RECEIVED
FEB 08 2013
DEPARTMENT OF
WATER RESOURCES

Project No. 1159-01-2011 and 1179MSB01

Rebuttal of Reports by Bryce Contor in the Matter of Rangen Inc. - Availability of Spring Flow and Injury to Water Rights

Prepared for:

Rangen, Inc.

February 8, 2013

PROFESSIONAL ENGINEER
REGISTERED
1696
02/08/2013
STATE OF IDAHO
CHARLES E. BROCKWAY

Charles E. Brockway, Ph.D., P.E. Brockway Engineering

David Colvin, P.G. Leonard Rice Engineers

Jim Brannon, Brannon Developments

Bryce Contor, in behalf of the Fremont Madison Irrigation District, and as an employee of Rocky Mountain Environmental Associates Inc. offered two reports in 2012 pertaining to estimated uncertainty in the ESPA water budget utilized for ESPAM 1.1.and, subsequently, for ESPAM 2.0 and ESPAM 2.1. These reports provided a lengthy dissertation on the sources of uncertainty in ground water models and particularly the ESPAM model version 1.1. Contor concluded, based on his analysis and the IWRRI 'Base Case Scenario" for ESPAM 1.1, that the 'estimated uncertainty in the ESPA model water budget was ±17 %. He further concluded that, because the estimated ESPA water budget for ESPAM 1.1 was ±17 % that the estimated uncertainty of the ESPAM2.0 ground water model water budget could be 'reasonably expected to also be in this range'.

He further propagated the water-budget uncertainty into an indication of the uncertainty of transmissivity (an aquifer hydraulic parameter) by applying Darcy's equation to the entire aquifer and assuming that the entire rate of flow through the aquifer was the estimated water budget and that all of the annual discharge flowed through the full width and length of the aquifer. He thereby concluded that the variance of the aquifer transmissivity was "driven entirely by the variance in the water budget".

The Idaho Water Resources Research Institute, for which Bryce Contor is a former employee and co-author of the ESPAM 1.1 and ESPAM 2.0 ground water models, issued the report "Hydrologic Effects of Continued 1980-2002 Water Supply and Use Conditions Using Snake River Plain Aquifer Model Version 1.1 Base Case Scenario" in December 2005. Appendix A of this report outlined a method of estimating confidence bars on the water budget based on the *variability in the estimation and measurement methods of individual components of the water budget*. The estimate of 'confidence limits' on the various defined components of the ESPAM 1.1 water budget are contained in Table A1 of the IWRRI report reprinted here:

Table A1

Estimation of Water-Budget Standard Deviation

Water-Budget Element ESPAM 1.1	Acre Feet/year	Confidence, +/-	Estimated Standard Deviation, acre ft/yr
ET on irrigated lands	-5,370,000	10%	270,000
Recharge on non-irrigated lands	527,000	50%	130,000
Precipitation on irrigated lands	1,720,000	10%	86,000
Net surface-water irrigation deliveries	6,870,000	5%	170,000
Offsite groundwater pumping	-66,000	10%	3,300
Fixed-point withdrawals	-139,000	10%	7,000
Seepage from perched tributaries	274,000	15%	21,000
Tributary valley underflow	924,000	50%	230,000
Canal leakage	459,000	10%	23,000

The listed variances of the water budget components of ESPAM 1.1 are all estimated based on expected accuracy of the estimation methods expressed as plus or minus a given percentage. A range is then calculated as a percentage of the estimated component water budget volume per year and the standard deviation for all components is estimated as one-fourth of the range. For example if the water budget for the ET on irrigated lands is 5,370,000 acre feet per year and the estimated confidence is ±10%, then the range is 2x.10x5,370,00=1,074,00 acre feet and the estimated standard deviation is 1/4x1,074,000=268,500 acre feet per year (Table A1, Appendix A, Base Case Scenario, IWRRI) . Only two components of the water budget, precipitation on irrigated lands and recharge from precipitation on non-irrigated lands are considered to be hydrologically correlated and the covariance was estimated by assuming a correlation coefficient of 0.8 in order to get an estimate of combined standard deviation of 440,000 acre feet per year. The analysis ignores the reduction in uncertainty that may come from negative correlation that occurs during balancing of the water budget even though any negative covariance reduces the overall uncertainty.

All of the inputs to the above analysis used to estimate the Water Budget Standard Deviation are estimated. The confidence ± was estimated to the nearest 5% with no statistical analysis (Table A1) and the standard deviation of all components was arbitrarily estimated for all components as one-fourth the estimated range. This table was compiled by IWRRI as an estimate only to ascertain a possible standard deviation for the water budget. Contor cites the Base Case Scenario report as indicating that the Water Budget uncertainty of ESPAM 1.1 is approximately ±17%. This statement is not included in the Base Case Scenario report or in the Appendix A to the report and it is not clear how the ±17% was calculated, either in the IWRRI report or in the Contor report. In any case, the estimate is not based on any rigorous statistical analysis and should be viewed at best as a broad estimate.

Contor, in his October 1, 2012 report, "Technical Report on ESPAM2.0 Modeling Issues" concludes on Page 11 that the transmissivity, T, of the ESPA is also on the order of 17% based on an incorrect application of Darcy's law. The Darcy equation stated on Page 11 of this Contor report, Q=Twdh/dl or T=Q*(1/w dh/dl) or T=Q*(1/wi) is correct. T=aquifer transmissivity, w=aquifer width, dh/dl is the gradient or i. Application of this equation is correct for a hypothetical aquifer which exhibits a uniform transmissivity throughout the entire aquifer, a uniform width and a hydraulic gradient which are perfectly known. However, to apply this formula to a heterogenous aquifer with some 11,000 calibrated T values and then assume that the variance of the gradient and the width are zero and the variance of the transmissivity is driven entirely by the variance of the water budget is incorrect. This incorrect application of the calculation of the variance of T, (V(T), leads to the erroneous assumption that the transmissivity, T, will exhibit an uncertainty on the order of ±17% which Contor has previously assumed is analogous to the ±17% V(Q) uncertainty which he somehow calculated, based on the IWRRI Base Case Scenario report. These assumptions are erroneous because the calculation of the variance of a product must include the products of the variance of all independent variables.

Contor states, page 23, that, "The uncertainties expressed here can be considered as expressions of the probability that a given administrative action will produce the benefits to seniors that the model says it will. Combined with the magnitude of benefit to the senior, model uncertainty should be viewed in context of the magnitude and absolute certainty of the effect that the junior *will* undergo. For any proposed action, a large, rapid highly probable benefit is more justifiable than a small, delayed and uncertain benefit". This statement is certainly not based on a hydrological finding or assumption and appears to instruct the administrator in how to apply some type of discretion in administrating water law. It appears to admonish administrators to be absolutely certain of the effect on the junior water right holder before any administrative action is taken. "Absolutely certain" normally implies zero uncertainty which is impossible in a ground water model. Contor is, we believe, a trained hydrologist and not an administrator.

He further states that 'quantity uncertainty is probably at least in the range of the 17% result obtained from water budget analysis and that "the IDWR Predictive Uncertainty work indicates that the difference between two Calibrated ESPAM 2.0-framework models can exceed 500% for some questions, though it is generally much smaller". The water budget statement is unsubstantiated and the statement relative to large differences between "calibrated" models neglects to state that the different 'calibrated models' are only different because the modelers allowed the calibration routine a broader objective function resulting in two models with poorer calibrations compared to the ESPAM 2.0 model. Utilization of percentage differences in output is misleading, especially when differences are small in absolute value. For instance, if the model output for a specific spring discharge is .02 cfs and the minimum and maximum simulated output using the predictive uncertainty procedure is 0.01 and .05 respectively, the calculated percentage difference (maximum effect/minimum effect x 100) is 500%. The arithmetic producing this large percentage number is correct but the absolute value of the difference, 0.04 cfs is likely not within the accuracy of the model output. The ratio max/min has no meaning relative to the accuracy or uncertainty of the model. This ratio does not reflect a statistically determined uncertainty, in fact the predictive uncertainty procedure utilized by IDWR for ESPAM@2.0 reflects only the predictive uncertainty of the model and does not incorporate all of the elements that would be included in a rigorous analysis like a Monte Carlo procedure. More useful parameters, available from the IDWR procedure would be the percentage of difference from the max or min to the calibrated model result coupled with the absolute value of the differences. The ESPAM 2.0 or ESPAM 2.1 models are the result of the best calibration that PEST could provide given the specified objective function.

References

Cosgrove, D.M., Contor, B.A., Rinehart, N., and Johnson, G., 2005, Snake River Plain Aquifer Model Scenario Update: Hydrologic Effects of Continued 1980-2002 Water Supply and Use Conditions Using Snake River Plain Aquifer Model Version 1.1 "Base Case Scenario", Idaho Water Resources Research Institute, University of Idaho.

Devore, J.L., 1987, Probability and Statistics for Engineering and the Sciences, Second Edition, California Polytechnic State University, San Luis Obispo, Brooks/Cole Publishing Co.