

February 7th, 2014

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This memo serves as a final assessment by the Independent Science Panel (hereafter referred to as the panel) of the Final Report concerning the HB12-1278 *Study of the South Platte River Alluvial Aquifer* submitted by the Colorado Water Institute on December 31, 2013 (hereafter referred to as the report). This memo is organized into five sections. The first section summarizes the background on the organization, makeup, and purpose of the review panel. This is followed by the panel's assessment of the HB12-1278 study analyses, findings, and recommendations. The last section contains recommendations suggested by the panel for future efforts.

Background

The Colorado Water Institute (CWI) convened an independent science panel of water resources scientists to serve as peer reviewers of the work performed by the Institute to meet the requirements of HB12-1278. The panel members are: Dr. John C. Tracy, Director of the Idaho Water Resources Research Institute (Chair); Dr. Deanna Durnford, Professor Emerita, Civil and Environmental Engineering, Colorado State University; Mr. Geoffrey Delin, Hydrologist and Regional Groundwater Specialist, USGS; Dr. Willem Schreuder, President and Principal Scientist, Principia Mathematica Inc.; and Mr. Peter Barkmann, Hydrogeology Supervisor, Colorado Geological Survey.

The panel was convened at a meeting organized by the CWI and held at Metro State University in Denver, CO on November 19th, 2012. At this meeting, the panel was charged to:

- Review the CWI team's approach to data management, summary and display
- Review the CWI team's analysis of the data
- Identify gaps in the data or analysis - areas where more science is needed to provide guidance for policy decisions
- Render a consensus view of what the data show (or do not show) is occurring under current management in the South Platte alluvial aquifer and river basin
- Recommend next steps for the State of Colorado to consider

Subsequent meetings of the panel were held:

- February 6th, 2013 (CDM Offices, Denver, CO);

- April 25th, 2013 (University of Colorado, Boulder, CO);
- September 25th and 26th, 2013 (University of Colorado, Boulder, CO); and
- December 5th, 2013 (University of Colorado, Boulder, CO).

At each of the review panel meetings, presentations were provided by members of the CWI study team, and other professionals knowledgeable about water resource management issues in the South Platte River basin. These presentations provided the panel with an opportunity to focus on specific issues associated with studies funded through HB12-1278 and to provide feedback to the CWI team as the study progressed.

Assessment of Study Analyses

The Colorado Water Institute is to be commended for undertaking a study of this magnitude in a very constrained period of time. In general, the Scientific Review Panel feels that the approach taken by the Colorado Water Institute for data management and display is appropriate.

The HB1278 study reports on components of the water balance (e.g. phreatophyte evapotranspiration, streamflow, groundwater storage as reflected in water levels, groundwater pumping, augmentation, and climate) in individual chapters. There are two types of analyses in the report. Some of the analyses use standard statistical methods to analyze measured data that vary spatially and temporally. For example, water-level trends are based on direct measurements of water levels in monitoring wells. Similarly, streamflow data are available over time at major gauges along the South Platte. Although, there may be a lack of data during some periods and for some locations, standard accepted methods were to determine trends and conditions based on these data.

In other cases, when measured data are not available, components of the water balance are estimated, and in most cases, standard accepted methods were used in arriving at these estimates. For example, the water pumped, augmentation recharge, and phreatophyte are estimated by indirect methods. Groundwater pumping is assumed to be the potential crop evapotranspiration estimated indirectly from climate data, modified by an efficiency factor based on the irrigation method (surface or sprinkler). Augmentation requirements are assumed to be equal to the calculated water consumed. Similarly, phreatophyte ET is estimated indirectly from Landsat data and the Normalized Difference Vegetation Index. We believe the trends reported are valid but the absolute numbers in these estimates may be in error.

The HB1278 study assumes that the aquifer is entirely unconfined and all storage is in pore spaces drained by gravity. The concept of the aquifer as simply a storage vessel misrepresents its complexity. In fact, the literature suggests that even the alluvial aquifer along the main stem of the river behaves locally as a confined or semi-confined aquifer. This heterogeneity is not effectively discussed in the study. Consequently, it would be easy to misinterpret data and

mismanage water in the basin if it continues to be treated as a simple storage vessel. The complexity of the aquifer may play an important role in understanding flow paths and why localized areas of shallow groundwater occur within the basin.

The study was hampered by a lack of good historical data, especially regarding groundwater resources. Given how important a resource the South Platte is to the wellbeing of the municipal and agricultural communities in Water Districts 2, 1 and 64, the panel believes that this lack of good scientific measurements of critical parameters should be rectified in the future by additional data collection and analysis. The South Platte Decision Support System (SPDSS) was a good starting point to integrate what data is available, but there are many data collection efforts by various entities that have not been incorporated into the SPDSS. What this study has demonstrated is that we are not collecting and integrating the data needed to be able to explain the cause-and-effect relationship of the different management options in the South Platte basin. In order to do so, a commitment must be made to continue data collection efforts already started as part of the SPDSS, such as the water-level measurement program, but also to incorporate data collected by other entities into these data sets.

The panel believes that, in isolation, each of the components are reasonably estimated and the results represent good science, but both the magnitude and trends in the data needs to be reconciled in a more holistic fashion as discussed below in the *Further Recommendations* section of this memo.

Assessment of Study Findings and Conclusions

In general, the data and analyses presented in the report support the study findings and conclusions.

At a basin scale, data show an increase in streamflow approximately a year after a corresponding increase in the net groundwater recharge. As such, it is appropriate for the HB12-1278 study to conclude that, at the basin scale, the water rights system is working as intended, i.e. recharge augmentation is replacing stream depletion.

One area where it is difficult to develop a clear cause-and-effect relationship is between augmentation practices and local rising water levels. One of the goals of the HB1278 study was to identify and conduct a feasibility-level evaluation of the causes of high groundwater tables in local areas. The data show that water tables have risen localized areas in the last decade (page 8). This rise in the water table *appears* correlated with an increase in augmentation recharge and a decrease in groundwater pumping. However, the data are insufficient to establish a causal relationship between specific actions and these higher water tables. To do so would require a detailed local-scale field and modeling study. The HB1278 study therefore cannot reach a specific conclusion as to what specific local conditions caused these higher water tables.

Assessment of Study Recommendations

To the extent that the goal of the HB1278 study was to investigate the causes of localized areas of high water levels, the data support the conclusion that water levels have risen in localized areas in recent years. Furthermore, this rise in water levels is correlated with an increase in recharge and a decrease in groundwater pumping at a basin scale. However, the data are insufficient to establish a causal relationship at the local scale. To address this, the study recommends two pilot projects be authorized and funded by the Legislature to track and administer high groundwater zones at Sterling and Gilcrest/LaSalle while testing alternative management approaches. The recommendation that smaller scale pilot studies should be performed to further investigate the causes of these high water levels and evaluate mitigating actions is appropriate.

The SPDSS groundwater model would be a good starting point for evaluating the pilot projects recommended. However, it does not currently cover the appropriate time periods, nor is it spatially sufficiently detailed for this purpose. Reference is made to developing a localized groundwater model as part of both pilot studies (under 2B of the recommendations). We agree and, furthermore, think that these new models need to be useful as water-management decision tools, not just groundwater or surface-water models. The review panel recommends that the models be capable of making decision-support predictions, simulating economics, pumping, injection, augmentation, or discharge rates at any location. These predictions need to be made within specified constraints, such as the economics of water rights, climate variability, call predictions, pumping needs, specified upper or lower bounds of hydraulic head, drawdown, head gradients, streamflow, streamflow depletion, and so forth. Following calibration, the models need to be useful as templates for other areas in the South Platte River Basin.

The panel found some of the study recommendations too detailed and prescriptive for the scientific knowledge that currently exists in understanding the behavior of the water resources within the South Platte Basin. For example, the recommendation that calls for a more detailed characterization of the hydrogeologic heterogeneity of the aquifer is appropriate, but identifying specific technologies (such as helicopter surveys of the entire basin) seems premature. Although helicopter surveys may prove to be the best approach, further study is needed to determine the appropriate technologies that should be used to characterize heterogeneity in the aquifer. In addition, to effectively analyze how this heterogeneity impacts the water balances and elevated groundwater levels in the South Platte Basin, a detailed three-dimensional model of the aquifer describing the heterogeneity in aquifer characteristics (hydraulic conductivity, storativity, stratigraphy, head distribution) needs to be developed.

We agree with the recommendation that the CWCB, CDA and DWR work with the USGS to implement the basin-wide monitoring program outlined in the study. However, before implementing the program, the program should be evaluated with regard to its ability to address water quality, as well as water quantity, issues factoring in what the data will be used for in terms of data analysis as well as modeling.

The recommendations regarding increased augmentation plan efficiency, a water bank, and similar actions appear to be sound, policy-level recommendations. We agree that basin-wide guidelines for the implementation of administrative curtailment orders that reduce waste and facilitate efficient management and distribution of available water supplies to storage and recharge water rights may have a significant positive impact on the basin. We also agree with the recommendation that a consultation to the water court regarding new recharge structures should be considered. However, from a scientific perspective, the data and tools to implement such policies are currently inadequate and the implications of these policies are unknown. We commend CWI for bringing these to the table. However, future phases of the study should be charged with obtaining the scientific data required to implement these policies, developing an integrative analysis framework to quantify the implications of these policies, as well as developing specific guidelines and procedures to ensure the effective implementation of these policies.

Further Recommendations

The biggest shortcoming in the HB1278 study is that it fails to put all the individual pieces together. In its current form, the study is fragmented and does not develop scientifically sound conclusions regarding cause-and-effect relating to the various stresses on the groundwater system. The study could be significantly enhanced by integrating the individual study components to obtain a more holistic understanding of the South Platte Basin in a systems analysis context. The first step in this integration would be to develop a water budget for the entire system, as well as a water budget for the groundwater system. These water budgets can then be used to construct a conceptual model of the behavior of the groundwater system, the interaction between the surface and groundwater systems, and provide a first-order approximation to the behavior of the system as a whole.

While the SPDSS was not explicitly used in the HB1278 study, it was referenced numerous times and there is a recommendation to continue strong support for the model. While we recognize the strengths of the SPDSS model, the panel is concerned that the SPDSS is oversold in the report. The report accurately states that the large SPDSS model as it currently exists will not be useable to make water-management decisions (page 25), which is what a water manager actually needs. The review panel suggests that a better use of resources might be to develop smaller-scale predictive models in areas of concern that can be used directly to address these concerns (as described above). In addition, there are many data collection efforts by various

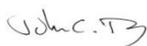
entities that have not been incorporated into the SPDSS. What this study has demonstrated is that data are not being collected and integrated in a manner that can help explain the cause-and-effect of different management options within the South Platte Basin.

The panel agrees with the recommendation in the report to authorize a pilot basin-wide entity with a defined sunset date. However, while the stated goal and long-term objective of this entity would be better basin-wide management, the panel wants to restate that we feel that the data and scientific basis for better basin-wide management does not currently exist. It is the recommendation of the Science Review Panel that a comprehensive research plan be developed first for the South Platte Basin to more fully address the issues identified in HB12-1278. This plan should include considerations for (a) integration of the data presented in the HB 1278 study, (b) clear research objectives and methods for a small-scale pilot study to evaluate alternative management approaches, and (c) a comprehensive evaluation of the economic, political, water resource and environmental consequences of alternative management options for the basin-wide management of the South Platte. The panel believes that with adequate data, proper data management, and good science, the South Platte surface water/ground water system can be managed in a holistic manner to the benefit of the region. Once these prerequisites are met, holistic management requires integration of the many, often divergent, interests within the basin, with the latter may be the greatest challenge ahead. We agree that curtailing the administrative calls on the river is one option that should be seriously considered. However, the implications and administration of this, along with other alternatives, should be more carefully studied.

Summary

The Scientific Review Panel feels that the HB1278 study has made a significant contribution to our understanding of water resources in the South Platte Basin and the CWI team is to be commended. However, there are gaps in data, modeling tools, and particularly in the integration of these data, that currently limit our understanding and ability to manage the basin effectively. The panel feels that further investments that focus on addressing these gaps in knowledge will significantly aid in the future management of water resources within the South Platte Basin.

Sincerely,



John C. Tracy, Chair



Willem Schreuder

X

Deanna Durnford

Deanna Durnford



Peter Barkmann



Geoff Delin