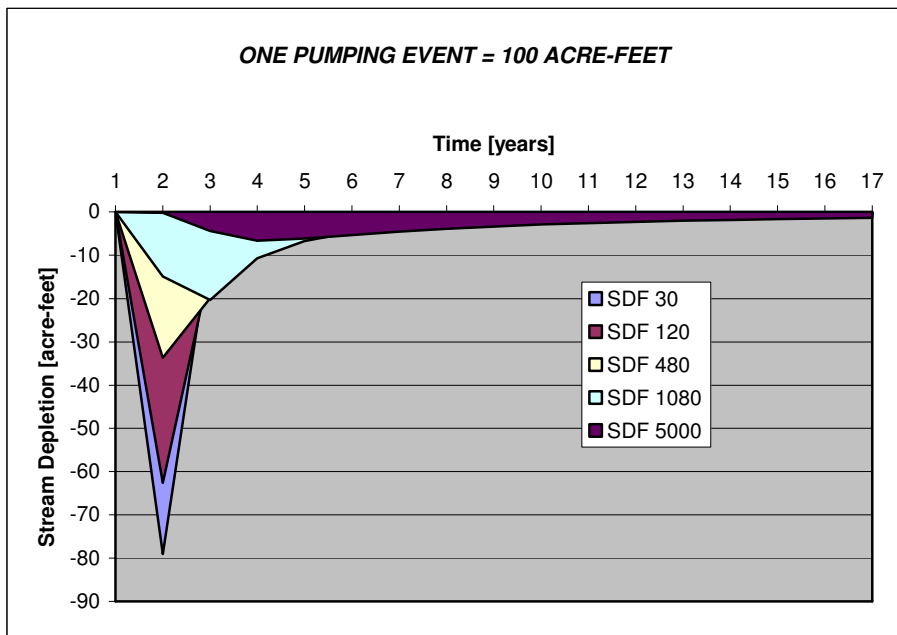


Fig. 2. Assume one pumping event at 100 acre-feet; if the well is located at 120 days from the river, most of its impact on the river will occur in the first two years after the pumping event. If the well is located 5,000 days from the river, the most significant impact on the river will occur 4 years after the pumping event.

water supply portfolio. Some examples of water replacement sources that are used in the basin include:

(1) **Storage Water** - many companies have storage water rights in reservoirs, which may be changed through the water court and used for augmentation purposes. Augmentation sources in storage offer a degree of flexibility over other augmentation sources because they can be released from the reservoir on an as needed basis. For example, Union Ditch Company owns several shares in a local reservoir company which it plans to use for augmentation. Union may request the exact amount of water to be releases at the exact time that water is needed.

(2) **Senior Direct Flow Water** – many companies are in the process of purchasing direct flow water rights from shareholders within their own company or within other companies. Once purchased, these water rights can be changed through the water court and used for augmentation purposes. In order to meet the objectives of the State, it is becoming increasingly important for augmentation groups to actually own, rather than lease their replacement sources. This has real

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implications for agriculturalists, who find it difficult to compete with the high market price of water in the region.

(3) **Excess Augmentation Credits** – the water replacement portfolios for each augmentation group differs significantly. As such, there may be times when one group has developed excess augmentation credits that they can lease to other groups that are in need. Union and NCLPIC are two of several groups that have identified each other in their augmentation plans as sources of additional water supply.

(4) **Dry-up of Irrigated Land for Bypass** – it is not known at this time if the temporary dry-up of irrigated land for purposes of bypassing water supplies is an acceptable source of replacement water. The concept is that during times of drought, farms would dry-up all or a portion on their irrigated land. Water previously dedicated for irrigation on this land would bypass the farm and become available for augmentation credit.

(5) **Retiming Wells** – ground water pumped from tributary wells can be a source of replacement water if the well is covered in an augmentation plan. Retiming wells are used to “retime” stream depletions. For example, a well group may pump their retiming well because they need replacement water in the river today, with the hope that they have water in the future to repay the retiming well depletions that are yet to occur in the river. Figure 3 shows a retiming well that is used to pump water into a spillway to the South Platte River. Because retiming wells do not provide a real source of replacement water (it is actually tributary ground water), they aren’t a preferred replacement source; however they are commonly used.

RECHARGE PLANS AND RECHARGE STRUCTURES

Another commonly used source of replacement water includes developing a new, junior water right for recharge. Both NCLPIC and Union filed for junior water rights in 2003 with the intent of diverting water from the South Platte River during wet periods and/or during the winter (whenever their new right is in priority). The water will be diverted into newly constructed recharge ponds located at varying distances from the river depending on the desired timing of the accretions. Water placed in the “recharge structure” ponds will be allowed to seep into the ground and will slowly move towards the river, where it will ultimately serve as augmentation credits. The IDS models can be used to determine the strategic location of these ponds to insure that recharge credits hit the river at the time needed to replace well depletions (Figure 4).

PLAN ACCOUNTING

A significant component to the augmentation plan is real-time measurement, recording, and accounting. Plan operations must be reported to the State at least on a monthly basis and must include a daily accounting of well depletions and replacement activities in the river. The most accurate measurement equipment is required for plan monitoring and reporting activities. This degree of accountability is needed to insure other water right holders and the public that well pumping is not unjustly impacting the water supply in the river. Interestingly, the checks, flow measurement structures, gates, and SCADA that may be required for plan monitoring and

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reporting are also desirable from the standpoint of modernizing the canal system. This is proved to be a factor in both the Union Ditch and the New Cache La Poudre Irrigating Co. situations.



Fig. 3. Retiming well in operation. Water is pumped from the ground and is delivered to the river to cover stream depletions from irrigation well pumping. Sometime in the near future, stream depletions from the retiming well will occur in the river, and must be covered.

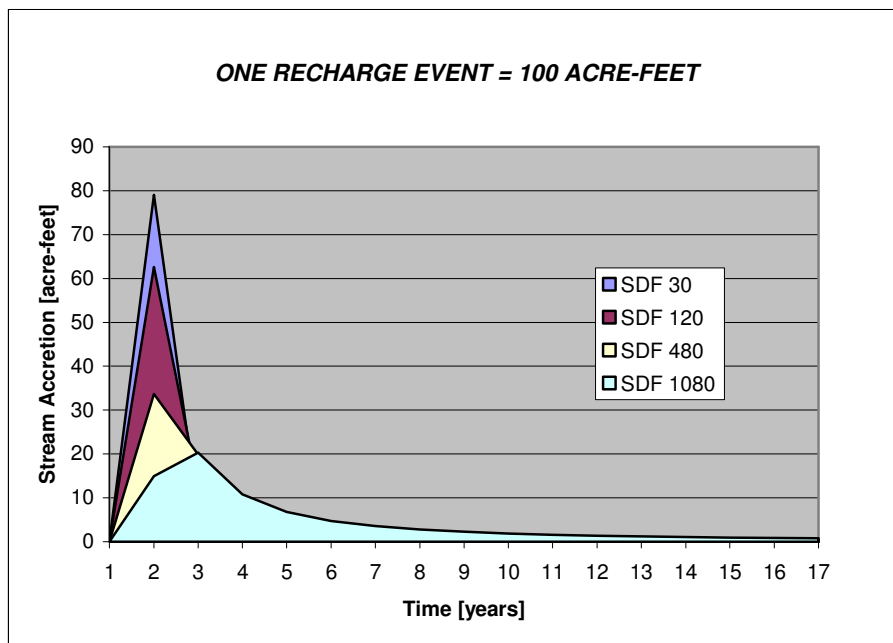


Fig. 4. The concept of ground water recharge is essentially the same as ground water depletion, only in reverse. Recharge ponds can be located so as to strategically time recharge to the river.

SUMMARY

Colorado's water supply is limited and, in many streams, over appropriated. Severe and unprecedented drought has aggravated an already difficult situation. Well pumping in the South Platte River basin has come to the fore as an issue and substitute water supply plans and well augmentation plans are receiving heavy scrutiny from objectors. Water court proceedings over the next few years will likely set law, rules, procedures, and impositions on all types of water rights.

So where is all of this likely to go? Likely future outcomes include:

- Increased scrutiny of all aspects of Colorado water rights.
- Increased reporting and administrative requirements imposed by the Colorado Water Court and the State Engineer's Office.
- Increased need for measurements, including real time measurements.
- Some agricultural wells will not be augmented, which results in all the related consequences and impacts on Colorado's agricultural economy.
- More difficult, time consuming, and expensive water court proceedings and challenges.
- More discord between conflicted interests without implementation of conflict resolution and negotiation elements into the process.

REFERENCES

Colorado Foundation for Water Education (CFWE). 2003. Citizen's Guide to Colorado Water Law. Prepared by Colorado Foundation for Water Education. www.cfwe.org