EASTERN IDAHO WATER RIGHTS COALITION
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EASTERN IDAHO
WATER RIGHTS COALITION

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12 January 2012

Rick Raymondi
Idaho Department of Water Resources
322 Front Street
Boise, Idaho 83720-0098

Re: Eastern Idaho Water Rights Coalition input on Trim Line.

Dear Mr. Raymondi:

This letter is a response to your invitation to members of the Eastern Snake Plain Hydrologic Modeling Committee (ESHMC) to "develop comments and suggestions in writing regarding the use of a Trim Line" and predictive uncertainty. It is made in behalf of the Eastern Idaho Water Rights Coalition (EIWRC). We respond with background and general comments, discussion of modeling issues, discussion of policy issues, and recommendations. While we focus on Eastern Snake Plain Aquifer Model Version 2.0 (ESPAM2.0), most of the comments apply also to Eastern Snake Plain Aquifer Model Version 1.1 (ESPAM1.1).

BACKGROUND AND GENERAL COMMENTS

EIWRC agrees with the comments of Dr. Willem Schreuder and Dr. Chuck Brendecke that the appropriate questions to ask are broader than just the Trim Line and predictive uncertainty. We agree with Interim Director Spackman that the essence of the Director's need is for the ESHMC to provide input to the Department on appropriate uses and application of ESPAM2.0; what the model can and should do, and what it cannot and should not. We suggest that the most important category for consideration is the realm of things which the model *can* do but *should not.*

We agree with John Koreny that uncertainty is *addressed* by the entire data gathering and modeling process, and that the ESHMC, IDWR and IWRRI have worked very hard to address uncertainty by refining the model and model data. We also agree with Dr. Brendecke that uncertainty can be *assessed* and we assert that it should be. Most sources of uncertainty can at least be discussed qualitatively and many can be estimated quantitatively. Predictive uncertainty can be rigorously assessed quantitatively using published methodology.

DISCUSSION OF MODELING ISSUES

While we believe the Trim Line and a deminimus standard are primarily policy questions, some technical modeling issues should be considered. All models are of necessity simplifications of reality. Simplification occurs because of lack of data, lack of knowledge of subsurface geometry and geology, lack of sufficient computing power, the need for timely completion of the modeling process, and finite resources with which to conduct data gathering. Despite their limitations, models can be extremely useful. Numerical groundwater flow models are often more useful than analytical solutions to groundwater flow equations because the numerical model can better approximate complex geometry, geology and spatial distribution of aquifer properties.

The ESPAM2.0 model is a refinement of ESPAM1.1. ESPAM1.1 was developed with participation of the ESHMC, and development of ESPAM2.0 is proceeding with even greater ESHMC participation. ESPAM1.1 has been deployed by IDWR in determining obligations under delivery calls for conjunctive administration of groundwater and surface-water rights, and for evaluation of potential injury from transfers of groundwater rights. This document discusses the applicability of ESPAM2.0 to the same kinds of administrative decisions.

This discussion of modeling will touch on four areas: 1) Procedural uncertainty; 2) Limitations of conceptual model; 3) Water budget data limitations; 4) Predictive uncertainty.

Procedural Uncertainty

In any process where the outcome materially affects the livelihood or financial fortunes of stakeholders, robust procedural protections are vital. Without implying any lack of professionalism or casting blame, EIWRC suggests that wherever there is simultaneous occurrence of opportunity and motive to bias modeling outcomes, great caution is in order.

In development of ESPAM1.1, most technical work was performed by IWRRI under the direction of IDWR, with some input data prepared by IDWR. The ESHMC process was used to receive non-binding technical input and to provide full transparency of the technical process. ESHMC input was considered but at times overridden by IDWR decisions, often at the suggestion of IWRRI. Hence, the procedural uncertainty of ESPAM1.1 is limited to the opportunities and motives that would have existed within the IDWR and IWRRI team.

ESPAM2.0 development differs in two important ways. First, ESHMC input has carried significantly more weight, with much less willingness of IDWR to override ESHMC input. Second, ESHMC members have provided much technical input to the ESPAM2.0 development process. This has occurred in three areas:

1. Provision of input data by ESHMC members or their clients. These have primarily been refined data on spring discharges, to be used as modeling targets.
2. Provision and review of the On-Farm algorithm and MKMOD software for calculating net recharge associated with irrigation.
3. Participation in core modeling decisions of parameter-estimation setup, weighting of targets,

calibration algorithms, and identification of water budget components to subject to parameter estimation.

The procedural uncertainty of ESPAM2.0 includes not only the potential motivations and opportunities of IDWR and IWRRI, but of all the participants in the three technical areas described above. EIWRC strongly recommends that IDWR explicitly and deliberately evaluate whether adequate oversight, transparency and accountability have been provided to address the issues of opportunity and motive surrounding all technical input to the modeling process. This is not meant to be an assertion of impropriety, but an effort to protect both the product and the participants.

Limitations of Conceptual Model

The conceptual model used in ESPAM1.1 and ESPAM2.0 differs from our actual understanding of the physical system in at least four important ways:

1. The model is a single-layer representation. However, there is strong physical evidence of vertical separation of aquifer zones or perhaps separate aquifers in a number of areas, including the Henrys Fork, the Rigby Fan, and the Burley area. There are anecdotal indications of two vertical zones in the aquifer immediately above the canyon rim west of Wendell.
2. The model represents the aquifer as a locally uniform porous medium, with aquifer properties smoothly interpolated between a few hundred pilot points distributed across an area of approximately 11,000 square miles. In reality we believe that much of the aquifer is hosted in fractured basalt (itself non-uniform), and that there are locations where the aquifer abruptly transitions between basalt and unconsolidated sediments, in either the vertical or horizontal direction.
3. The model uses the USGS MODFLOW code, which can only represent the hydraulics of spring discharge using the linear Darcy equation.[i] This may differ from reality:
   - 3.1. Spring discharges are large enough, and confined to small enough discharge areas, that flow velocities may be high enough to violate Darcian flow assumptions, even if occurring in a locally uniform porous medium;
   - 3.2. The existence of discrete springs (rather than a broad seepage front) and observation of rubble zones and fractures on the canyon face suggest that fracture or conduit flow may actually govern spring discharges. This type of flow is more likely to be governed by non-linear turbulent processes.
4. The model does not explicitly represent distinct fault zones and breaks in subsurface geology known to exist in the Rexburg Bench and Oakley Fan areas.

These departures from reality were taken deliberately and for good reasons, and in our opinion are generally appropriate given the resources and data available for this modeling project. Nevertheless, these conceptual model decisions have important implications on uncertainty and spatial and temporal applicability of the model.

1. Single-layer representation means that all wells in a small geographic region will be represented to have essentially identical effects upon springs and river reaches. In reality a deep well completed in a lower aquifer will tend to have more of its effects expressed at distant locations, while a nearby shallow well will have more of its effects expressed at nearby springs or river reaches. Similarly, in reality the propagation of effect from the deeper well will be delayed in time relative to the shallower well.
2. Representation as a locally uniform porous medium also tends to attribute similar effects to wells in a small geographic region. In reality two nearby wells may have markedly different effects, if

one is completed in gravels and another in adjacent basalts, or if one is near a fracture zone and another is within a mass of relatively unbroken rock.

3. Using a linear representation of what may be non-linear hydraulic processes has directly affected the combinations of aquifer parameters and adjustments to input data that have been adopted in parameter estimation, in order to best match the temporal hydrographs of target discharges.
4. Omission of known faults and geologic boundaries means that modeled indication of propagation of effects across these boundaries will most likely be incorrect.

All of these uncertainties are a function of the spatial scale at which answers are sought. If the question is asked: "How much pumping at location X will propagate to river and spring reaches?" the answer can be determined with very little uncertainty, and independently of the limitations described above.

If refined estimates of above-Milner vs. below-Milner effects are required, the uncertainty depends on the location of the well. For wells distant from Milner, none of these conceptual simplifications are likely to materially affect the answer. For wells near to Milner, all of these affect the results and a different set of assumptions would be expected to produce a markedly different result.

Similarly, refining the question to include some understanding of the timing of effect begins to introduce additional uncertainty. The answer to "How much will propagate in time period Y" is less certain than "How much will eventually propagate," and results are sensitive to changes in conceptual simplifications.

Water Budget Data Limitations

IDWR, IWRRI and the ESHMC have expended much effort to refine input data, and ESPAM2.0 will include a number of improvements over ESPAM1.1. Nevertheless, there is still significant uncertainty associated with input data. Water budget data uncertainty derives from imprecise knowledge of the quantity, location and timing of fluxes of water. These propagate into uncertainty in the ability of the model to correctly predict the quantity, timing and location of effects from pumping, recharge or mitigation efforts. While a given percentage of uncertainty in a water-budget component does not translate directly to the same numerical uncertainty in model results, concepts of uncertainty should still inform deliberations of demiminus policy.

Quantity Uncertainty. In a modeling scenario,[ii] IWRRI calculated the standard deviation of the ESPAM1.1 aquifer water budget at approximately 440,000 acre feet per year. This translates to an expected range of uncertainty[iii] of plus or minus 880,000 acre feet, or about 17% of total annual flow through the aquifer. However, the estimated uncertainty of individual water budget components ranged as high as plus or minus 50 percent.

Spatial Uncertainty. The model uses one-mile grid cells, but this does not mean the spatial resolution of data is at a scale of one mile.

1. The location of individual irrigated parcels is derived from remote sensing data, with a precision of approximately 30 to 400 meters (including issues of georeferencing), depending on the data set.
2. Precipitation data are based on only a handful of weather stations distributed across 11,000 square miles, but are interpolated to a four-kilometer grid.
3. Recharge from precipitation on non-irrigated lands is derived from precipitation data and from generalized soils maps with a horizontal precision of perhaps one kilometer.

4. An important consideration of spatial uncertainty is the fact that evapotranspiration of irrigated crops is represented by a single crop mix and single reference evapotranspiration depth, per county.
5. Surface water diversion volumes are applied to entire groups of canal companies or irrigation districts, without data to inform more refined distribution.
6. Spatial distribution and total quantity of application of surface water to mixed-source lands is poorly understood.

Temporal Uncertainty. Diversion data from Water District 01 are available on a monthly basis. Diversion data for some non-Snake sources were obtained only on an annual basis, and were interpolated to monthly values. Estimates of tributary underflow volume were obtained on a long-term average basis and were interpolated to monthly values.

Effects of Water Budget Uncertainty. The model calibration process consists of adjusting model aquifer properties, and in the case of ESPAM2.0, water-budget inputs, to aid the model's ability to match observed targets. Imprecision in the water budget will affect the calculated model aquifer properties, which in turn affect the model's prediction of effects of pumping, recharge or mitigation.

Quantity imprecision in the water budget is likely to mostly affect the overall range of transmissivity and storage coefficient, and river and spring conductance values. This will have some effect on the model's ability to spatially distribute effects, and more effect upon its indications of timing of effects.

Spatial imprecision interacts with the conceptual model consideration of a locally uniform porous medium, spring hydraulics, the one-mile model grid cells, the number of pilot points, and the effort to calibrate to individual spring targets. While the excellent results obtained for many target springs are admirable, we submit that given the spatial imprecision of input data, these matches were only obtainable by false precision in the array of aquifer properties, and perhaps false precision in modifications to water-budget data. Combining this serious consideration with conceptual model limitations suggests to us that while the model *can* estimate effects at individual springs, it *should not* be applied to administrative decisions on an individual-spring basis. Similarly, the model *can* estimate on a cell-by-cell basis the effects of groundwater transfers, but transfer decisions *should not* be made on a single-cell basis.

The effects of temporal imprecision are analogous to the effects of spatial imprecision, but are compounded with concerns about the difficulty the calibrators have had in matching seasonal amplitude in some target springs. These suggest to us that while the model *can* be used to estimate effects on a monthly basis, it *should not* be used to make administrative decisions that hinge on monthly distribution of effects.

POLICY DISCUSSION

The concept of a Trim Line is essentially an identification of a deminimus standard below which groundwater rights will not be administered to satisfy a conjunctive administration delivery call. We believe it is similar in concept and nature to the concepts currently applied to groundwater-right transfer analysis, in both the minimum transfer distance which triggers analysis and in the minimum percentage change in modeled effect that requires mitigation. Both hinge upon the spatial and temporal resolution at which the model can be relied upon. This general policy discussion is meant to apply broadly to all these topics and specifically to the narrower "Trim Line" question. It is presented as a series of questions that EIWRC suggests must be further explored. We believe that these policy questions are weightier considerations than the modeling discussion presented above.

Questions

1. Can the Conjunctive Management Rules[iv] paragraph 010.07 definition of Futile Call provide guidance on a deminimus impact?
   1.1. If a well is curtailed where 10% of the foregone extraction benefits the target reach, this means that 90% of the foregone extraction does *not* benefit the reach. Does the criterion of preventing "waste of the water resource" apply to this reallocation of 90% of the groundwater pumper's water right to reaches where no relief has been ordered?
   1.2. When wells are distant from the target reach the benefits of administration are delayed. For instance, ESPAM1.1 indicates that if a well were administered at model cell Row 5 Column 106 (within the 10% Trim Line for Near Blackfoot to Milner), less than 0.1% of that reach's benefit would accrue the irrigation season that administration occurs. This extreme case leaves more than 99.9% of benefit to arrive after it has been determined to be needed. Should the criteria of satisfaction "within a reasonable period of time" inform the deminimus decision process?
2. Do Judge Wood's discussions[v] of providing relief "consistent with the exigencies of a growing crop during an irrigation season" and protection of "crops in progress, being green" inform the considerations of "reasonable period of time?"
3. Does the Idaho State Constitution[vi] provide guidance with its requirement that the legislature may provide "limitations [of priority of use] as to the quantity of water used and times of use... having due regard both to such priority of right and the necessities of those subsequent in time?"
   3.1. Does legislative adoption of the Conjunctive Management Rules satisfy the requirement of legislative provision?
   3.2. While the specifics of the discussion in the constitutional convention were different from the specifics of conjunctive administration, conjunctive administration was not yet contemplated at the time of the convention. Does the Constitution apply to general principles or only to specifics debated and considered by the convention?
4. The defacto assumption in transfer administration, without evaluation or analysis, is that any change in location or timing of effects of pumping will work injury. Is this justified?

RECOMMENDATIONS

1. The ESHMC and IDWR should adopt the list of elements of uncertainty proposed by Dr. Brendecke. All should be described qualitatively and where possible a quantitative estimate should be provided. Those amendable to more precise quantification (such as the water budget) should be further specified.
2. IDWR should proceed with the analysis of predictive uncertainty following guidelines published by Dr. John Doherty, author of the PEST software used in calibration of ESPAM1.1 and ESPAM2.0, using the outline proposed by Dr. Allan Wylie.
3. It is appropriate for the Department to consider some deminimus standard for water right administration. While model uncertainty must be part of this evaluation, it is the smaller part.
4. The spatial scope and scale of model application to administrative questions should be constrained by the factors presented in the model discussion above.

4.1. For administration of water delivery calls, the model should be used on a reach basis and not an individual cell basis.
4.2. Transfer analysis should be made on a zone basis.[vii] Fifteen to twenty zones should be considered.
4.3. Recharge within any of the transfer zones should be deemed applicable to mitigation requirements within the same zone, without discount or additional analysis.

5. The model should not be applied for administrative purposes to time scales finer than quarterly (three months).
6. The Department should consider University of Idaho work[viii] suggesting that transfers in aggregate tend to be in self-canceling directions. It would be very possible to set up a robust set of rule-of-thumb guidance principles (i.e. transfers moving in the eastward direction must mitigate by surrendering X% of the annual diversion volume per mile of change in location of POD; transfers in the westward direction must surrender Y%). Periodic modeling and review of the net effect of the prior period's transfers could allow adjustment of the guidance, while allowing transfers to proceed at low transaction cost to the applicant and low review cost to the Department.
7. No existing administrative decision, delivery call order, approved mitigation plan or approved transfer should be changed upon adoption of a new model. To do otherwise sets the Department up for endless review and reworking of old decisions and analyses, and deprives all parties of certainty in administrative decisions.
8. Administrative decisions relating to the effect of groundwater transfers on the Snake River should be considered in light of physical delivery of water and the practical effect upon delivery of surface water rights. Any transfer whose main consequence is to shift the location of pumping effects between the Henrys Fork and South Fork has no physical impact on the availability of water:

8.1. Any increase in effect to either reach will be accompanied by a corresponding reduction in effect to the other, so that the net effect below the confluence is zero;
8.2. Storage water is being delivered to downstream users at all times when priority administration would affect either reach; hence, carriage water is always available to physically sustain all in-priority uses above the confluence.
8.3. It is possible that current surface-water accounting would respond to the effects of the transfer in ways that result in harm. This could happen by causing a change in the priority cut calculated at either reach, even though adequate carriage water is present to allow physical delivery without harm. In this case we recommend that the appropriate response is not to deny the transfer but to update the accounting methodology.

9. We suggest that neither are technical staff the best people to provide policy input nor is the ESHMC the best forum. We encourage the Department to consider convening a policy advisory committee to provide non-binding policy input, so that the ESHMC can return to its original role of providing non-binding technical input. Ideally, stakeholders themselves and not representatives should be the members and attendees of such a group.

SUMMARY AND CONCLUSION

Eastern Idaho Water Rights Coalition appreciates the opportunity to provide input on the Trim Line, and on the use of the ESPAM1.1 and 2.0 models. We support the use of a deminimus standard in administrative decisions and applaud the Department's willingness to consider it.

Model uncertainty is one of many factors that must be weighed in this decision. We support evaluation of predictive uncertainty using the plan previously authorized by the ESHMC. We also encourage evaluation of other sources of model uncertainty, acknowledging that in some cases the analysis can only be qualitative.

We urge the Department to be judicious in relying on model results, especially where very fine spatial or temporal resolutions are involved. We strongly recommend that the model not be used for administrative decisions to either single-grid cell or single-month resolution, even though it can be applied at these scales.

Respectfully Submitted,

W. Roger Warner, President
Eastern Idaho Water Rights Coalition

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[i] In ESPAM2.0 the innovation of two drains per model cell has been employed. This could have allowed introduction of a piecewise linear approximation of non-linear discharge, if the upper spring had been set at an elevation where it could dry and re-wet as water levels fluctuate through a normal range.

[ii] Donna M. Cosgrove and Bryce A. Contor, Nathan Rinehart and Gary Johnson. 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." http://www.if.uidaho.edu/~johnson/ifiwrri/projects.html#model

[iii] R. Lyman Ott. An Introduction to Statistical Methods and Data Analysis, Fourth Edition. 1993. page 90.

[iv] Idaho Administrative Code, Department of Water Resources. IDAPA 37.03.11 – Conjunctive Management of Surface and Ground Water Resources.

[v] In the Fifth District Court of Idaho, Case No. CV-2005-0000600, Order on Plaintiffs' Motion for Summary Judgment, July 2006.

[vi] Article XV Section 5

[vii] Donna M. Cosgrove and Gary S. Johnson, 2005. *Aquifer Management Zones Based on Simulated Surface-Water Response Functions,* Journal of Water Resources Planning and Management, ASCE. March/April 2005 pp. 89-100.

[viii] Gary S. Johnson, Bryce A. Contor and Donna M. Cosgrove, 2008. *Efficient and Practical Approaches to Ground-water Right Transfers Under the Prior Appropriation Doctrine and the Snake River Example,* Journal of the American Water Resources Association Vol. 44 No. 1 February 2008, pp. 27-36